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- **The International Conference on Applied Sciences – ICAS 2019**, organized by University Politehnica Timisoara – Faculty of Engineering Hunedoara (ROMANIA) and University of Banja Luka, Faculty of Mechanical Engineering Banja Luka (BOSNIA & HERZEGOVINA), in cooperation with Academy of Romanian Scientists (ROMANIA), Ministry for Scientific and Technological Development, Higher Education and Information Society of the Republic of Srpska (BOSNIA & HERZEGOVINA), Academy of Sciences and Arts of the Republic of Srpska (BOSNIA & HERZEGOVINA), Academy of Technical Sciences of Romania – Timisoara Branch (ROMANIA), General Association of Romanian Engineers – Hunedoara Branch (ROMANIA) and Association Universitaria Hunedoara (ROMANIA), in Hunedoara, ROMANIA, 09–11 May, 2019. The current identification numbers of the selected papers are the #1–3, according to the present contents list.
- **The 9th International Conference on Industrial Engineering and Environmental Protection – IIZS 2019**, organized by Department of Mechanical Engineering, Department of Environmental Protection and Department of Industrial Engineering in Exploitation of Oil and Gas, Technical Faculty “Mihajlo Pupin” Zrenjanin, University of Novi Sad (SERBIA), in cooperation with partners University Politehnica Timisoara, Faculty of Engineering, Hunedoara (ROMANIA), University "St. Kliment Ohridski", Technical Faculty, Bitola (MACEDONIA), "Aurel Vlaicu" University of Arad, Faculty of Engineering, Arad (ROMANIA), University of East Sarajevo, Faculty of Mechanical Engineering East Sarajevo (BOSNIA & HERZEGOVINA) and University of Giresun, Faculty of Engineering, Giresun (TURKEY), in Zrenjanin, SERBIA, in 03–04 October, 2019. The current identification numbers of the selected papers are the #9–12, #18–21 and #24–25, according to the present contents list.

Also, the **ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering, Tome XIII [2020], Fascicule 1 [January–March]** includes original papers submitted to the Editorial Board, directly by authors or by the regional collaborators of the Journal.



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NEW SEVERE PLASTIC DEFORMATION METHOD FOR 316L MEDICAL GRADE STEEL PROCESSING NEW SPD METHOD FOR 316L STEEL PROCESSING

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Abstract: In this paper, a new method for bulk severe plastic deformation (SPD) processing is presented. The method is based on upsetting of prismatic samples in axial direction until it reaches certain height, while the length is increased along the mould length. Since the width of the sample is constant, the plane strain state in the sample is present. After first upsetting, the sample is rotated for 90 degrees and is upset again. Number of upsetting passes depends on material failure and total accumulated plastic strain for the upsetting process is calculated as a sum of strains per upsetting pass. The material chosen for this study is 316L steel, widely used for medical implants. Review on this subject at SCOPUS database showed that severe plastic deformation on 316L steel is scarcely used. Therefore, the results of this research would be promising. After the upsetting at room temperature, material exhibit improved tensile strength and microhardness, while workability is slightly reduced. Improved mechanical properties allow to reduce the dimensions of implants made of the SPD processed materials compared to conventionally produced implants, while keeping the same implant function. Smaller implant dimensions mean faster post operational recovery time for patient and less intrusion in patient's body during surgical operations. Additional advantage of the new die presented in this study is that the die can be also used for workability examination for triaxiality stress ratio $\beta \sim -1.73$.

Keywords: severe plastic deformation, plane strain compression die, 316L stainless steel

INTRODUCTION

The research conducted by Hall [1] and Petch [2] in the 1950s, revealed that for the improvement of material properties it is necessary to significantly reduce the crystal grain size of the material. That fact attracted the interest of many scientists and engineers around the world [3]. One of the benefits of this is that the increase of material strength allows reducing the weight of the parts.

Shaping the material by certain metal forming methods, such as cold extrusion, forging, bending and others, slightly change the grain size compared to undeformed billet. However, metal forming processing, such as drawing and rolling, refine the grains in some local zones up to submicron dimensions [4]–[6]. The disadvantage of those methods, from the crystal uniformity standpoint, is that fine grains occupy just a small amount of total volume of the part and refinement process is not possible to control [7].

Processes that can generate fine grains are vapor deposition, fast solidification, high-energy ball milling and severe plastic deformation (SPD) [3], [8]. Severe plastic deformation is a metal forming method in which high values of plastic strain is introduced into the part in high hydrostatic pressure conditions [9]. During SPD processing, three stages of crystal grain changes are present. In the first stage, existing grains are getting elongated, while subgrains are being formed inside the grains, creating low angle

grain boundaries. The second stage is characterized by the formation of high-angle boundaries by the division of existing subgrains. Elongated grains in the third stage are becoming refined from the effect of strain localization and shear bands [3]. These stages are not found with conventional metal forming processing that usually exhibits microstructure with elongated grains low-angle boundaries. While the increase of yield and ultimate tensile strength is usually accompanied by the reduction of workability, this may not always be the case for the material processed by SPD [10].

The advantages that processing by SPD offers may be very interesting for the medical industry as well. Implants have been used since early times, but back then one of the major problems was rejection by the human body [11]. This was due to poor biocompatibility and low corrosion resistance. Nowadays many different types of materials (organic and nonorganic) are being successfully used for implants and metal-based biomaterials are usually used for hard tissue substitution or rehabilitation and for total joint substitution. Stainless steel, cobalt alloys, titanium and titanium alloys are the most used metallic materials for medical implants. Biocompatibility, corrosion resistance, material strength, fatigue endurance and impact toughness are the most important implant properties. For example, high values of tensile and fatigue strength of implants made of titanium alloys ensure high durability of

implants [12]. To further increase the durability and to prevent or extend revision surgery, implants that exhibit even higher fatigue characteristic are demanded. As an example, 50 MPa increase of fatigue limit, increase the fatigue life of an implant for a number of times. Another example is the application of UFG CP Ti for increased fibroblast growth (major cells that are responsible for the creation of collagen, glycoaminoglycans, and proteoglycans [13]) compared to CG CP Ti. Increased fibroblast growth is linked with shorter recovery time and better integration of implants with the patient body [14]. The use of UFG CP titanium for dental screws helped to reduce the diameter from 3.5 to 2.4 mm, making it possible to be used with the front teeth and on children.

When manufacturing the implants by metal forming technologies [15], [16], workability of the processed metal is of great importance. High workability help to impose high values of strains and create the desired shape of the product and without material failure [17]. The workability can be described as a correlation of limit strain (φ_{elim}) on the average triaxiality factor (β_{avg}). However, despite advances that processing by SPD offers, there are just a few dozen of papers that cover the subject of severe plastic deformation, 316L stainless steel and workability.

The laboratory for metal forming at Faculty of Technical Sciences, University of Novi Sad is conducting the research on severe plastic deformation and workability as well. In the laboratory, the V-shape dies were developed that can be successfully used as an SPD method [18] and for workability determination [19]. The new dies presented in this paper, “Plane strain compression dies”, can be used to initiate severe plastic deformation in processed metal, but can be also used for the determination of the workability for average triaxiality factor β_{avg} value about $-\sqrt{3}$. In this paper, the detailed information about the dies is presented.

MATERIALS AND METHODS

The cross section of the plane strain compression die is presented in Figure 1. SPD processing is carried out as following: prismatic sample (3) is upset in the axial direction by a punch (1) until it reaches a certain height, while the length is increased along mould (2) length. Since the width of the sample is constant, plane strain state in the sample is present. After first upsetting, the sample is removed from the dies, rotated for 90 degrees, reinserted between into the die and upset again.

A number of upsetting passes depend on material failure. When the sample is pressed by the punch, the height is reduced, the length is increased and material flow in axial direction occurs. In order to reduce the friction between the sample and the mould and to

facilitate the material flow during upsetting, stearine is inserted in between. High values of strain can be imposed into the sample by repeating these compression passes. The working parts of the die are made of X210Cr12 steels, while the rest of the parts are made of 42CrMo4.

The dies are mounted on hydraulic press Sack & Kiesselbach 6.3 MN and the upsetting is conducted at room temperature, with punch speed of 1 mm/s (Figure 2). CAD and finite element method (FEM) were used to optimize die geometry.

Prismatic samples (20 x 20 x 14 mm) were made of 316L stainless steel. In order to retain the stearine between the sample and the mould, a small amount of the material (0.2 mm) was removed from the sample (Figure 3). During upsetting, low friction also makes strain distribution in sample more uniform.

One of the tests that can be used to determine the workability of processed material is upsetting of cylindrical samples by flat plates. The cylindrical samples are machined from upset prismatic samples. The dimensions of the cylindrical samples are presented in Figure 4a.

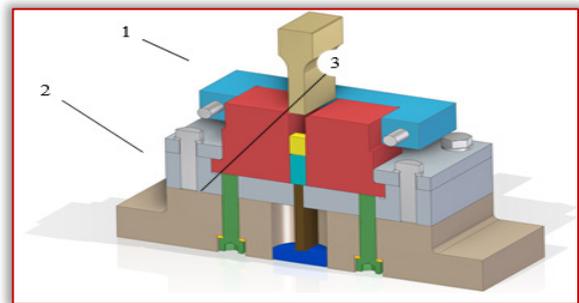


Figure 1. Section of the die CAD model; 1 - punch, 2 - mould, 3 - sample



Figure 2. Plane strain compression die mounted on hydraulic press

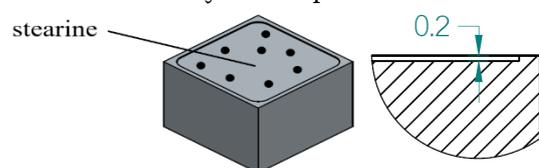


Figure 3. A CAD model of the sample and pocket height

During the workability test, the friction is present on contact surfaces and material cracking occurs at free surface in the equatorial area. Because of that, the calculation of stress components is relatively easy since $\sigma_r = 0$ which means that plane stress condition is present [19, 20].

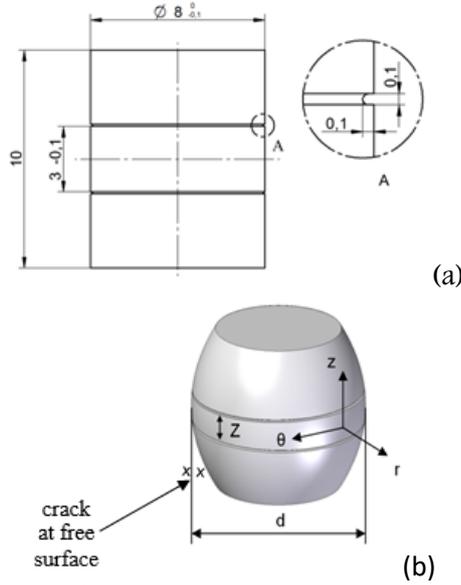


Figure 4. Cylinder dimensions (a) and crack at free surface (b)

In order to calculate the stress-strain state at the site of material crack during cylinder upsetting, the change of cylinder diameter (d) in the equatorial zone and the change of the height of zone (Z) where the crack is about to initiate, is measured for each upsetting pass (Figure 4b). Logarithmic strains in tangential, radial and axial directions can be calculated by Eq.(1), while an effective strain is calculated by Eq.(2). Letter i refers to the current, while $i-1$ refers to the previous upsetting pass.

$$\varphi_{\theta i} = \ln\left(\frac{d_i}{d_{i-1}}\right), \quad \varphi_{z i} = \ln\left(\frac{Z_i}{Z_{i-1}}\right), \quad \varphi_{r i} = -(\varphi_{\theta i} + \varphi_{z i}) \quad (1)$$

$$\varphi_e = \frac{\sqrt{2}}{3} \cdot \sqrt{(\varphi_r - \varphi_\theta)^2 + (\varphi_\theta - \varphi_z)^2 + (\varphi_z - \varphi_r)^2} \quad (2)$$

After that, the history of deformation in the tangential and axial direction is plotted and strain component ratio α is calculated by Eq.(3):

$$\alpha = \frac{d\varphi_\theta}{d\varphi_z} \quad (3)$$

Strain ratio is used to calculate stress in the tangential and axial direction (Eq.(4)) and to calculate triaxiality factor β as well (Eq. (5)).

$$\sigma_\theta = \sigma_z \cdot \left(\frac{1+2\cdot\alpha}{2+\alpha}\right), \quad \sigma_z = -K \left[1 - \frac{1+2\cdot\alpha}{2+\alpha} + \left(\frac{1+2\cdot\alpha}{2+\alpha}\right)^2\right]^{\frac{1}{2}} \quad (4)$$

$$\beta = \frac{\sigma_\theta + \sigma_z}{K} \quad (5)$$

The average value of triaxiality factor β_{avg} is essential for the construction of the workability diagram,

where the dependence of β_{avg} on φ_{el} is presented. The average value can be calculated by Eq.(6).

$$\beta_{avg} = \frac{1}{\varphi_{e\lim}} \int_0^{\varphi_{e\lim}} \beta(\varphi_e) \cdot d\varphi_e \quad (6)$$

RESULTS AND DISCUSSION

The distribution of effective strain at the longitudinal cross-section of the sample in plane strain upsetting conditions obtained by FEM is presented in Figure 5. Three different locations at cross-section were chosen: center, near free surface and half-distance between the center and free surface. Upsetting was conducted in five passes, with a total punch stroke of 43.9 mm. The stroke for the first pass was 4 mm, while the strokes for the rest of the passes were 10 mm.

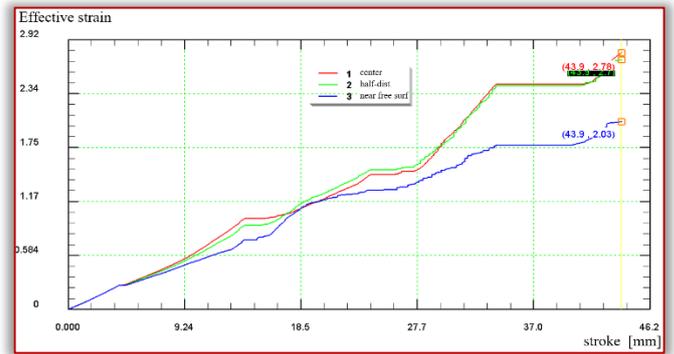


Figure 5. Effective strain distribution at sample cross-section in three different locations

Few conclusions can be drawn from FEM results. Firstly, it can be observed that the effective strain uniformity is very good – the difference between the center (2.78) and free surface (2.03) is not so pronounced. Secondly, the difference between strain value at the center and a half distance from the center (2.7) is almost insignificant and this may be due to the consecutive rotation of the sample between the passes. Finally, these values of effective strain and the change of strain path can lead to severe plastic deformation and grain refinement.

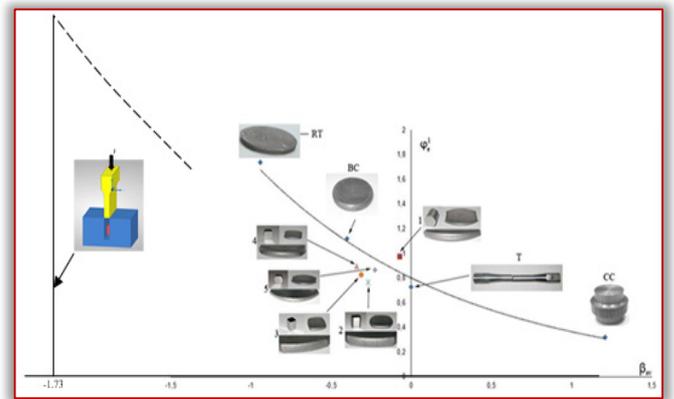


Figure 6. The position of Plane strain compression process in workability diagram [20]

This die can also be used for workability determination in stress conditions near $-\sqrt{3}$ (Figure 6).

Obtained workability is valuable for metal forming processing under these stress conditions.

CONCLUSION

- Upsetting by Plane strain compression dies can be successfully used as an SPD method
- Effective strain uniformity is very good – center (2.78), half distance (2.7) and near the free surface (2.03)
- The dies can be also used to determine workability for $\beta_{avg} = -1.73$

Acknowledgments

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Note:

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INVESTIGATION OF THE CONTACT STRESSES ON THE END FACES OF THE DRILL PIPE CONNECTION THAT INCLUDES THE TAPERED THREAD MANUFACTURED BY THE CUTTER LATHE TOOL WITH THE SPECIALLY MODIFIED CUTTING EDGE

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Abstract: Drilling tool joints are being manufactured using technology of turning machining. The result of this technology is the existence of a screw-shaped gap. The value of the pressure drop in the medium of the drilling fluid depends on the size of cross-section of this gap. In the case of the initial stage of permeability because the small looseness between the face ends of the pin and box appear, the pressure drop between the start and end of the screw gap can be 10 times. If the thread is made by using of the specially-profiled cutter it is possible to achieve a reduction in the height of the across section of gap by three times. In this case, in condition of the initial loss of tightness the pressure drop in the screw gap can be 100 times. Therefore the contact pressure between the face ends of the pin and the box at a consider torque value in the tapered thread increases relative to the normal state of tightness. The magnitude of the contact pressure increase in the case of partial permeability can reach a value of 1-10%.

Keywords: contact pressure, turning, tapered thread, tightness

RELEVANCE OF THE PROBLEM

Tightness is one of the operational parameters of a drill string. A drilling mud solution is pumped inside a drill string under a pressure up to 10 - 20 MPa. Its purpose is to rinse the drill bit from the sludge and transport it from the depths to the surface of the ground. The drill string consists mainly of drill pipes which are connected by means of drilling tool joint which consist of box 1 and pin 2 (Figure 1). Quickly screwing of pin and a box is possible due to tapered thread.

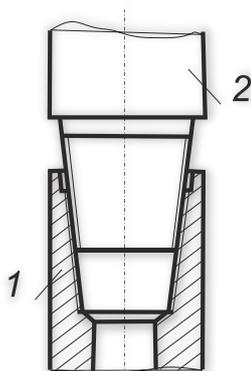


Figure 1. Scheme of drill tool joint.

Marking: 1 – pin, 2 – box

The existence of a gap between the thread surfaces of the pin 1 and the box 2 (Figure 2) is on the obstacle of tightness ensuring. Due to the Interference fit screwing the box and the pin the process of tight closing of the face ends of the box 4 and the pin 5 with each other is provided (Figure 2). So the tightness is ensured by the quality of the face end manufacturing.

It is because of the tight adjoining of these two ends of each other that avoiding the flow of the part of the drill solution from the inside tube to outwards is avoided. But thanks to the screw gap and deformation processes on the face ends that accompany the multiple process of screw driving of the drill pipes initially partial, and then the full depressurization of the connection occurs. Complete loss of tightness is the reason for replacing the drill pipe, or repairing of it.

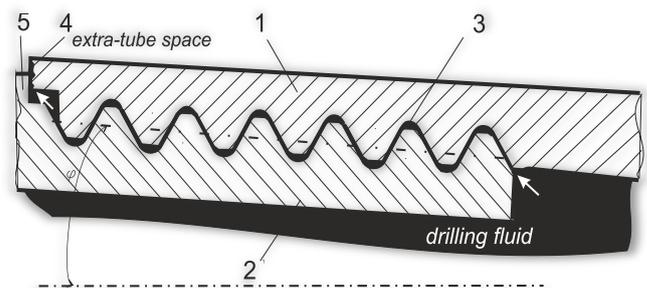


Figure 2. Scheme of screwing gap in the drilling tool joint

Modern manufacturers of drilling tool joints use for it the process of turning [2]. Accordingly, the shape and size of the screw gaps must be provided by turning tool. In papers [3, 4] it is a question of the effect of the cross-sectional dimension of these gap channels on reducing the velocity of drilling mud solution in it during the first manifestations of permeability between the face ends of the pin and box. Decreasing the velocity may cause reducing of wearing on the thread surface because abrasive

influence [4]. At that time, the operability of the drilling fluid which is the non-Newtonian fluid [5] may be such that, the pressure of the drilling mud in it can reduce if the cross-sectional dimension of the gap channel decreases. Therefore, it is important to determine the influence of the shape of the channel, and profile the cutting edge of the cutter to ensure the tightness and the value of contact pressure between the ends of the pin and box.

2. LITERATURE REVIEW

In the works [6, 7] the calculating of the moment of screwing of the drilling tool joint, taking into account the pressure of the drilling mud, acting both in the inner of the pipe itself and in the gap channel is offered. Figure 3 shows the scheme for creating the required contact pressure between the ends of the box 1 and the pin 2.

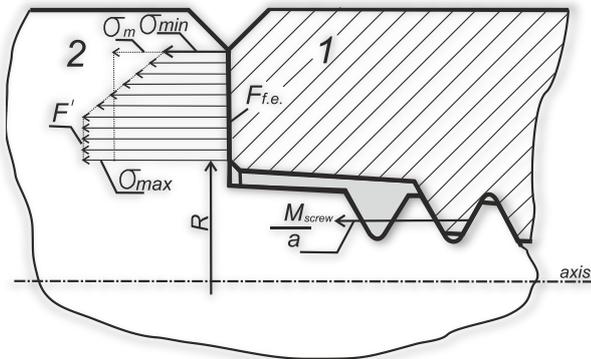


Figure 3. Scheme for determining the average contact pressure between the ends of the pin and the box in the screwed state of the drilling tool joint.

According to [6], the average contact pressure σ_m acting on the area $F_{f.e}$ must correspond to the equation (1):

$$\sigma_m = \frac{M_{screw} - (N + P_{m.s.} \cdot F_g) K_b}{F_{f.e} \cdot a}, \text{ (MPa)} \quad (1)$$

where:

M_{screw} – torque of the pin and the box screwing (Nm);

σ_m – average contact pressure at the face ends (Pa);

F_g – the value of the thread gap section area (m^2);

$P_{m.s.}$ – inside pressure of the mud solution (Pa);

N – external axial gravitational load (N);

a – constant value of the drilling tool joint, which takes into account the geometric dimensions of the tapered thread and screwing conditions (m).

If formula 1 is solved with respect to M_{screw} then it has the following form

$$M_{screw} = (\sigma_m F_{f.e.} + (N + P_{m.s.} \cdot F_g) K_b) a, \text{ (kNm)}$$

In the works [7, 8], it is proposed that the torque of screwing be solved using a slightly different formula:

$$M_{screw} = (k \cdot \sigma_m F_{f.e.} + N \cdot K_b + \psi \cdot P_{m.s.} \cdot F_g) \cdot a, \text{ (kNm)} \quad (2)$$

where:

$$a = 0,16 \cdot P + 0,5\mu'(D_p + 0,866 \cdot D_m), \text{ (kNm)} \quad (3)$$

P – pitch of thread;

D_p – mean diameter in a main plane of a tool joint;

D_m – mean diameter in a face end section;

μ' – coefficient of friction at the thread surfaces, which is 0,09 for thread screwed with oil P-416, is 0,14 for covered thread and is 0,3 for dry surface;

ψ – coefficient of tightness of adjoining. According to [8] it should be taken $\psi = 1,5 \dots 3$;

K_b – coefficient of external load of the drilling tool joint;

k – ratio of optimal tightening stresses and the boundary of fluidity of the connection material box which can be defined empirically [7, 8]. Figure 4 shows a graph for determining the coefficient k .

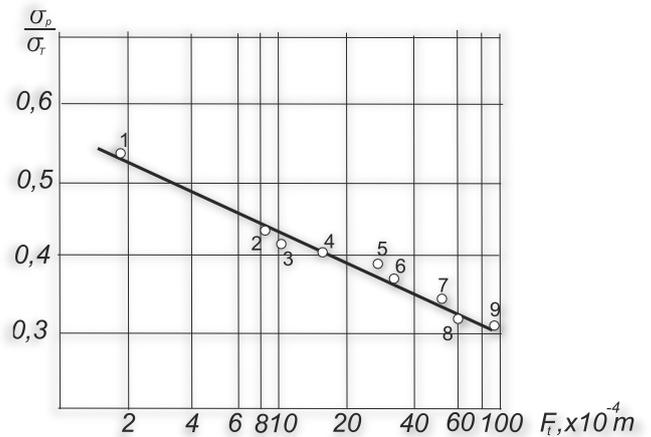


Figure 4. Definition diagram of the ratio of optimal tightening stresses and the boundary of fluidity of the connection material box

According to [7, 8, 9], the area of F_g and $F_{f.e}$ are calculated in cross-sections according to the scheme shown in Figure 5.

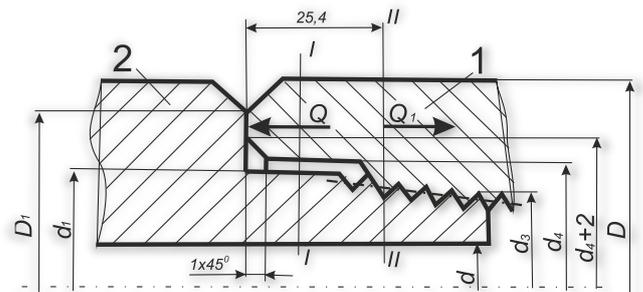


Figure 5. Scheme of the distribution of the clamping force components in the screwed state of the drill tool joint

So $F_{f.e}$ is the area near the face end of the box in the section I. The force Q acts in it. According to [7] Q is a component of formula 2:

$$Q = \sigma_m F_{f.e.}, \text{ (kN)} \quad (4)$$

In this section, the area $F_{f.e}$ is defined by the formula:

$$F_{f.e.} = \frac{(D^2 - d_4^2) \cdot \pi}{4}, \text{ (m}^2\text{)} \quad (5)$$

Section II passes through the root of a pin which contacts with the first thread of the box. In this section papers [7, 9] suggest calculating the value of F_g according to the corresponding formulas. The

component-force Q_1 acts in it. It in accordance to [7] is the element of formula 2:

$$Q_1 = N \cdot K_b + \psi \cdot P_{m.s.} \cdot F_g, \text{ (kNm)}, \quad (6)$$

In this section, the area F_g is defined by the formula:

$$F_g = \frac{((d_1 - 2H)^2 - d^2) \cdot \pi}{4} \text{ (m}^2\text{)}, \quad (7)$$

Reference [9] provides value on the data: a , F_g , F_{fe} , μ' , K_b for various types of drilling tool joint.

The studies presented in [6, 7, 8, 9] take into consideration the effect of value $P_{m.s.}$ on the magnitude of the torque of the M_{screw} . The specified value characterizes the internal hydrostatic pressure. It is thanks to it the pipes are tested for tightness using water or other liquid as a medium for transferring this pressure to all sides inside the drill string, including in the drilling tool joint. By the law of hydrostatics, the internal pressure of the liquid in the section I, section II and in the inner part of the pipe with the diameter d are the same. Thus, using the formulas 2, 3, 4, 5, 6, 7, it is possible to determine the value of the contact pressure at the box-pin face ends under conditions of complete tightness using the formula:

$$\sigma_m = \frac{M_{screw}}{a} - \frac{(N \cdot K_b + \psi \cdot P_{m.s.} \cdot F_g) K}{F_{f.e.}}, \text{ (KPa)} \quad (8)$$

However, in reality, the drilling fluid is not Newtonian fluid, which is water. This means that if the first signs of fluid leakage appear because of the non-tensions between the face ends of the box and the pin, then the laws of hydrodynamics come into force.

RESEARCH METHODOLOGY

— Simulation of the operability of the drilling fluid in the screw channel between the thread surfaces of the pin and the box

As in [3, 4], a virtual experiment to simulate the operability of a drill fluid is carried out in a Flow Simulation environment, under similar conditions for the tool joint tapered thread NC26:

- # input and output of the channel are extended by rectilinear sections and finished with end faces for the possibility of creating virtual stubs LID1 and LID2;
- # type of analysis is internal, since the working fluid is liquid and limited by the walls of the solid. The heat exchange is not taken into account, considering that the solid is cooled intensively by the flow of the solution through the central hole of the drill string and from the outside;
- # parameters of the drilling solution: density 1200 kg/m^3 and initial kinematic viscosity 10 sSt . The viscosity change characteristics are based on the Herschel-Balkley rheological model (Figure 6);
- # the boundary conditions of the study are the pressure on the internal face of the input lid, equal

to 10, or 5 MPa, and the pressure of the external medium (on the inner face of the initial cover), equal to atmospheric - 0,1 MPa;

- # because the small size of the channel it is given rather high (the sixth in the gradation of automatic adjustment) the degree of split into the elements.
- # the dimensions of the channel are applied as standard, and are executed with the help of a cutter, which makes it possible to reduce the cross-sectional area of the screw channel 2-3 times.

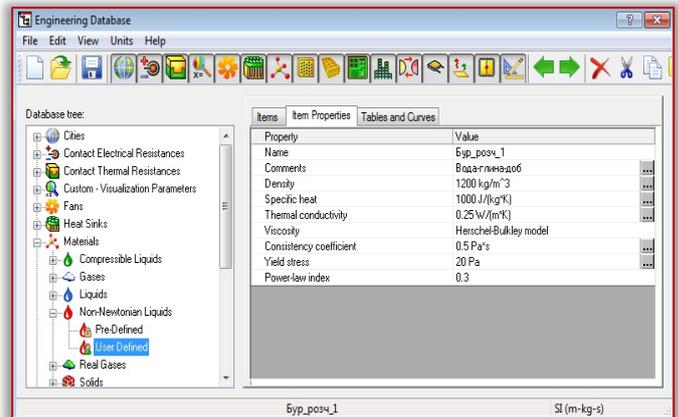


Figure 6. Fragment of the Float Simulation application with the parameters of the mud solution

RESEARCH RESULTS

The subject of the study in this experiment is the pressure. Figure 7 shows the diagram of the pressure distribution along the screw gap channel in the drilling tool joint with tapered thread NC26 in accordance to the standard API 7.

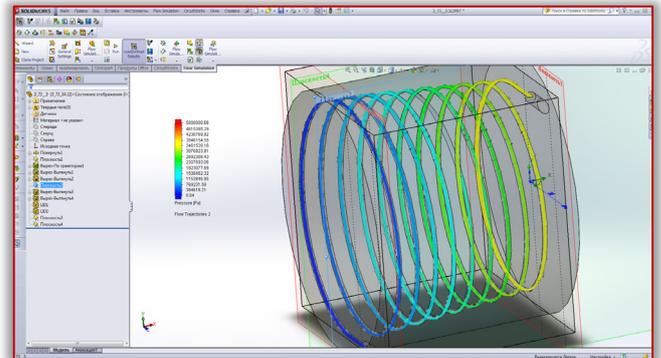


Figure 7. Distribution of pressure in a screw gap with a standard value of the cross-section

— Distribution of drilling fluid pressure in a channel with a cross section of normal size

Investigations show the absence of gaps in jets. Input pressure of central part of pipe 5 MPa due to a sharp decrease in cross-section of gap channel falls to 3.8 MPa. (yellow colour in the diagram). At the final thread (the largest diameter), the pressure dropped to a value of 0, 38 MPa. It indicates a pressure drop of 10 times in the process of flowing through the screw channel.

— Distribution of drilling fluid pressure in a channel with a cross section of smaller size

According to studies [10], the profile of the section can be obtained by lathe tool cutter in such a way that the working height of the profile h is greater than the usual one. Newly designed thread has the working height h^* .

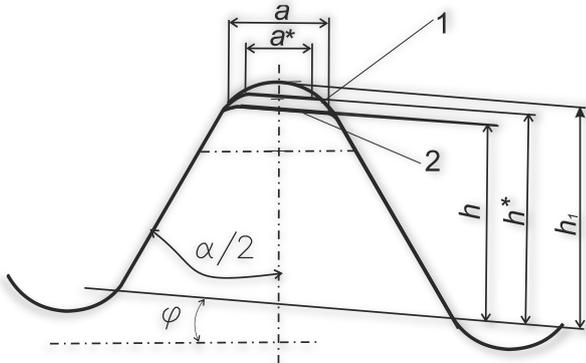


Figure 8. Scheme illustrating the technology of reducing the cross-sectional dimensions of the screw gap

Thus, the screw channel sharpened by means of a modernized profile cutter has root flat $a_1 = 1$ mm. But usual cutter has standard size of root flat $a = 1,65$ mm. Figure 9 shows new small ABCD gap (gray colour) against the background of the old DEF gap (shaded). Thus, the technological gap is suggested to decrease by 0,328 mm, that is, from $h_1 - h = 0,462$ mm to $h_1 - h^* = 0,134$ mm, which reduces the gap by 71% [11]. In this case $\delta = 0,328$ mm.

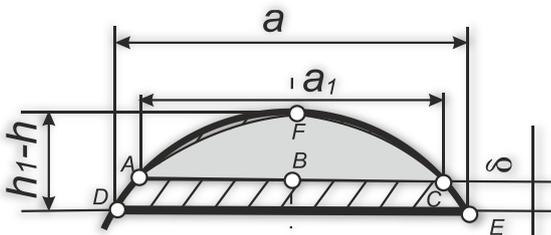


Figure 9. The exact scheme of reducing the cross-section of technological channel

Figure 10 shows a diagram of the distribution of pressure in a screw channel whose cross section is made as in Figure 9.

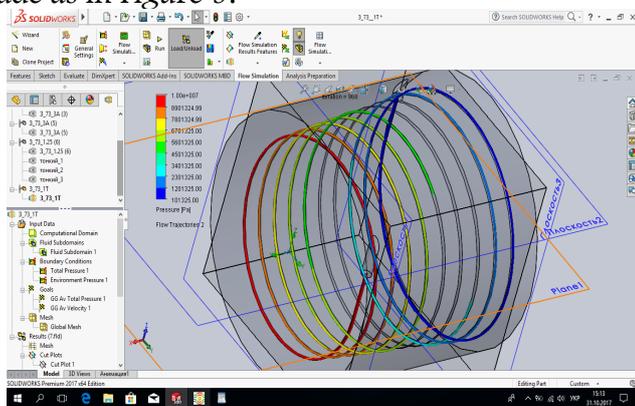


Figure 10. Distribution of pressure in the technological gap with a reduced cross-section

Investigations show the absence of gaps in jets. Input pressure of central part of pipe 10 MPa (red colour in the diagram) due to a sharp decrease in cross-section of gap channel falls to 0,1 MPa. (blue colour in the diagram). It indicates a pressure drop of 100 times in the process of flowing through the screw channel.

— Design scheme for determining the clamping force of the ends of the box and the pin during initial loss of tightness

According to studies of the distribution of pressure in the screw channel, which are illustrated by the diagrams in Figure 7 and 10, the authors suggest an alternative schema to the figure shown in Figure 5 for calculating the force of the clamping and contact pressure between the face ends of the pin and the box. Thus, in Figure 11, in addition to the figures 5 of the sections I and II, section III is also shown. This section passes through the plane of the smaller base of the pin. The first thread of the screw channel is located in it. According to the research in Figure 7 the last thread of the connection between the pin and box is placed in section II. Therefore, in the case of partial depressurization, the pressure in the drilling fluid between the planes I and II (grey medium in Figure 11) falls to 0,38 MPa and even to 0,1 MPa. Therefore, according to the authors, the component-force Q_1 in the section II is less than in the absence of the least depressurization, that is, in hydrostatic pressure conditions. [10]

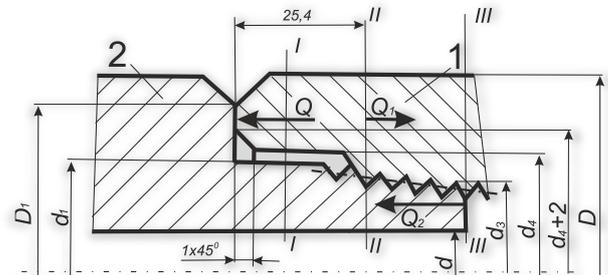


Figure 11. Scheme of distribution of clamping component-forces in screwed state of the drilling tool joint in the condition of partial depressurization. Instead, the hydrostatic pressure $P_{m.s}$ acting in the drilling solution effects on the inner end of the pin in the section III. It is the reason the component-force of Q_2 appears. It acts in the same direction as Q . It can be calculated by the formula:

$$Q_2 = \psi \cdot P_{m.s} \cdot F_2, \text{ (kN)}, \quad (9)$$

where: F_2 – area dimension of the smaller base of the pin. It can be calculated by the formula:

$$F_2 = \frac{((d_3 - 2H)^2 - d^2) \cdot \pi}{4} \text{ (m}^2\text{)}, \quad (10)$$

where: H – height of fundamental triangle of thread, mm.

Consequently, the contact pressure on the face end of the pin and box can be calculated by the formula:

$$\sigma_m = \frac{M_{\text{screw}} - (N \cdot K_b - \psi \cdot P_{m.s.} \cdot F_2)K}{a \cdot F_{f.e.}}, \text{ (KPa) (11)}$$

— **Examples of calculation of the value of the contact pressure for the pin-box face ends of the drilling tool joint of ZU108 in condition of hydrostatic pressure and in condition of the initial loss of tightness**

In the example, the reduced section of the screw gap is applied as in paragraph 3.2. Therefore component-force Q_1 is calculated without taking into consideration the action of the hydraulic pressure of 0.1 MPa in section II.

Table 1. Data for calculating the value of the contact pressure at the pin-box face ends of the drilling tool joint ZU 108

No	Name of dimension	Symbol of dimension	Value of dimension
1	Coefficient of tightness of adjoining	ψ	1,5
2	Coefficient of friction at the thread surfaces	μ'	0,14
3	Coefficient of external load of the drilling tool joint	K_b	0,64
4	Ratio of optimal tightening stresses and the boundary of fluidity of the connection material box	k	0,4
5	Constant value of the drilling tool joint, which takes into account the geometric dimensions of the tapered thread and screwing conditions (m)	a	0,0127
6	Torque of the pin and the box screwing (Nm x 10 ³)	M_{screw}	20 or 6
7	Inside pressure of the mud solution (Pa x 10 ⁶)	$P_{m.s.}$	10
8	Area dimension of the smaller base of the pin (m ² x 10 ⁻⁴)	F_2	8,91
9	External axial gravitation load (N x 10 ⁴)	N	10
10	Minor diameter of a drilling tool joint (m x 10 ⁻³)	d	54
11	Diameter of the minor base of the pin (m x 10 ⁻³)	d_3	71,29
12	Major diameter of a drilling tool joint (m x 10 ⁻³)	D	108
13	Diameter of a drilling tool joint in a face end section (m x 10 ⁻³)	D_1	103,5
14	Diameter of the major base of the pin (m x 10 ⁻³)	d_1	86,13
15	Inside diameter of a box in a face end section (m x 10 ⁻³)	d_4	87,7
16	Height of fundamental triangle of thread (m x 10 ⁻³)	H	5,487
17	Pitch of thread (m x 10 ⁻³)	P	6,35
18	Area of the across section on the face end I_I (m ² x 10 ⁻⁴)	$F_{f.e.}$	32,6
19	Area of the across section on the first thread of a box II_II (m ² x 10 ⁻⁴)	F_g	22,5

Table 1 summarizes all the necessary data for calculating the contact pressure in both full tightness and partial permeability conditions.

The datum row number 8 is calculated by the formula 10. Data rows No. 5, No. 18, No. 19 are derived from reference data [9] and can be calculated using formulas 3, 5, 7. Datum row No. 4 is derived from reference datum [9] and can be defined from Figure 4.

After substituting data from table 1 in formulas 8, 11, the following results are obtained:

At $M_{\text{screw}} = 20 \times 10^4 \text{ Nm}$, the contact pressure at the box-pin cross-section is $400 \text{ Pa} \times 10^6$ (formula 8) in the case of full tightness and is $406 \text{ Pa} \times 10^6$ (formula 11) in the case of partial permeability.

At $M_{\text{screw}} = 6 \times 10^4 \text{ Nm}$, the contact pressure at the box-pin cross-section is $61,5 \text{ Pa} \times 10^6$ (formula 8) in the case of full tightness and is $68 \text{ Pa} \times 10^6$ (formula 11) in the case of partial permeability.

Consequently, the growth of contact pressure can be from 1.5% to 10.5%.

CONCLUSIONS

— Tapered thread is machined by turning tool. As a result this thread has a screw gap channel. Their across dimensions are dependent on profile of cutting edge. The value of the pressure drop inside of the drilling fluid in this gap depends on these dimensions. According to the hydrodynamic conditions in the medium of the drilling fluid, that is, if there is a slight permeability from the non-densities between the ends of the pin and the box face ends, the pressure drop in the screw gap channel may have 10 times the dimension. If to make the tapered thread using the tool with the special profile of the cutting edge, then it is possible to achieve a reduction in the height of the gap three times: from 0,460mm down to 0,140 mm. In this case, if there is also a slight permeability, then the pressure drop in the screw gap can be 100 times.

— Under normal hydrostatic conditions, the contact pressure between the ends of a pin and a box does not depend on the across dimension of the screw gap. In the event of an initial depressurization, the contact pressure at a consider torque value increases relative to the same pressure in hydrostatic conditions of the drilling solution. The magnitude of the this increase is 1,5 up to 10%.

Note:

This paper is based on the paper presented at International Conference on Applied Sciences – ICAS 2019, organized by University Politehnica Timisoara – Faculty of Engineering Hunedoara (ROMANIA) and University of Banja Luka, Faculty of Mechanical Engineering Banja Luka (BOSNIA & HERZEGOVINA), in Hunedoara, ROMANIA, 09–11 May, 2019.

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IMPACT ANALYSIS OF ZIPLINE KINEMATIC PARAMETERS

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Abstract: This paper presents analysis of the influence parameters and the procedure for determining kinematic quantities of person traveling along zipline. Zipline is consisted of tightened rope by which the person is carried by high speed travelling trolley with aim of causing increased excitement. At first sight it is a very simple system, where in the case of small lengths the problem is solved by connecting the rope ends to the pylon (e.g. existing trees) and adjusting the inclination and motion parameters on the spot. But, for quality design and safe usage of longer zipline, it is necessary to perform a detailed analysis of persons kinematic parameters dependence from a range of influential sizes such as person's weight, tensile rope force, inclination angle, position during lowering, wheel resistance, wind, etc. This is especially important in case of long span and extreme inclination angle. The calculation itself is based on the catenary theory, while the analysis are made by computer simulations for concrete conditions of zipline whose installation was planned on Fruška Gora, Serbia. The size of above mentioned significant parameters were varied and the analysis results are given through diagrams that shows the person's speed characteristics.

Keywords: zipline, catenary, motion resistance, wind velocity

INTRODUCTION

Zipline represents a system where the anchoring points of carrying rope are at different heights, along which the trolley carrying a person is moving. Their original purpose was bridging of canyon or river, often only for lowering the cargo, while today they are more used for the purpose of entertainment as the so-called adrenaline sport.



Figure 1. Example of zipline

As it is a relatively new system, whose name has not settled yet, beside the mentioned zipline (which will be used in this paper), it is also known under the names such as: *aerial runway*, *aerial ropeslide*, *death slide* or *flying fox* in English, *Seilrutsche* in German, *Tirolienne* in French or *Guerillarutsche* in the Austrian.

They expanded over the past two decades, with construction in various locations such as hilly areas, parks, lakes, bridges, the city core, etc. [4].

Ziplines are mainly foreseen for individual lowering of persons, but there are few cases of ziplines where several persons are lowering side by side (never one behind other). Figure 1 shows an example of parallel zipline located in hilly area.

STATE OF THE ART

At the time, the world's longest zipline is *Jebel Jais Flight* in the United Arab Emirates with a length of 2832 m. Longest European zipline is *Stoderzinken* in Austria, which actually consists of two sections with total length of 2500 m. Zipline with the highest drop is *ZipFlyer* in Nepal, with a height difference of 610 m, [8]. However, although this is an imposing altitude difference, the inclination angle of the section ($\sim 18.7^\circ$) is not the greatest. The zipline with greatest inclination angle is the *Letalnica Bratov Gorišek*, within the same named ski jumping hill in Slovenia, which amounts 38% or $20,8^\circ$ [7].

According to [8], the highest achieved speed until 2015 amounts 235 km/h.

The most interesting movement parameters which should be determined are the maximum velocity, duration of travel, the travelled distance and the velocity at the end of the section ("velocity at limiter").

The most significant size that influences those parameters is the inclination angle. For inclination angle larger than 10° , high speeds are achieved at the section, but also at the entry of lower station which is a significant problem for safe stopping of the person. In cases of inclination angles lower than 5° , there is a problem with arriving to the lower station, especially in cases of unfavorable wind direction or changes of the area exposed to the air flow (body position, spreading of hands, etc.) during movement. For such cases, there is often a need for "pulling out" the person from the section.

FUNDAMENTALS FOR ANALYSIS

This chapter shows a short review of significant relations for the theory of so-called "horizontal rope",

which was developed for calculations of ropeways, cable cranes, overhead power lines, etc. More detailed can be seen in [2], [9] and [10].

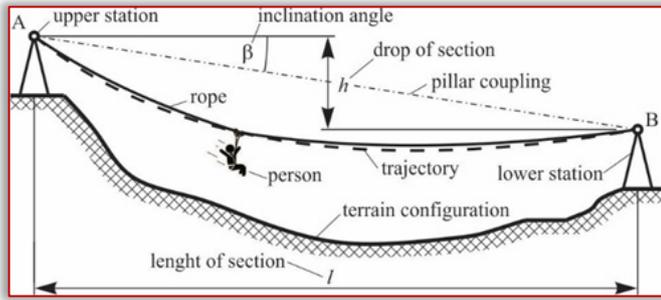


Figure 2. Route and zipline parameters

Figure 2 shows a zipline scheme with basic notations.

–Rope loaded by its own weight

Line that describes the position of the elastic flexible thread freely hanging between two supports located on the horizontal (l) and vertical (h) distance and loaded with its own weight is called a catenary.

The catenary equation can be obtained by observing the static equilibrium of forces shown in Figure 4.

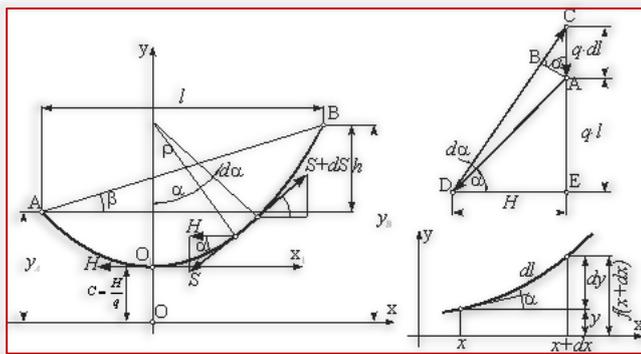


Figure 3. Catenary parameters [11]

Based on the static equilibrium equations that can be written for the elementary section of the rope, and after their rearrangement, the catenary equation is obtained as:

$$y = C \cdot \operatorname{ch}\left(\frac{x}{C}\right) \quad (1)$$

where the catenary parameter can be defined as:

$$C = \frac{H}{q}$$

where:

H - horizontal component of tension rope force,
 q - own weight of rope.

The difference of forces between any two points of rope can be determined by the expression:

$$\Delta S = S_B - S_A = q \cdot (y_A - y_B) = q \cdot h \quad (2)$$

The use of the catenary theory provides the correct solutions, but as the use of hyperbolic functions is relatively complicated, in the engineering practice the catenary is replaced by the appropriate parabola.

Figure 4 shows the possibility of replacing the catenary with a parabola. The errors in the size of the

deflections which are made by this approximation are 2 ÷ 3% (the deflections are smaller in case of parabola than in the case of a catenary). Accuracy can be increased by introducing a correction coefficient (k).

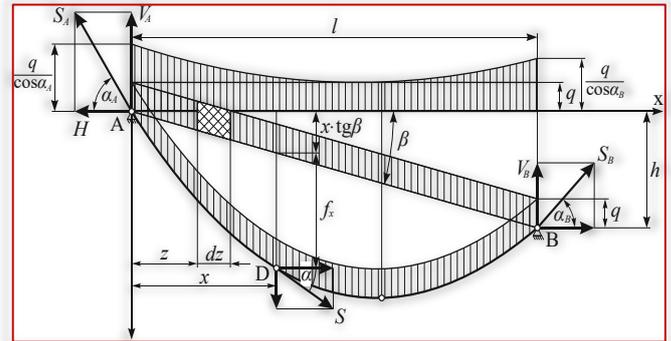


Figure 4. Parabola method [9]

Parabola method, obtains the equation of the curve as:

$$y = \frac{q \cdot x \cdot (l - x)}{2 \cdot H \cdot \cos \beta} \cdot k + x \cdot \operatorname{tg} \beta \quad (3)$$

where f_x represent deflection which is calculated as:

$$f_x = \frac{q \cdot x \cdot (l - x)}{2 \cdot H \cdot \cos \beta} \cdot k \quad (4)$$

where:

$k = 1 + \frac{\cos^2 \beta}{p} \cdot \left[\frac{1}{p} \cdot \left(x^2 - l \cdot x + \frac{l^2}{2} \right) - 2 \cdot (l - 2x) \cdot \operatorname{tg} \beta \right]$ - correction coefficient,

$p = \frac{H}{q} \cdot \cos \beta$ - parabola parameter.

–Rope loaded by its own weight and concentrated load

Unlike most of metal constructions like beams, frames or grids, where the influence of deformation on the static equilibrium is neglected, that is not the case for the “horizontal rope”, so the second-order theory must be applied.

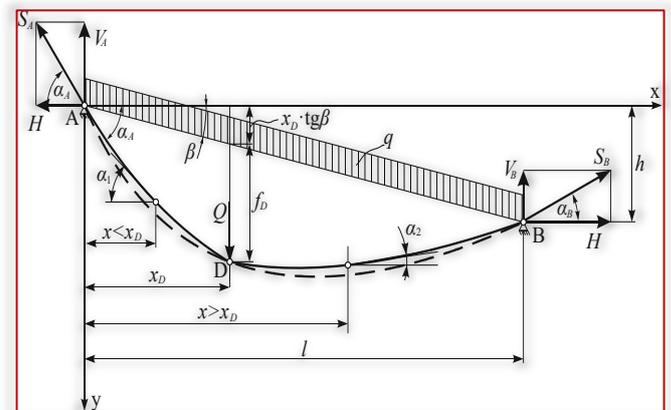


Figure 5. Rope loaded with its own weight and concentrated load [1], [9]

Observing the rope, whose supports are at different highs, which is loaded with its own weight and concentrated load (Q), the equation of the load trajectory, shown on Figure 5, can be presented as:

$$y = x \cdot \operatorname{tg} \beta + f_x \quad (5)$$

where the deflection at the distance x_D where the load is acting can be calculated as:

$$f_D = \frac{x_D}{l \cdot H} \cdot \left[Q \cdot (l - x_D) + \frac{q \cdot (l - x_D) \cdot l}{\cos \beta} \right] \quad (6)$$

while the maximal deflection is calculated by:

$$f_{\max} = \frac{l^2}{8H} \cdot \left(\frac{q}{\cos \beta} + \frac{2Q}{l} \right) \quad (7)$$

ANCHORING ROPE ENDS

There are two ways to achieve anchorage of the rope ends:

- both sided anchorage,
- anchorage at one end and tightening with the weight at other.

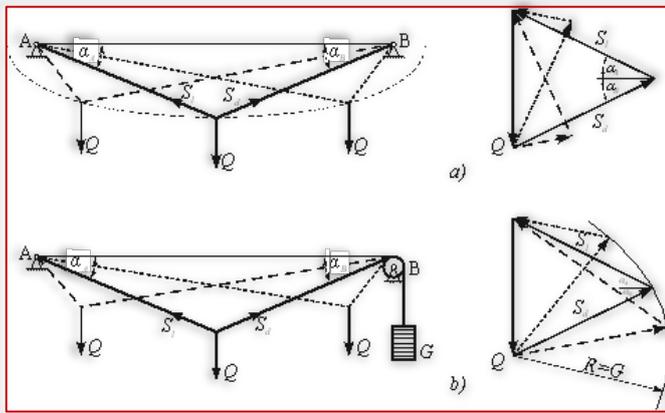


Figure 6. The rope force change in case of a both sided anchored rope (a) and in the case of tightening with a weight (b)

Case of a both-sided anchored rope is a statically indeterminate system with a significant change in the rope force when the load is moving. Besides that, there is significant impact of temperature and rope elasticity. On the contrary, this case is easy to perform, which is reason why it is often applied for short ziplines (so-called “from tree to tree”).

The case of a rope that is anchored at one and tightened with weight at other end is considerably more favorable, because the rope forces aren't changing much and there aren't influences of the temperature and rope elasticity, but the system is more expensive and solution requires more space on the pillar.

Change of rope force for three characteristic load positions are notable on Figure 6.

This paper will further be based only on case of rope anchored at one and tensioned with weight at other end.

COMPUTATIONAL MODEL FORMING

The adequate computational model will be formed by neglecting small quantities of high order. The terms (5) and (6) are determining the so-called static trajectory of movement. In the case of tensioning with weight and “shallow” catenary, according to [9] and

[10], the oscillation of the rope in the vertical plane is relatively small and can be neglected. A person connected with trolley forms a mathematical pendulum, but if the start is smooth and the belt length are short, the effect of swinging can also be ignored. According to that, the computational model which is shown on Figure 7, can be represented as the concentrated mass that is moving along trajectory determined for static conditions, [5].

Air resistance and rolling resistance are acting onto concentrated mass during the movement, [1], [5] and [13]. The direction of resistances is always opposite to the direction of the movement.

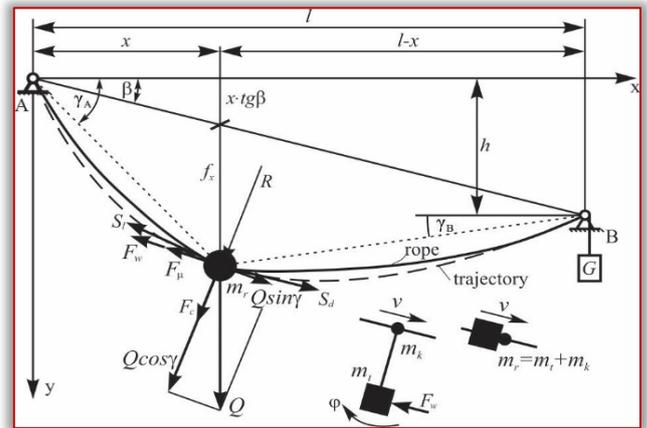


Figure 7. Computational model

As the load is moving along curved path, there is an influence of the centrifugal force. If it is assumed that generally the maximum velocity doesn't exceed 120 km/h (~33,33 m/s), the maximum possible impact of the centrifugal force in relation to the component of person's weight is:

$$\frac{F_{c, \max}}{Q \cdot \cos \beta} = \frac{v_{\max}^2}{g \cdot R_{\min} \cdot \cos \beta} = \frac{33,33^2}{9,81 \cdot 4982} \sim 0,02$$

where $\cos \beta \approx 1$, and the radius of the trajectory curve for given conditions is:

$$R_{\min} \square \frac{G}{q + \frac{2Q}{l}} = \frac{62500}{10,5 + \frac{2 \cdot 1500}{1467}} = 4982 \text{ m}$$

As seen, the maximum impact of the centrifugal force is less than 2%, so it can be ignored.

–Determination of rolling resistance

Every wheel that is rolling along deformable surface has a resistance component due the friction in wheel bearings and due to deformation of contact surfaces. Wheel that is rolling along the rope has additional resistance component due the rope stiffness. Unlike the perfectly flexible rope, the real rope will not take the position of the tangents behind and in front of the wheel, which can be seen as a “wrinkling” of rope in front of the wheel which is shown on Figure 8.

This effect can be included by the relation (8), where the lever arm of rolling torque includes the influence of contact surfaces deformation and the “wrinkling”

of the rope, so the value is higher than in case of “standard” wheel.

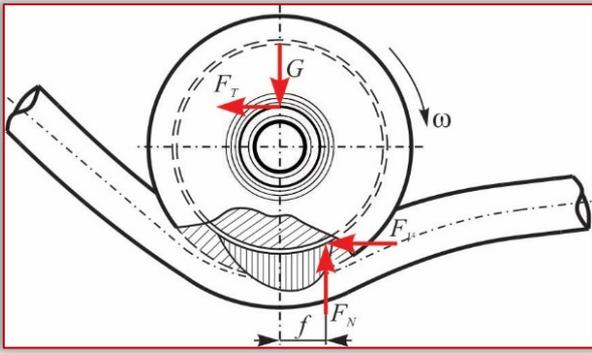


Figure 8. Wheel model

Resistance of wheel that is rolling along steel rope is calculated as:

$$F_{\mu} = \mu \cdot \Sigma G = \left(\mu_0 \cdot \frac{d}{D} + 2 \cdot \frac{f}{D} \right) \cdot \Sigma G \quad (8)$$

where:

- μ - total resistance coefficient,
- μ_0 - bearing friction coefficient,
- d - bearing diameter
- D - wheel diameter,
- f - lever arm of rolling torque,
- ΣG - sum of vertical forces.

Based on expression (8) it can be seen that the total resistance coefficient depends on the geometric size of the wheel (d , D), as well as the rolling resistance coefficient in the bearing (μ_0) and the rolling resistance between the wheel and rope (f). The bearing friction coefficient and lever arm of rolling torque are determined experimentally.

–Determination of air resistance

As person travelling along zipline typically generates high velocity, air resistance has a significant impact on all driving parameters. Air resistance is influenced by a large number of dimensions, such as the type of flow (laminar or turbulent), area exposed to the air, the shape of the body, velocity etc.

Air resistance is, according to [3], calculated:

$$F_w = c_w \cdot A \cdot \frac{\rho \cdot (v \pm v_v)^n}{2} \quad (9)$$

where:

- c_w - drag coefficient,
- A - frontal area,
- ρ - air density,
- v - person velocity,
- v_v - component of wind velocity in the direction of movement,
- n - dimensionless exponent depending on velocity, according to [3]:
- $n=1$ for velocities smaller than 1 m/s,
- $n=2$ for velocities between 1 m/s and 300 m/s,
- $n=3$ for velocities greater than 300 m/s.

As the air density doesn't change much for some standard conditions, and the velocity is more often expressed in km/h than in m/s, formula (9) can be written in the form:

$$F_w = 0,0473 \cdot c_w \cdot A \cdot v^2 \quad (10)$$

whereby the velocity (v) is expressed in km/h, the specific air density is taken as $\rho=1,225 \text{ kg/m}^3$, medium air humidity as $w=60\%$ and medium air temperature as $t=15 \text{ }^\circ\text{C}$.

When temperature or pressure vary from ordinary, a corrected term for density is used:

$$\rho = 1,25 \cdot \frac{B}{1,015} \cdot \frac{293}{T} \quad (11)$$

where:

- B - pressure (bar)
- T - temperature (K)

The orientational values of the drag coefficient (c_w) are obtained experimentally and according to [6] approximately amount:

- standing person $\sim 0,78$,
- cyclist in an upright position $0,53 \div 0,69$,
- cyclist in bent position $\sim 0,4$.

COMPUTER SIMULATIONS

Within this point the procedure and the results of the analysis for a concrete example of zipline whose construction was planned on Fruška Gora will be presented. Figure 11 shows the geometry of the route with section length of 1467 m and a drop of 99 m. Hence, the inclination angle amounts:

$$\beta = \text{atan} \frac{h}{l} = \text{atan} \frac{99}{1467} = 3,86^\circ$$

This represents a limiting case because of the small inclination angle

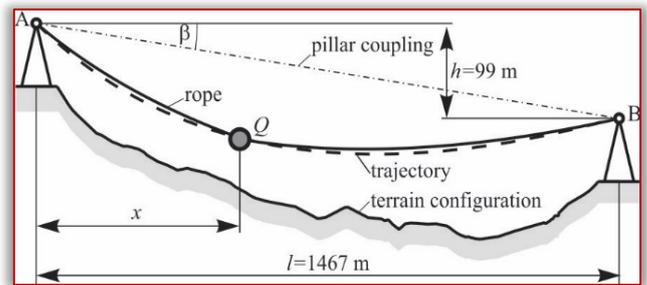


Figure 9. Example zipline, size 1: 2.5

The selection of the rope type and its diameter, as well as the foreseen tensile rope force, are detailed elaborated in [12]. The simulation results will be shown for the steel rope of Warrington 6x19+IWRC construction with diameter of 16 mm.

Determination of motion parameters was performed using computer simulations in the MSC Adams program package. As mentioned in previous section, the system was modeled as a concentrated mass that moves along a trajectory defined by equation (5). Air and rolling resistance are acting on the concentrated mass which is moving under the influence of its own

weight. The direction of resistances is always opposite to the direction of movement. Simulations were performed by varying the persons weight from 50 to 150 kg. Areas exposed to air are depending on the persons size (weight) and the lowering position, which can be sitting, half-sitting and lying. For case of lowering in a sitting position, those areas can be aproximated by the average dimensions of the persons given on Figure 10:

- $A = 0,25 \text{ m}^2$ - for persons weighting less than 60 kg,
- $A = 0,3 \text{ m}^2$ - for persons weighting between 60 kg and 100 kg,
- $A = 0,4 \text{ m}^2$ - for persons weighting between 100 kg and 140 kg,
- $A = 0,5 \text{ m}^2$ - for persons weighting more than 140 kg.

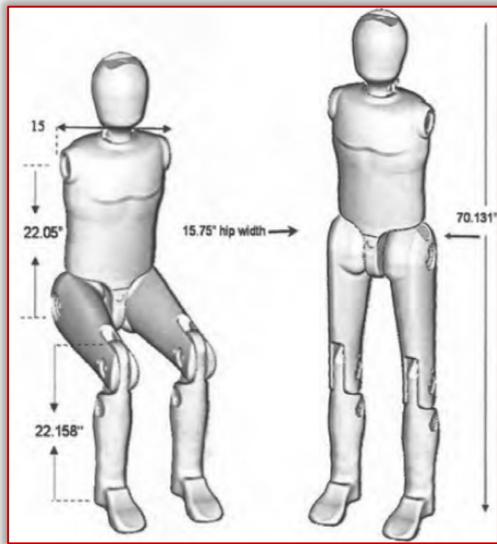


Figure 10. Determining the areas exposed to air (wind), [12]

Areas exposed to air flow for lowering in half-sitting and lying position are smaller and amounts $0,18 \text{ m}^2$ and $0,1 \text{ m}^2$ respectively.

The drag coefficient depends on the lowering position:

- $c_w = 0,6$ - for sitting,
- $c_w = 0,4$ - for the half-sitting and
- $c_w = 0,2$ - for lying position.

The total resistance coefficient of movement, based on the bearing and wheel diameter for concrete trolleys ($d = 22 \text{ mm}$ and $D = 100 \text{ mm}$) and literature based bearing friction coefficient $\mu_0 = 0,01$ and lever arm of rolling torque $f = 0,7 \text{ mm}$, is calculated as:

$$\mu = \mu_0 \cdot \frac{d}{D} + 2 \cdot \frac{f}{D} = 0,01 \cdot \frac{22}{100} + 2 \cdot \frac{0,7}{100} = 0,016$$

This average value of the moving resistance coefficient can significantly deviate depending on the d/D ratio, bearing type, rope type or H/q ratio.

Above mentioned parameters were varied during simulations within limits up to 25%.

RESULTS OF SIMULATION

Presentation of characteristic results is shown below.

–Impact of persons mass

Diagram of velocity for different values of person’s mass is shown on Figure 11.

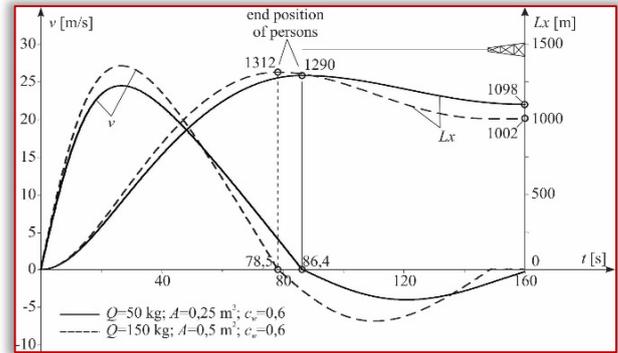


Figure 11. Diagram of velocity for different values of person’s mass

From Figure 11, it is notable that persons do not reach the lower station.

–Impact of lowering position

The diagram shown on Figure 12 represents the simulation results for the different lowering positions, where it is notable that the seating position can not be applied for the given conditions.

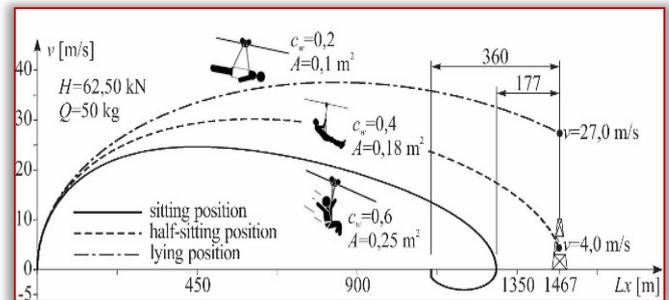


Figure 12. Diagram of velocity for different lowering positions

However, even the “half-sitting” and “lying” positions should be carefully analyzed, because these positions are significantly more “sensitive” to changes such as spreading of the hand for “selfi” (a larger area), which significantly changes the conditions of the person’s arrival in the lower station.

–Impact of wind

Previous paragraphs show only the case of the body moving through the “quiet” air. The following analysis will show the effect of changeable wind direction. Velocity of moderate breeze (intensity 4 on Beaufort scale) amounts between $5,5 \text{ m/s}$ and $7,9 \text{ m/s}$, so the average values of $6,5 \text{ m/s}$ was taken in simulation.

The diagram given on Figure 13 shows the influence of the wind in the direction of movement in the case of the tailwind and headwind for person weighting 50 kg.

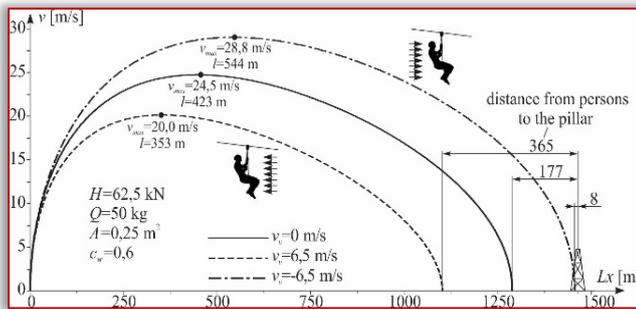


Figure 13. Diagram of velocity for different wind directions

CONCLUSION

For quality design, production and safe use of zipline, it is necessary to perform a detailed analysis of persons kinematic parameters dependence from a range of influential sizes such as person's weight, tensile rope force, inclination angle, position during lowering, wheel resistance, wind, etc. It is essential to form adequate computational model which allows the simulation and determination of so-called "driving characteristics" for concrete conditions.

Note:

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DESIGN, ADDITIVE MANUFACTURING AND EXPERIMENTAL STUDY ON SMALL SCALE WIND ROTORS

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Abstract: Development of energetically effective technological solutions and parallel cost effective manufacturing technologies brings up the idea of micro-scale wind generators. Large scale wind power plants are widely used and studied. Small sized wind generators may have advantage of mobility and ability of utilizing intensive air flow in a relatively small space. In this paper we present development of a series of rotors and experimental investigation of their efficiency. In this study we designed a series of small size, multiblade rotors and fabricated them by additive manufacturing. Wind tunnel experiments were performed and rotors compared with the same type but larger sized rotors in efficiency. Body models were used in two way. After exporting those into STL file format those were imported in an additive manufacturing system which printed out real specimen. On the other hand CAD models of rotors were utilized for building up a model for numerical simulation.

Keywords: additive manufacturing, wind power plants, micro-scale wind generators, small scale wind rotors, multiblade rotors, efficiency, experimental investigation

INTRODUCTION

Streaming fluids carries kinetic energy. On Earth we have significant amount of flows like wind and different form of water motion (e.g. rivers or undulation), which can be utilized as sources of so-called renewable energy. Expression „renewable” refers to the fact that energy of them finally comes from the Sun, which of course contains not infinite amount of energy, but from „terrestrial” point of view it can be considered as an inexhaustible source of power [2,3].

Nowadays science, technology and application of wind power plants accumulated a large amount of knowledge and experience. Size, construction, buildup, shape, working speed are some of important parameters which influence efficiency and economy of a wind power plant [4,5,6].

Figure 1 points to one of most interesting feature of different types of wind rotors that is how their efficiency varies by tip speed ratio. One cannot state which the best is. Indeed an appropriate solution can be selected for special circumstances.

Tip speed ratio (λ),

$$\lambda = \frac{\text{rotor tip speed}}{\text{wind velocity}}$$

shows the ratio between wind velocity and the speed of the end point of a blade of a rotor. It depends on the radius of the rotor and its angular velocity. Consequently the same tip speed ratio with the same wind velocity can be reached with a larger rotor by smaller angular velocity.

There is a complex comprehension between tip speed ratio, wind velocity, aerodynamically force on the

blade and the diameter of the rotor. Tip speed ratio also depends on control system of a wind generator while larger power gain from the rotor results in a smaller angular velocity, so a smaller tip speed ratio. This is a critical point of wind generator control to obtain energy from a rotor so that it works with a tip speed ratio value close to optimal, in other words not to slow down it too much, and not to allow to rotate too fast.

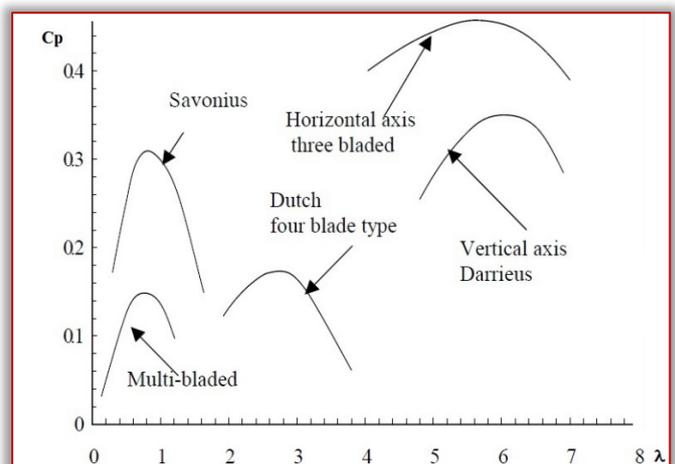


Figure 1. Efficiency can be characterized by power coefficient (C_p) as function of tip speed ratio (λ) for different types of wind rotors. In our work curve for multi-bladed rotors is relevant. Source: Matthew S: Wind energy ... p 22 [9]

Power coefficient (C_p) of a rotor vary with tip speed ratio. Albert Betz derived from the axial momentum theory of rotors a theoretical maximum value of power coefficient

$$C_p = \frac{16}{27} \approx 0.593 = 59.3\%$$

This value called as Betz–limit. In practice most wind generators fall far behind this theoretical limit. As Figure 1 shows horizontal axis three bladed rotors come near to this value, that’s why this is the most frequently applied form. [9]

When large amount of energy has to be gained for supply for example a city, industrial factories, or a whole country best solutions for wind power plants are large scale generators usually installed in clusters forming wind farms or wind parks. However medium and small size wind generators used standalone for domestic or small scale industrial applications [1].

Development of energetically effective technological solutions and parallel cost effective manufacturing technologies brings up the idea of micro–scale wind generators.

In this paper we present development of a series of rotors and experimental investigation of their efficiency.

DESIGN

In our experiments we investigated rotors designed by ourselves. Without going into details of calculation we refer to textbook [9]. Now we describe only main design parameters and give an example of results.

As first step we selected NACA4412 blade profile, which is widely used for airfoils and wind turbines. We choose 12 degrees for angle of attack (α), because for this profile lift force coefficient (C_L) has maximum at this angle. It can be read from C_L – α diagram that $C_L=1.4$ at this angle. The radius of the rotor (R) was set to 115 mm. As we designed 3 different rotors with different number of blades, values of this were 3, 5 and 7. Tip speed ratio at the design point (λ_D) was chosen to 2.

With these parameters design of cross sections were performed according to [9]. As an example we demonstrate results for 3 bladed rotor in Table 1.

Calculations were performed for cases of 3, 5 and 7 bladed rotors. From these results orientation and scale parameter of standard NACA4412 cross section are given for each selected radius (r) values. By these data a series of closed curves were generated in a CAD software. Body model of a single blade was generated by lofting. Then whole body model of rotors were generated. It is important to note that cross sections and shape of blades are different for the three different cases in spite of many design parameters of them are identical. This is because number of blades is also a variable factor in formulas applied for calculations.

Body models were used in two way. After exporting them into STL file format those were imported in an additive manufacturing system which printed out real specimen. On the other hand CAD models of rotors

were utilized for building up a model for numerical simulation. Figure 3 illustrates the process of design, fabrication and simulation model building.

Table 1. Results of design calculations for cross sections of 3 bladed rotor (r: radius, distance from the axis of rotor, λ_r : speed ratio at radius r, ϕ : β : blade setting angle, C: chord length)

r [m]	λ_r	β [°]	C [m]
0,01	0,173913043	41,42279537	0,024180963
0,02	0,347826087	35,21399465	0,038385826
0,03	0,52173913	29,63145895	0,045340643
0,04	0,695652174	24,7836739	0,047655979
0,05	0,869565217	20,66060873	0,047308794
0,06	1,043478261	17,18741651	0,045587489
0,07	1,217391304	14,26710711	0,043253177
0,08	1,391304348	11,80446093	0,040725455
0,09	1,565217391	9,71603809	0,038222033
0,1	1,739130435	7,932601226	0,035847487
0,11	1,913043478	6,398197246	0,033645238
0,115	2	5,710034118	0,03261305

FABRICATION

3D body models of rotors converted to STL (standard triangulation language) models and were exported into STL files. An STL model approximates surfaces of a body by plane triangles, like a „tessellation”.

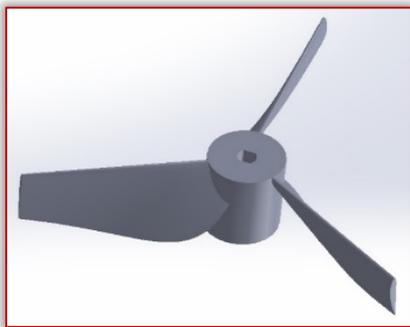
From an original CAD model it is possible several different STL model depending on what accuracy is required. Quality of STL model is controlled by STL parameters. Deviation tolerance and angle tolerance are two most important STL parameters. Deviation tolerance is a parameter which controls how far nodes positioned from the original surface. Angle deviation parameter controls the fine structure of triangles like following curved details of a surface so influencing shape accuracy. In both case smaller value means higher accuracy. We applied highest accuracy in our work.

Digital model of rotors were imported into the preprocessing software. Orientation of the model was set to horizontal so that curved surfaces of wings could be built up more accurately in vertical direction. Surface quality was set to mate, because with this option more support material is added to the surroundings of the model, what ensures higher size and shape accuracy.

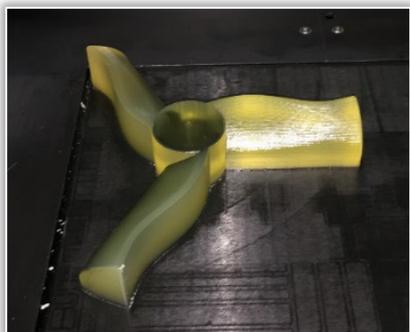
Rotors were fabricated in the Additive Manufacturing laboratory at University of Nyíregyháza. We applied an OBJET Eden 350V additive manufacturing machine. It works with photopolymer resins, we used FullCure 720 material [10]. This machine applies a certain type of so–called material jetting additive manufacturing technologies, PolyJet. Generally

material jetting methods build models by letting material in liquid form onto the surface of the tray of build surface where they cure so the model builds up layer by layer. This kind of methods have the advantage of high surface quality and high resolution. In the machine applied in this work photopolymer resin is stored and pumped as a liquid before manufacturing process.

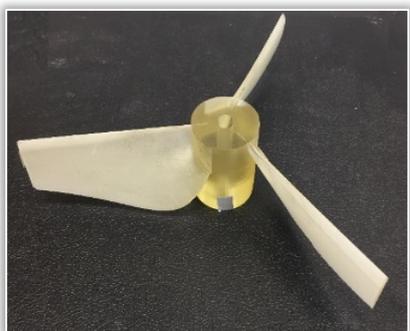
Printing unit involves 8 printing head with several holes 5 micrometers in diameter. Piezoelectric crystals are responsible for ejecting the material in the appropriate time instant while the unit performs alternating movement. It is controlled by an inner auxiliary computer of the 3D printing machine. Material droplets fly onto the upper surface of the model, and a strong ultraviolet lamp irradiates the layer, so resin cures and turns into solid state material.



(a) Model of 3 bladed rotor



(b) 3 bladed rotor before cleaning



(c) 3 bladed rotor made by AM

Figure 2. Main steps of production of rotors: electronic STL body models of rotors, a shot when it was printed out but before cleaning (removal of support material), and experimental workpiece made by additive manufacturing (AM)

This AM machine builds models with support material in order to ensure good size and shape accuracy. It can be shown out that this technology has orientation dependent error in size less than 0.1 mm with small standard deviation [7]. At the end of printing process support material must be removed by mechanical and chemical treatment.

Figure 2 demonstrates manufacturing process from digital body model to real part. Definite advantage of additive manufacturing at this size is promptness and moderate cost.

Aerodynamical flow significantly depends on not only the mere geometry of a body, but the surface quality. That's why additively manufactured surfaces were also polished after cleaning, because this kind of surface is comparable with surface quality of molded plastic or fine machined metal parts.

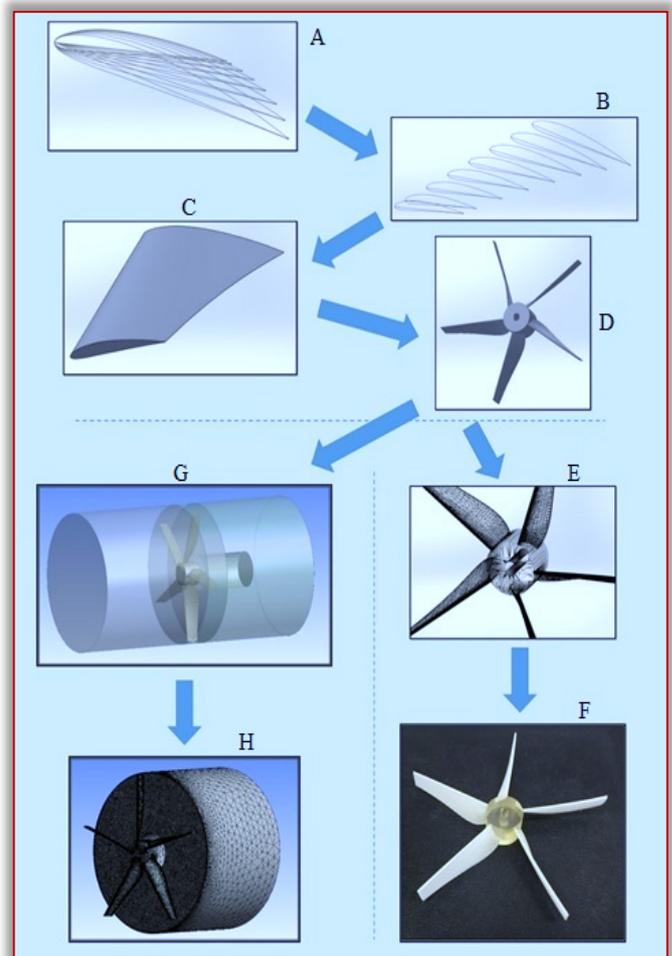


Figure 3. Main steps of design, manufacturing, preprocessing of simulation and their connection during the research process, labels A ... H are explained in the text

- ≡ A – cross sections calculated by given parameters,
- ≡ B – importing cross section into a CAD software (SolidWorks),
- ≡ C – one blade created by lofting the cross sections,
- ≡ D – copies of the blade arranged and the body model of the rotor built up,

- ≡ E – an STL file generated from the body model for the additive manufacturing system,
- ≡ F – experimental workpiece fabricated by additive manufacturing (AM),
- ≡ G – body model imported into a FEM software (Ansys) for preprocessing,
- ≡ H – finite element mesh generated from the geometry.

Main advantage of this process is that common body model was used for both additive manufacturing and simulation so geometries investigated by different ways were identical within accuracy of manufacturing. It was important because air flow is highly sensitive for geometry, that's why not too large differences in the shape might have led to significant artificial errors between results of simulation and experiments.

EXPERIMENTS

Objective of our experiments was to investigate efficiency of rotors designed by ourselves and compare them with literature data.

We applied a wind tunnel for generating air flow. Rotors were installed on an electric generator. Wind tunnel does not simulate a freestanding wind generator, indeed a kind of that what has some cover, or works in a narrow place. Really small scale wind generators may be positioned in such a way utilizing intensive airflow in a small spatial area.

Principle of measurement is determining the difference in electric energy demand of the rotor at a certain angular velocity without airflow and with airflow. Measured quantities were the followings:

- ≡ angular velocity of the rotor in stationary state (ω),
- ≡ mechanical power gained by the rotor from air flow (P).

We performed two series of measurement with two different velocity (v) of air (wind) 6.7 m/s and 8 m/s. Tip speed ratio (λ) was calculated from angular velocity and wind velocity:

$$\lambda = \frac{R\omega}{v},$$

where R stands for radius of the rotor.

Efficiency coefficient (C_p) results from the following formula:

$$C_p = \frac{P}{\frac{1}{2} \rho A_d v^3},$$

where ρ means mass density of air, A_d area of cross section of the rotor, v velocity of the air.

RESULTS

Efficiency coefficients and tip speed ratios were calculated from experimental data and demonstrated on diagrams Figure 4 and Figure 5. Each figure shows 3 diagrams simultaneously in order to support

comparison of them. One diagram contains data belonging to the same wind velocity experiments, and consecutively to 3, 5 and 7 bladed rotors. Results at lower wind velocity are more disturbed by errors than results at higher wind velocity.

It can be stated that each diagram shows maximum at least in trend. On Figure 5 it is more obvious. This feature stands in accordance with what we can expect by literature. On Figure 1 curve for multi-bladed rotors has a maximum at $0.7 < \lambda < 0.8$ with value $1.4 < C_p < 1.5$. In our experiments for our rotors in case of $v = 6.7$ m/s the maximum is at $\lambda \approx 0.54$ and $C_p \approx 0.75$ (except when number of blades is 3). In case of $v = 8$ m/s the maximum is at $\lambda \approx 0.6$ and $C_p \approx 0.75$.

We may account it as a qualitative accordance. Of course since rotors and constructions are different, and performance of wind generators highly depends on those, we cannot expect exact coincidence with data of literature. Difference may arise also from the fact that literature reports freestanding wind generators, but our experiments were performed in a wind tunnel.

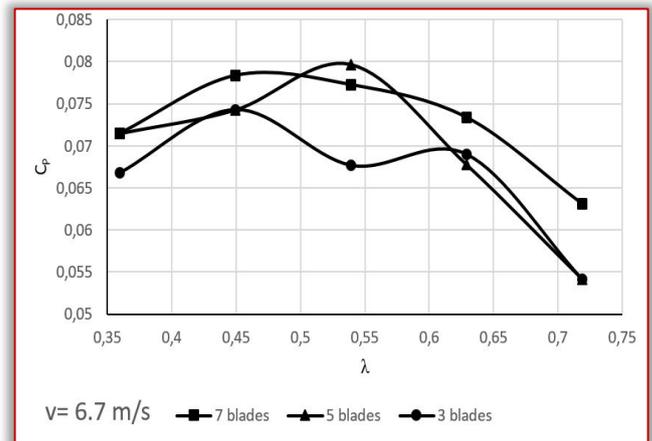


Figure 4. Efficiency result of experiments at $v=6.7$ m/s wind velocity

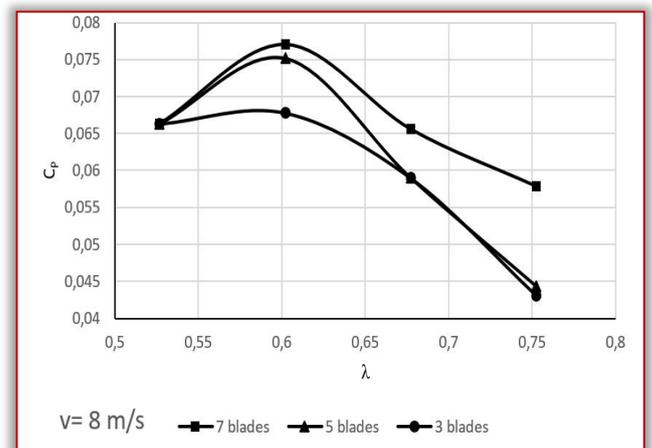


Figure 5. Efficiency result of experiments at $v=8$ m/s wind velocity

CONCLUSIONS

Rotors with 3, 5 and 7 blades were designed with NACA4412 airfoil cross section. Body models were applied for additive manufacturing of rotors. Wind tunnel experiment was built up and two series of measurements were performed at 6.7 m/s and 8 m/s. Power coefficient by tip speed ratio diagrams were derived from measured data.

Shape of diagrams at $v=8$ m/s are in qualitative agreement with data of literature. It has maximum, and value of maximum is higher and higher as number of blades increases. Diagrams at $v=6.7$ m/s shows not so clear maxima, but tendency is similar. Wind speed in this case probably is too low and errors of measurements makes evaluation more difficult.

Such kind of experiments may bring more knowledge about features of rotor sin a wind tunnel which is able to provide higher wind velocity.

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DESIGN AND ANALYSIS OF U-SLOT MICROSTRIP PATCH ANTENNA FOR MOBILE COMMUNICATION AT 60 GHz

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Abstract: A low loss and high gain millimeter wave microstrip patch antenna has been proposed in this paper. The antenna is designed by cutting a U-slot on the patch and it is excited by microstrip feed line. The advantages of this design are high gain and low fabrication cost. Their performances depend on the shape and size of the antenna. The future aim of wireless communication is to provide data with high speed data range even in harsh geographical areas. Here aim is to design a U-slotted patch antenna at a frequency of 60GHz with maximum antenna gain and minimum radiation loss using high frequency structure simulator (HFSS). We will use Rogers RT/duroid 5880 as substrate due to its suitable mechanical and insulating properties. Resonant frequency used will be 60 GHz and height will be 0.508 mm.

Keywords: Microstrip Patch antenna, Substrate, Dielectric constant, millimeter frequency, ISM band, resonant frequenc

INTRODUCTION

Most promising technology WiGig technology which delivers multigigabit throughput in mobile communication. Digitized data which is not compressed, video and voice contents could be transmitted in the space with very short distance and the rate is 8gbps at resonant frequency 60 GHz. FCC (Federal Communications Commission) has assigned 57 to 64 GHz unlicensed frequency for high data rate. Microstrip patch antenna are increasingly use for commercial purpose. It is very easy in fabrication and comfortable with curved paths of device.

Therefore easy integration with microwave integrated circuits (MICs) [I-V]. They are light weight, small size and therefore end up with small device. It can be of various shape rectangular, circular, elliptical etc. We choose the shape which is best suitable for the device application. The resonant frequency 60GHz is reserved band for millimeter frequency according to the Federal Communication system (FCC).

The antenna comprised of three main parts ground, substrate and patch at the top [VI]. The ground plane is bottom most layer with negligible thickness. Substrate used will be Rogers RT/duroid 5880 for its suitable mechanical and insulating properties height of the substrate is 0.508 mm. There is a metal patch on top with dimensions L and W representing length and width, respectively.

A U shaped slot is cut into the patch and excited by microstrip feed line. The slot made is in order to produce maximum gain and minimum radiation in order to make efficient working of antenna. The matching impedance is 50 Ohm. So we will analyze the reflection coefficient, radiation pattern that occur internally.

The parameters of the antenna are computed on resonant frequency 60 GHz. This frequency can replace traditionally used fiber optics technique and now a day's 5th Generation is based on it, WiGig technology that is IEEE 802.11ad, high definition videos, satellite communication, and automobile communication. For security purpose this frequency is used in body scanners [VII-X].

Also it can also be used in motion sensors, collision avoidance, automatic doors, and detection of speed in vehicles. Millimeter frequencies have higher bandwidth due to which data rate is also high. It can achieve up to 10gbps data rate. In this decade it is fastest growing technology. In this paper we will make a microstrip patch antenna ground sheet on the base, put a substrate material on it .a patch is created and two E and one H slot is made.

Microstrip line feed is given to it with the help of lumped port. Simulations are carried out in HFSS software. The S11 graph showing return loss of the proposed antenna design at 60GHz will be analyzed here. The resulting gain is also analyzed.

The patch antenna has wide range of advantages as small in size cheaper cost, easy fabrication and integration. The antenna is efficient if it will show maximum gain and minimum loss at the resonant frequency [XI-XIII].

ANTENNA CONFIGURATION AND DESIGN

We use microstrip feeding technique is used. Simulations are carried out in the software - High Frequency Structure Simulator (HFSS). A microstrip patch antenna is designed and simulated here. The aim is to design the antenna with proper feed. [II]

— Geometrical specification of single patch antenna—

$$W = \frac{1}{2f_r \sqrt{\mu_0 \epsilon_0}} \sqrt{\frac{2}{\epsilon_{\text{reff}} + 1}}$$

$$\epsilon_{\text{reff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}$$

$$L = \frac{1}{2f_r \sqrt{\epsilon_{\text{reff}} \sqrt{\mu_0 \epsilon_0}}} - 2\Delta_l$$

$$\frac{\Delta_l}{h} = 0.412 \frac{(\epsilon_{\text{reff}} + 0.3) \left(\frac{W}{h} + 0.264\right)}{(\epsilon_{\text{reff}} - 0.258) \left(\frac{W}{h} + 0.8\right)}$$

These formulas are used and the substrate having dimension 7.50 x 9.50 x 0.508 is designed. The substrate used will be Rogers RT/duroid 5880 with $\epsilon_r = 2.2$ with 0.508 mm thickness. ϵ_{reff} symbolizes effective dielectric constant. 'L' is the length of the patch. f_r is the frequency at which the antenna resonates.

The performance parameters are width of the patch represented by 'W'. ϵ_r represents dielectric constant. μ_0 is permeability. ϵ_0 is the permittivity [I]

Directivity

In antenna, the ratio of radiation intensity in a direction to that of radiation intensity averaged in all direction.

$$D = \frac{4\pi U}{P_{\text{rad}}}$$

Gain

The ratio of radiation intensity of the antenna in a particular direction to the total input power fed to the antenna is termed as gain of the antenna.

$$G = 4\pi \frac{\text{Radiation intensity}}{\text{Total input power}}$$

Bandwidth

Bandwidth of an antenna is defined as the particular set of frequencies or frequency band in which the antenna operates. It can be on either side of the central frequency. There are two types of bandwidths - narrow and broad.

$$B.W = f_h - f_l$$

Return loss

Return loss is the reflection of the signal power from insertion of a device. It is expressed in dB.

$$R.L = 10 \text{ Log } \frac{P_r}{P_i}$$

— Design of series feed antenna array:

The data above shows the parameters of the designed antenna. The parameters are obtained with the help of the calculations made with the help of substrate, resonant frequency and height values.

Table 1. Parameters of the designed antenna

Parameters	Dimensions (in mm)
Lg	7.5
Wg	9.5
Lp	1.5
Wp	1.48
Ls	0.6
Ws	0.5
Wq1	0.2
Lq2	2.63
Wq2	0.5

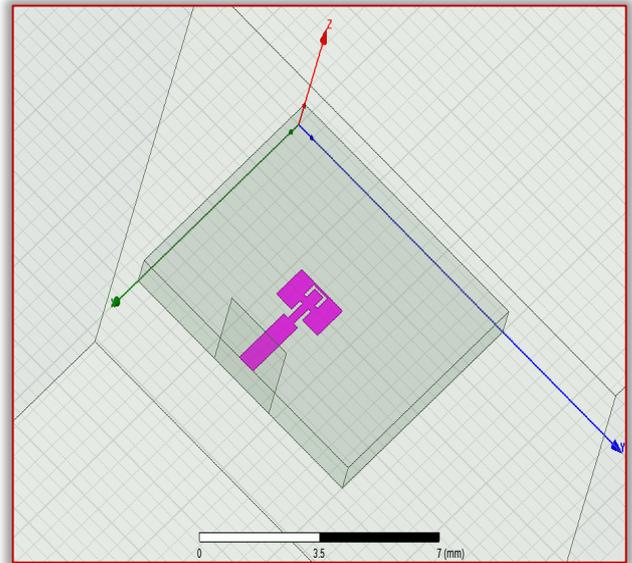


Figure 1. Model of proposed antenna design

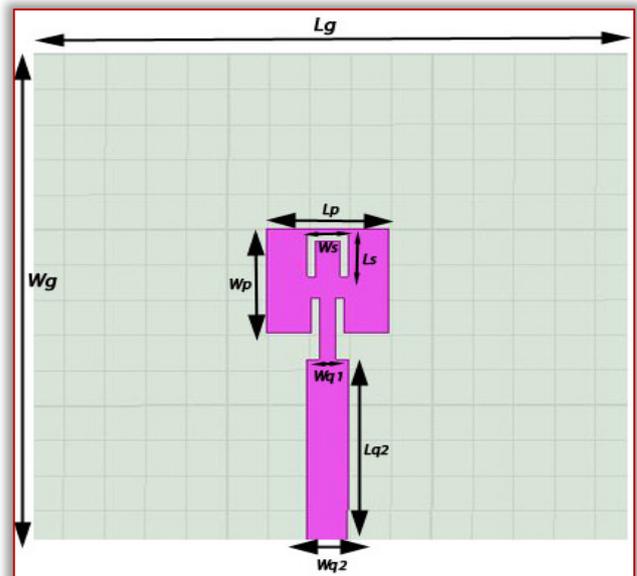


Figure 2. Dimensions of proposed antenna design
The overall dimension of the patch antenna i.e. substrate is 7.5 x 9.5 x 0.508mm³. The magnitude of Lg is 7.5mm and Wg is 9.5mm. Height of substrate is 0.508mm. 1.5mm and 1.48mm are the true length and width, respectively, of the patch.

First there is a ground patch on which a substrate of same dimension is placed. The excitation used is Lumped port. The dimension of the U-slot which is cut out is L_s and W_s with 0.6mm and 0.5mm respectively. W_{q2} and L_{q2} are the width and length of the of the feeding strip.

RESULTS

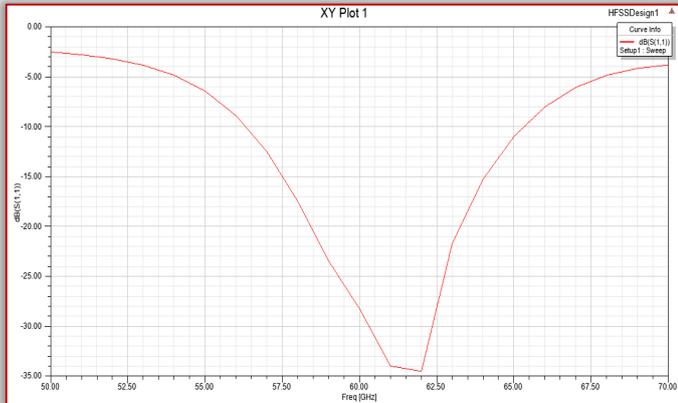


Figure 3. Return Loss graph of proposed antenna design
The S11 parameters or Return loss graph shows minimum loss of -28.3633 dB at frequency 60GHz in case of U-slotted patch antenna at 60GHz

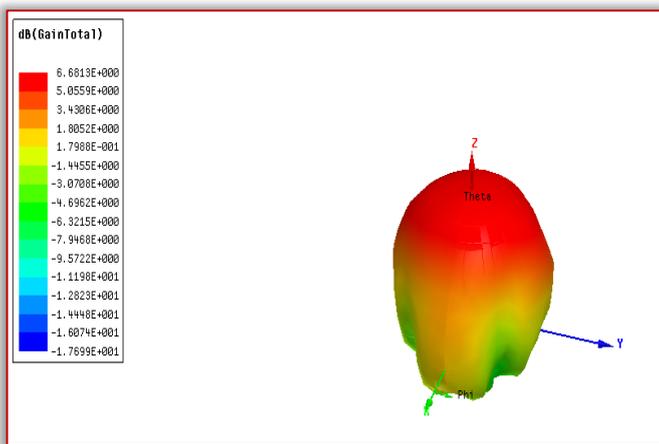


Figure 4. Gain of proposed antenna design
Overall the return loss is -28.3633dB and gain is 6.6183dB,so, the antenna can work efficiently. While finding the maximum gain of antenna in case of U-slot microstrip patch antenna is 6.6183 dB which is at 60GHz frequency.

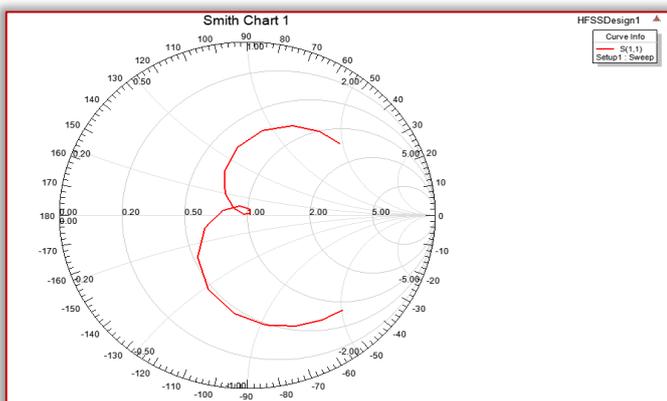


Figure 5. Smith chart of proposed antenna design

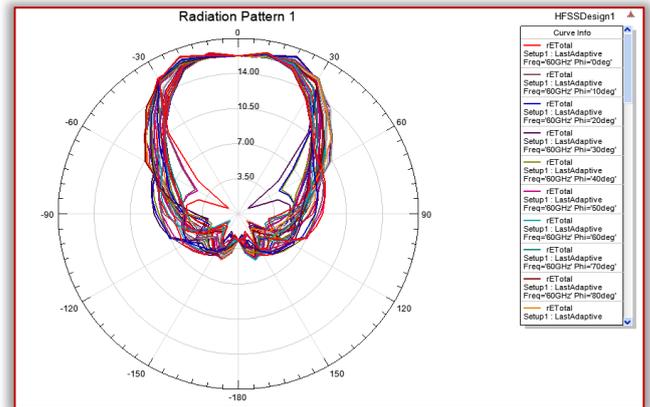


Figure 6. Radiation pattern of proposed antenna design

Table 2. Results of proposed antenna design

Function	U-slot microstrip patch antenna
Gain	6.6183 dB
Return Loss	-28.3633 dB at 60 GHz Frequency

CONCLUSION

A design and after that simulation has done for the antenna which has been designed with the parameters 7.50 x 9.50 x 0.508mm³ for the U-slot microstrip patch antenna. It is observed that the designed array antenna has showed increment in gain as 6.6183 dB.

This gain is obtained in compensation with return loss. This U-slot microstrip patch antenna operates at 60 GHz resonant frequencies which make it suitable to provide data with high speed data range even in harsh geographical areas.

The patch antenna finds potentially high applications in millimeter-wave frequency in wireless communication.

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APPLICATION OF EXPERIMENTAL DESIGN IN LOGISTICS SYSTEMS

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Abstract: Design of Experiments (DoE) is a well-known method in quality management but seldom used in the logistics area. An important question of science is to find the real factors to control complex processes and systems and to know their levels and influences to control all processes and systems in a right manner. To find the optimum in control there are many experiments necessary – practical and theoretical ones. Here the sensitivity analysis as well as simulation and Design of Experiments are used. That is why this paper gives an overview about the basics and ideas of Design of Experiments. An example of practical use is given, showing how a special logistics system (a sorter), can be optimized. The problem is to minimize the failure rate of not identified items with the help of the two factors speed of the sorter and distance between the packages. The experiment should answer several questions and reduce the costs for optimisation of the logistics system. The paper shows all relevant steps to solve the problem and gives some useful hints for applying DoE procedure to other similar problems.

Keywords: Design of Experiments, logistics systems, sorter, optimisation

INTRODUCTION

DoE has an old tradition and history. Famous names in this context are Fisher, Taguchi and Shainin. DoE is a structured and established method of quality management. (Fig. 1, Compare [1] [2]) The goal is to realize as few experiments as possible to minimize optimisation costs. DoE requires only a small set of experiments and thus helps to reduce these costs.

The Shainin methods (Compare [3] [4]) include the full factorial ones. These are typical methods of classic statistical research methods. DoE determines the relationship between the different important factors (x_i) affecting a process or system and the output (result) of that process or system (y). DoE has significantly more to offer than a “one change at a time experimental method”.

A “one change at a time experimental method” has always the risk that the researcher finds only the most significant effect on the output. DoE also focuses on dependency and interactions between the most important factors. DoE first plans for all possible dependencies and interactions, then it describes exactly which data are necessary to assess them.

The main objective in the practice of experimental statistical design is to obtain the necessary information with the least amount of costs and the greatest rapider possible.

The exact length and size of the experiment are set by the experimental design before the real experiments begin. DoE involves designing a set of experiments, in which all relevant factors are varied systematically. When the results of these experiments are analysed, they help to identify optimal conditions.

Other results of DoE are the factors that mainly influence the results (high effect), the factors that

have little influence on the results (small effects), as well as the detection of interactions and synergies between the factors.

The common way to realize DoE is the following one:

- # Define the objective of the investigation.
- # Define the variables (factors) y_k that will be measured to describe the output.
- # Define the variables (factors) that will be controlled x_i during the experiment.
- # Define the ranges of variation and the factor levels of each factor.
- # Define and optimise the experimental plan.
- # Prepare and carefully carry out the experiments and secure the results.
- # Do the statistical analysis and interpret the results.
- # Use the knowledge to optimise the process or system.

This is only a short introduction in DoE. Use the literature in [5] and [6] for further information about the basics of DoE, especially the full-factorial ones. DoE is used only seldom in the logistics area because it is real little unknown in this field.

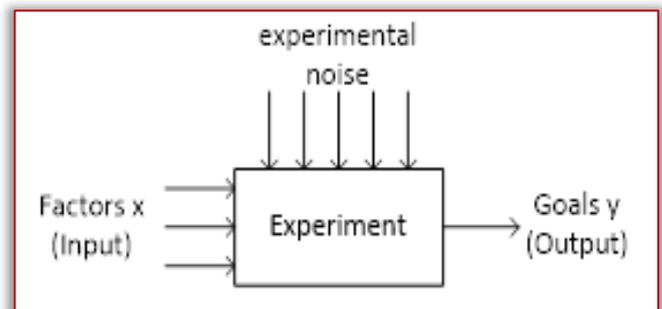


Figure 1. Simple model of DoE

PRACTICAL PROBLEM

Now in this case, a logistical system is being investigated, the sorter, to give a practical example of how to realize DoE in logistics. A sorter is a complex and modular logistical technical system that includes the logistical sorting process. The task of the sorter is to place small parcels, packages, fragile and sensitive products as well as heavy freight goods, boxes and baggage safely onto a conveyor. After that, it is necessary to discharge them into the right destination. The main objective of a sorter system is to fast sort items. This should be realized by using a big quantity of items, a high efficiency of the sorter process and a short throughput time of items. (Hundred percent of items and other objects should be sorted at the very first time.)

To calculate the efficiency rate, the amount of packages or other items is used. It describes the items, which fulfil more than one circulation in the sorter system. This rate is marked as the failure rate of the system.

On one side the main objective is to minimize the amount of packages, with more than one circulation in the sorter systems, and on the other side as many items as possible should be sorted to achieve a high efficiency.

DESIGN ON EXPERIMENTS

Often staff responsible for the optimisation of the logistics systems believe, that there is a great number of relevant factors, but really only two factors are the most important ones. These are:

- # Factor 1: Speed of the sorter
- # Factor 2: Distance between the packages

This is a classical 2-factor-problem with;

$$k = 2 \text{ factors} \quad (1)$$

The staff is convinced that a high speed and a small distance between the packages is good to realize a high efficiency of the sorter system. How will this change the failure rate? Will the failure rate increase with higher speed and smaller distance? The experiments should help to answer several questions:

- # How many experiments are necessary to analyse the problem?
- # How many failures will happen at each combination of factors?
- # How big is the influence of speed and distance on the failure rate?
- # Is the influence of both factors speed and distance significant or not?
- # Which combination of speed and distance will achieve the smallest failure rate?
- # Are there visible limits of the sorter?
- # How many failures should be accepted in total?

SOLUTION

Each factor gets two levels: a low level and a high one. The low level gets the value (-1). The high level gets the value (+1).

Two factors (k) and two factor levels (p) come to four possible combinations in summary.

$$m=4 \quad (2)$$

Moreover, each combination should be realized two times to make a statistical analysis possible. The task is to get more information on which combination is the best.

The number of necessary repetitions n.

$$n=2 \quad (3)$$

There will be three repetitions, but that is one repetition cycle more than statistical necessary. Therefore, we will get three results in each combination (y_1, y_2, y_3).

We use the number of repetitions n.

$$n=3 \quad (4)$$

The interaction the both factors is signed by x_1x_2 . It is calculated as the product of x_1 and x_2 .

Table 1. Results of experiments $y_1, y_2,$ and y_3

No.	x_1	x_2	x_1x_2	y_1	y_2	y_3
1	-1	-1	1	7.6	7.9	7.8
2	1	-1	-1	13.2	13.6	13.9
3	-1	1	-1	4.3	4.1	4.3
4	1	1	1	9.4	10.0	10.1

The results are listed in table 2. It is important to mention that the sequence of experiments should be pure chance.

The sequence of experiments must be completely random. Random numbers can be generated or simply an urn can be used.

Table 2. Calculation of the arithmetic mean and the formula

No.	Y	Yx_1	Yx_2	Yx_1x_2
1	7.8	-7.8	-7.8	7.8
2	13.6	13.6	-13.6	-13.6
3	4.2	-4.2	4.2	-4.2
4	9.8	9.8	9.8	9.8
Sum	35.40	11.40	-7.27	-0.20
Sum/4	8.85	2.85	-1.82	-0.05

The first result is the following formulas (Compare Table 2):

$$b_0 = (\Sigma Y)/m=2,85 \quad (5)$$

$$b_1 = (\Sigma x_1 * Y)/m = 2.85 \quad (6)$$

$$b_2 = (\Sigma x_2 * Y)/m = (-1.82) \quad (7)$$

$$b_{12} = (\Sigma x_1 * x_2 * Y)/m = (-0.05) \quad (8)$$

$$y=8.85+2.85x_1-1.82x_2-0.05x_1x_2 \quad (9)$$

Of the results of Main, effects and interactions can be interpreted:

- # The best combination with the lowest failure rate is the combination of speed and distance [(-1) (1)]. That means that a slow speed and a big distance is good for the results, for a small failure rate.

- # The influence of speed (2.85) is higher than the influence of distance (1.82) is.
- # The higher the speed x_1 the higher the failure rate y .
- # The bigger the distance x_2 the smaller the failure rate y .

— **Analysis of variance (ANOVA). Test of homogeneity of variance**

Y and the variance s_i^2 are used to calculate the variance homogeneity. This is an important test to check the DoE in general.

The main idea is that the variances of the experimental results are equal at all combinations of factors, because there were only the levels of factors are changed.

The formula is:

$$H_0: s^2 = s_1^2 = s_2^2 = s_3^2 = s_4^2 \quad (10)$$

Should this hypothesis be true, so the planning and the realization of experiments are also both true. Following the next values can be analyzed.

Otherwise, the planning or the realization of experiments is wrong. That means important factors are ignored. The conditions or other factors were not at a constant level during the experimental phase. In summary so we have wrong conditions at whole. It is possible that now more experiments are necessary to realize.

We use the formula 11.

If

$$(S_{max} / S_{min}) \leq F_{f1, f2, 95\%} \quad (11)$$

then H_0 is true, otherwise H_0 is wrong

With

$$f_1 = f_2 = n - 1 = 3 - 1 = 2 \quad (12)$$

Because the thesis H_0 (compare formula 13) is true the experiment design is true too. Now the quantities can be analyzed.

$$(S_{max} / S_{min}) = 10.75 \leq F_{f1, f2, 95\%} = F_{2, 2, 95\%} = 19.00 \quad (13)$$

— **Test of significance of each single factor and of interactions**

Now the test of significance of each effect is done. Therefore, we need the number of experiments (N) with the formula

$$N = m * n \quad (14)$$

The values are now calculated

$$S_d = \sqrt{\left(\frac{m}{N}\right) S^2} \quad (15)$$

with $s^2 = (\sum s_i^2) / m = 0.159$

Then the degrees of freedom are calculated

$$f = N - m \text{ and } t_{f, 95\%} = t_{8, 95\%} \quad (16)$$

At last will be calculated

$$t_{f, 95\%} * S_d = 0.296 \quad (17)$$

The test gives the following results:

The factor with the most influence on the results is speed (2.85). A higher speed leads to a higher rate of failures. The coefficient is significant because it is higher than [0.296].

The factor with less influence on the results is distance (-1.82). A smaller distance leads to a higher rate of failures. The coefficient is significant because the value [1.82] is higher than [0.296].

The existence of interactions and synergies between both factors (-0.05) is given. This is not significant for the output, because the coefficient level [0.05] is smaller than the significance level [0.296].

Now it is possible to simplify the function as following (Compare to formula 9):

$$y = 8.85 + 2.85x_1 - 1.82x_2 \quad (18)$$

The end of the experiments is not achieved yet. The task is to optimize speed and distance. Therefore, further experiments are necessary.

— **Adequacy of statistical model**

Now we use the formula 18 to calculate the theoretical results of experiments y_p (Table 3).

We calculate the difference

$$(Y - y_p)^2 \quad (19)$$

Table 3. Calculation of the differences between practical experiments and theoretically based calculated values

Nr.	Y	y_p	$(Y - y_p)^2$
1	7.77	7.82	0.0025
2	13.57	13.52	0.0025
3	4.23	4.18	0.0025
4	9.83	9.88	0.0025
Sum	35.40	35.40	0.01
Sum/4	8.85	8.85	0.0025

This third test compares the formula 18 and the results of the experiments (Table 3). If the variability of the model is smaller than the practical experimental standard deviation, then the model can be accepted and be used further. (Formulas 20–24)

$$F_{f1, f2, Model} \leq F_{f1, f2, 95\%} \quad (20)$$

$$f_1 = m - (k + 1) = 4 - (2 + 1) = 1 \quad (21)$$

$$f_2 = m = 4 \quad (22)$$

$$F_{1, 4, Model} \leq F_{1, 4, 95\%} \quad (23)$$

$$0.03 \leq 7.709 \quad (24)$$

Because the variability of the model (0.03) is smaller than the experimental standard deviation (7.709) the model can be accepted and be used further.

Here in necessary to keep in mind, that these results are valid only for the evaluated experimental interval and under the established experimental conditions.

It should be noted that even at the highest levels of development of modern industry, such as industry 4.0

and logistics 4.0 [7] the detailed study of the influence of factors on the response of a given variable continues to be of vital importance.

CONCLUSIONS

This paper gives an overview about the basics and ideas of Design of Experiments. The focus is on the full factorial experiments. An example of practical use is given. It shows how a special logistics system, a modular sorter, can be optimized by using DoE. The practical problem is to minimize the failure rate of not identified items. There are two factors especially important. These are the speed of the sorter and the distance between the packages. The experiment should answer several questions and reduce the costs for the optimisation of the logistics system. The paper shows all relevant steps to solve the problem and gives some useful hints to transfer the procedure to other similar problems.

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SEISMIC REINFORCED CONCRETE DESIGN AND SAND FRICTION DAMPER

¹. SASTRA Deemed University, 2 Tamilnadu St, Thanjavur, INDIA

Abstract: The seismic design of reinforced concrete dampers buildings structural design considerations, based on the Intensity of the earthquakes such as minor, moderate, and strong. Usually, a minor earthquake occurs mostly in some frequency and causes of crackings in a loss of durability and collapsibility. The strong earthquake has been rarely some time the probability of occurs of a strong earthquake may exceed the lifetime of the structures. These earthquake resistance building should resist the effect of ground motion. Even though they may get damaged and not collapsed during the strong earthquake. These paper based on same thematic and should provide the special RC foundation and sand friction dampers in a footing and improvements of the ductility resistance strength in related resist the strong movements. Sand friction dampers are provided in a structured frame footing of a building to absorb the seismic energy ground during an earthquake. Thus dampers reduced the shaking the building deforms is less, so a change of damage is reduced. Which having high damping capacity and greatly decreased the seismic energy entering the building. That study based on the analysis in numerically designed to the better way to outcomes the results of beams, columns design included the confining reinforcement spacing is designed in special damper footings columns and beam joints connections improvements of ductility nature. Application and improvements that design concept is effectively work in an under seismic action without collapsed in limitations. Especially constructed in seismic prone zone areas.

Keywords: Ductility resistance, Confining Reinforcement, concrete wall design, columns and beams shear connections, special designs and friction dampers

INTRODUCTION

A large sum of seismic motions is created the horizontal and vertical earth motions are based on an earthquake motion. The vertical ground motions having a smaller magnitude are most usually the vertical ground motion due to earthquake can be resisted the factor of safety provided structure (allowable load/factor of safety). These structures, which are designed to carry only a gravity load, will not able to resist the horizontal ground motions [1]. The horizontal ground motion is effective and causes the most significant effects on the structure of shaking the foundation. It's necessary to check the adequacy of the structures to withstand the horizontal motions. The mass of the building resistance movements shaking by setting up so as to resist an altar inside velocity of a purpose it's like to along with in conflicting directions.

The structural dampers should be properly designed the lateral forces even its expensive [2]. The seismic analysis zones should be done to determine the magnitude referred to the previous loss impacts and designed to the dampers the magnitude directions of lateral earthquake forces [3]. Dampers are works in correlated in base isolation systems [4]. These systems found useful for short period structure says less than 0.7 seconds, including soil structure of interactions its principles of alteration and conventional fixed based design structure and may be cast of effective compared to normal buildings [5].

It provided the new building were very strong ground motion likely [6]. The criteria for the effective damping system is not fit for soft soil, building of low, medium or height ($H/L < 1$), the content of the building sensitive to high frequency of vibrations, building rigid properties effectively resist the lateral loading system, other earthquake loads (wind, live, dead load) $< 10\%$ weight of structure [7].

The seismic dampers process that causes an oscillation in a system to decay rapidly to zero amplitude [8]. It is a very important phenomenon in vibration suppression or isolation [9]. Damping causes the energy to be diverted from vibration to other energy sinks. It's installed in structural frames of a building to absorb some of the energy going into the building from the shaking ground during an earthquake [10]. Dampers reduce the energy available for shaking the building.

DUCTILITY RESISTANT IN A BUILDING STRUCTURE

The arrangement is able to continue elastic beneath the action of the utmost expected earthquake in the compliments zones, but increasing the elastic properties with the insist was established as an extravagant method of the construction, that concept is a ductile chain design [11].

The ductility in earthquake-resistant buildings, they have the ability to reverse large lateral deformations before failure during an earthquake and to withstand earthquake effects with some damages but without collapse [12]. These beneficial to purpose structures

in some case earthquake vibrated in the structure and form in some cracks without collapsing [13].

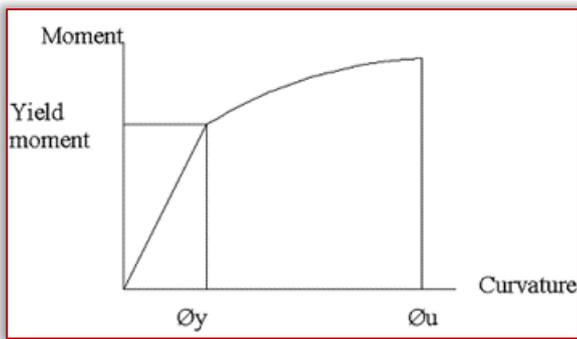


Figure 1- Moment curvature ductility diagram

Moment curvature ductility diagram represent that the result obtained moment curvature ductility resistance, if the Curvature ultimate strength of the idealized bilinear $M-\phi$ relationship sections, to the curvature at yield in a first section [14]. It's procured from moment-curvature relationships.

ASSUMPTIONS OF EARTHQUAKE DESIGN

PHILOSOPHY

Under minor frequency shaking the main member of the buildings that carry vertical and horizontal forces should not damage nonetheless building parts that do not carry load may endure repairable damage [15]. Under moderate shaking, the main members may sustain repairable damaged duration the other parts of the buildings may be damaged and predetermined after the damaged structural members replaced the after earthquakes. Under the strong, but are shaking the main member may sustain severely damaged, but should not collapse [16]. This main design philosophy of helping to protect the building from collapse.

SPECIAL DAMPERS OR SAND FRICTION DAMPERS

Special dampers are used in providing a special structural element for controlling seismic damages in structures [17]. It's absorbed into the lateral force energy and reduces the motion of the building [18]. The sands frictions dampers are costs low and better economical actions compared to other dampers likes viscous, metallic friction, tuned mass dampers.

Sand friction bed dampers are natural parts and base isolation that will absorbed shaking over each other during a strong earthquake, when the part of sand acting at isolation process over each other [19]. The building vibrated the sand damp are compressed pulling and pushing the damp sideway and making it deforms.

DISCUSSIONS

— Site grouting

Grouting technique is provided by the column points. The slow flowing water cement mix (1:1) ratio injected the under pressure the soil in a column marking points [20]. Bulb forms displace is densities the surrounding soil. Compacted grouting is a good option if the foundations. Infeasible to inject the

grouting from the include angles to reach beneath the building.

— Building plan

The structural plans have an uncomplicated and usual geometry and consistently dispersed accumulation and rigidity in the plan, undergo have to less compensation than buildings with the uneven pattern. The symmetrical building plan should be prepared for seismic resistance.

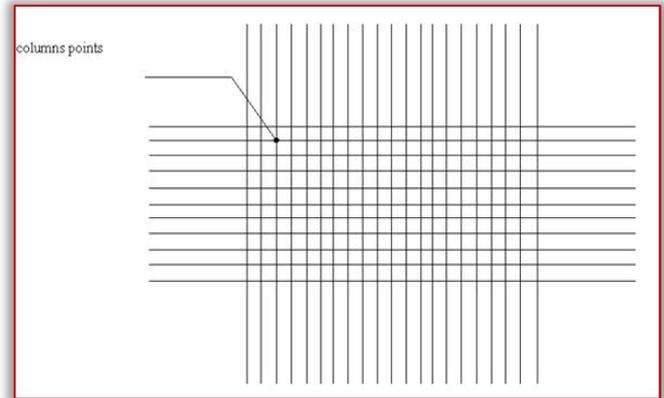


Figure 2- Symmetrical grid line building plan in seismic designs

Each line crossing points represent to decided columns point. Simple rectangular grid line sections plans and are both with respects to mass and rigidity, so that the centre of mass and rigidity of the building coincide with each other. In case of no separate sections other than expansion gap to continuations necessary IS 3414:1968.

— Special RC design

The special reinforced design is followed by a limit state of serviceability. The structures under service load and durability in environmental working conditions. In the design of serviceability and stability of structure as a seismic resistance. But structure situated in high seismic zones required special ductile design and detailing [21]. The code practices of IS 13920: 1993 [22].

Under the severe ground motion, it is ensured that in structure. Designed to resist earthquake forces in a ductile manner, large lateral deformation and vibration will be induced which result in the formation of plastic hinged at a predetermined location in the frames [23]. These requirements apply to frame members which have a factored axial stress in excess of $0.1f_{ck}$ under the effect of earthquake forces. The minimum dimensions of the member need to, not less than 200mm. However in frames which have beams within the centre span exceeding 5m or columns not less. Special confining reinforcement should be provided over a length (l_0) from each joint face towards mid-span and on either side of sections. Where flexural yielding may occur under the effects of earthquake forces.

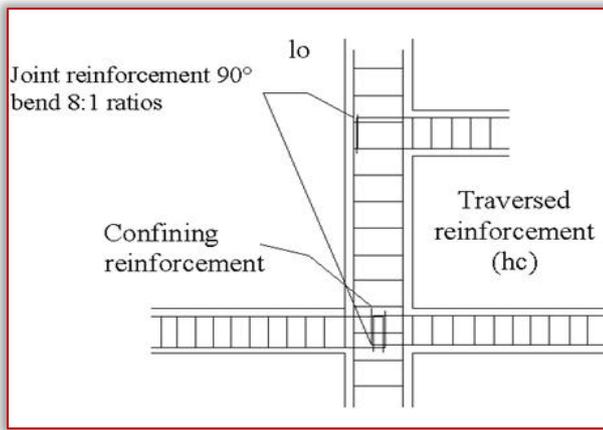


Figure 3- Columns and joint detailing

The columns and joint detailing the section x-y plane represent to the length (l_o) shall not be less than large dimensions of the members at a section where yielding occurs, and $1/6$ of the clear span of the member and these connections of columns in preferred in 450mm dimensions of structural members. And joint the interlocking beams is jointing reinforcement bents is a 8:1 ratio. The columns and joint detailing the section x-y plane represent to the length (l_o) shall not be less than large dimensions of the members at a section where yielding occurs, and $1/6$ of the clear span of the member and these connections of columns in preferred in 450mm dimensions of structural members. And joint the interlocking beams is jointing reinforcement bents is a 8:1 ratio.

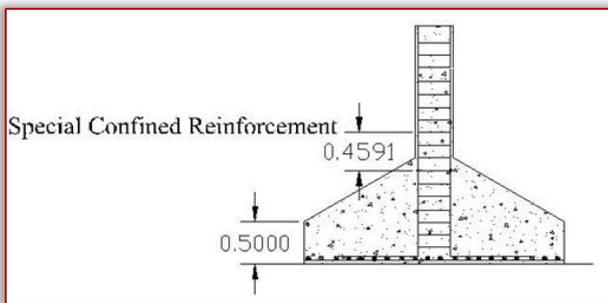


Figure 4- Special confining reinforcement footing

Special confining reinforcement section drawing explained to footing column terminates into a footing mat special confining RC elements extend at least 300mm into a footing. Under the effect of gravity and earthquake loads is not within middle $1/2$ half of span member's clear height, special confining reinforcement provided over the full height of the columns. And the footing paver thickness is 500mm; paver mix is 1:1.5:3.

— Sand friction dampers

RC frame sand frictions will damp process that causes an oscillation in a system to decay rapidly to zero amplitude revealed in sand friction dampers are RC frames footing.

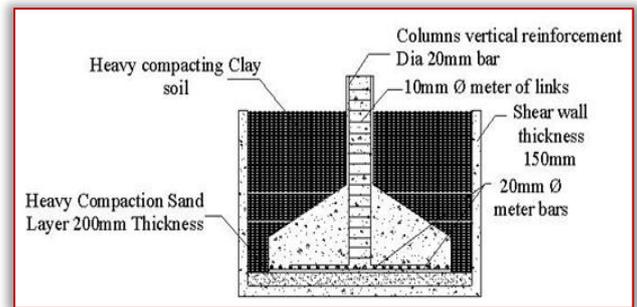


Figure 5- Sand friction dampers are RC frames footing. It's extremely significant in vibration suppression or isolation. Sand friction damping causes the energy to be diverted from vibration to other energy sinks. RC frame sand dampers are mainly used for reinforced concrete structures [24]. That lateral load applied that the footing concrete frames are it compressed the heavy, compacted sand and elastic clay to deform positions.

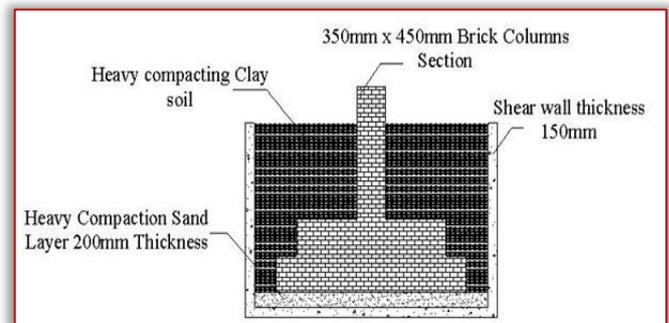


Figure 6. Sand friction dampers Brick batten structural frames

Sand friction dampers Brick batten structural frames that systems reduced the base shear in Load bearing structure (LBS-Structures) primarily because of the natural vibration period of the isolation mode. Sand friction dampers provided most of the response, is much longer than the fundamental period of the fixed base structure [25]. It's leading to much smaller spectrum ordinates higher modes. It's essentially not excited by the ground motion. Sand friction damping in the isolation system and associated energy dissipation vibration and in reducing structural response. Its same methodology in RC sand dampers and change the structural materials.

— Materials

Quality and grade mainly depend on the structural strength response to the seismic energy. The high-grade material is used to the structures its improvements of the ductility resistant capacity of building structural elements. It resists the moderate vibrations in seismic waves. And is uses second-grade quality materials it is not resisting capacity of the vibrations. The structural ability of the buildings is constantly low efficient. 53-grade types of cement are preferable in seismic designs for residential buildings and better construction values and its use OPC used in

RCC and pre-stressed concrete. If 53 it is higher grades of cement concrete applications its uses for special soil grouting immediate plugging mortars. Anywhere initially higher strength of concrete. Loses and hardened broken sands are used. Its high comprised grains of disintegrated rocks. The grain diameters are 0.06 and 2 mm sizes.

It's a generally available river sand material is essentially used in constructions in sand friction dampers. Gravels are known as other names of coarse aggregates. It's sharp and fine irregular angular darks grey blues textures. It occupies 70 to 80 percentages of the entire volume of concrete. It's 20 and 40mm sizes of aggregates are most useful in building constructions. 20mm sizes - structures (Ordinary Portland Cement) mixes and 40mm sizes - foundations PCC mix. Brick batten is a moulding clay in a rectangular section of blocks it is uniform sizes (19*9*9 cm) burning these blocks. It's according to the quality of the mortar.

The quality of the bricks and thickness of the mortar joints. Brickworks in cement mortar in first class. In this type of brickworks, cement or lime mortars are used. These bricks are manufacture in table moulded and of standard shapes. The surface edges are sharps and straight. A thickness of mortar joints has not exceeded in 10mm. Safe permissible load on brick masonry is 44 to 55 t/m². It's considered as the strongest bond in brickworks. Alternate courses consist of stretcher and header. That brick work bind with mortars are a binding material of bricks and stone works. It's mixtures of cement, sand and water. It's also similar in concrete, but except coarse aggregate. It mixes ratio is (1:2) dry mix, wet mix (1:1.5).

Water required for these two functions is about 0.50 to 0.60 times the weight of cement. These ratios of the amounts of water to the amount of cement by weight is termed as w/c ratio and the strength and quality of concrete primarily depend upon these ratios. W/c ratios for structures which exposed to the weather should be carefully decided. For instance, a structure which regularly wetting and drying, water cement ratio by weight should be 0.45 and 0.55 for thin section mass concrete respectively.

Clay soil is natural materials and pure clay is best of back filling of concrete footing and brick masonry wall footing systems. It's composed of particle they have synthetic and glue properties. Heavy compaction natural clay is a better action to resist the lateral movements 40 to 50 % of clay content soil has a good ability to improve high plastic index their structure basement resist earthquakes. And in conventionally controlled moderate seismic engagements. Mixing proportions of concrete is volumetric proportions of cement, sand and aggregate. Fixed arbitrarily such as

1:1.5:3 (M20) grade depending upon the nature of the works.

SPECIAL DESIGN OF WEB REINFORCEMENT

Special RC web reinforcement are shall consist of vertical hoops. Vertical hoops have a closed in 4 corner sides having a 135-degree hook with 10mm diameter extensions <75mm. At each end that is embedded in confined core completing contains circumstances.

Strips bending in 2 types, first one is u-bend; box bends each hook a 10mm diameter extension. The hooks shall engage peripheral longitudinal bars. The minimum diameters are used in strips; the hook is 6mm & 8mm diameters in either Mild steel or HYSD bars.

CONCLUSIONS

This paper studied in seismic design, numerical analysis concrete in structural frame buildings. These types of sand fictions dampers used only in a 2 and 3 stores residential and apartment buildings.

Its cost lays wise economical and better seismic resist actions in moderate earthquakes. It contains improvements of ductility resistance and resists lateral loads depend upon seismic philosophy. This severity of these forces and the demands of the performance of these brace joints for greater understanding of their seismic behavior.

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THE EFFECT OF VARIOUS IMPERFECTIONS ON THE BUCKLING OF AN AEROSOL CAN

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Abstract: In this article, the effect of small errors or changes in various parameters (material, geometry, tool angle) on the load bearing abilities of an aluminium aerosol can is investigated. The commercial finite element software Abaqus is used with the Static, Riks step to trace the equilibrium path in order to find the buckling load. Nonlinearities are included in the model. The geometry is mapped by thin shell elements. It is found that although the effect of one imperfection is, in general, not relevant, if multiple of these occur at the same time, the combined potential effect can become significant in a negative way. At the same time, the potential positive effect is less than a half of this.

Keywords: shell, buckling, aerosol can, Abaqus, imperfection

INTRODUCTION

It is well-known that the behaviour of shells is strongly nonlinear. There are many studies devoted to their buckling behaviour. Articles [1-7] detail the effect of various circumstances. One of these effects is the presence of geometrical errors: a significant fluctuation can be experienced in the experimental buckling loads because of very small and diverse geometrical errors.

As for thin-walled cans, because of the nonlinearities and the wide range of possible shapes, it is not possible to establish analytical models for the stability investigations. At the same time, numerical studies are available in the literature. Articles [8,9] focus on the stability of axially loaded aluminium (beverage) cans, with emphasis on the effect of initial geometrical imperfections. Scientific works [10,11] aim to predict the burst pressure level using commercial finite element software. As for the production process of aluminium cans, there are also available sources [12-15]. These later ones focus on one major step during the whole process (like blank drawing, or redrawing the cup).

During the plastic forming process of aerosol cans, the desired final geometry is always reached within a bunch of steps because if too much plastic deformation is applied in one step, buckling (pan) happens resulting in waste product. At the same time, if the number of shoulder shaping steps could be reduced or minimized, it would mean more efficient (faster) production process. Thus, there is a continuous demand to use the reserves in the material more and more efficiently. With the available commercial software packages, it is nowadays absolutely possible to support such efforts.

In this article, focus is put on one intermediate shoulder forming step. The effect of various parameters on this step is investigated numerically by means of commercial finite element computations. After the introduction, the initial data and the solution

method are discussed. These sections are followed by the numerical results, conclusions and references.

DATA AND SOLUTION METHOD

The initial (perfect) geometry of the investigated aerosol can is shown in Figure 1 with the so-called related reference values being listed hereinafter. The material is aluminium, modelled with linearly elastic and linearly hardening characteristic. The Young modulus is 73 GPa, the Poisson number is 0.4 with the yield stress being 0.17 GPa. The wall-thickness is constant 0.45 mm. The piece is constrained at its bottom against vertical displacement and, at its side of 42 mm height, against radial motion – as if the can was placed in a sleeve. There is a prescribed vertical displacement at the upmost edge of the can to initiate buckling.

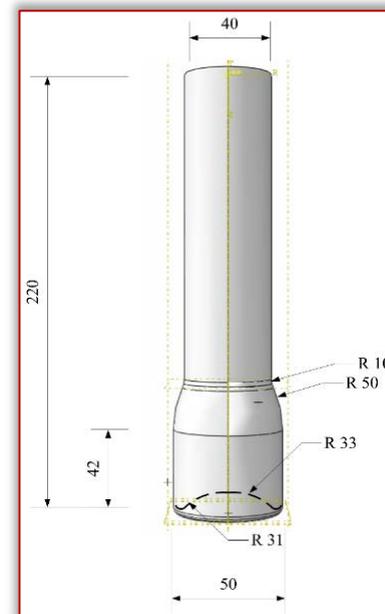


Figure 1. The initial geometry of the can
Numerical simulations are carried out using the commercial finite element software Abaqus 6.13. The can geometry is mapped by its middle surface, using

thin shell elements with reduced integration and large-strain formulation. The Static/Riks step with geometrical nonlinearities is selected to trace the primary equilibrium path and thus, to find the limit point corresponding to buckling. First, the load bearing abilities of the reference (or perfect) can is examined. Various small imperfections will then be introduced to the model to evaluate the influence of these perturbation effects. These imperfections are small (<5%) possible errors or changes in the material, geometry and forming tool angle.

In Abaqus, to introduce geometrical imperfections, the eigenshapes of the unloaded can are extracted using the Linear perturbation/Frequency step. Various scaled linear combination of these normalized shapes are then added to the perfect geometry within a possible manufacturing tolerance range to make the can geometry realistic.

To achieve converged and reliable results, simulations with multiple meshes and element types are carried out. The results are gathered in the forthcoming Section.

NUMERICAL RESULTS

First, the typical reference values are selected to get the reference value of the buckling load (if all the circumstances are ideal). As it can be seen from Figure 2, the buckled can shape is then – as expected – axisymmetric. This figure is plotted well after buckling with deformations magnified to be illustrative. Buckling occurs at the location of the radii change. The reference buckling load (reaction force) is $F_{ref}=5.73$ kN. The colour gradient shows the von Mises stress distribution.

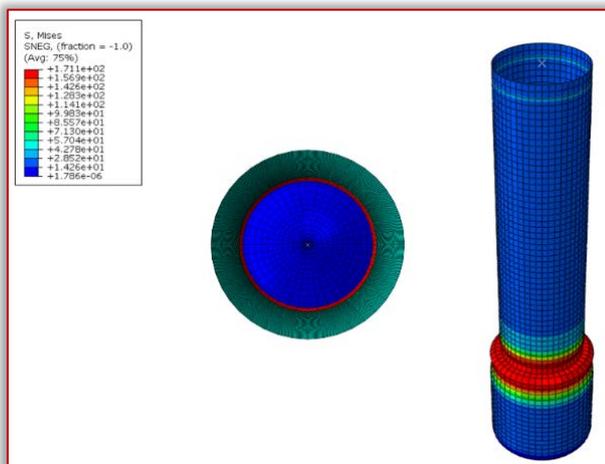


Figure 2. The buckled can shape if all the circumstances are ideal

Next, some of the possible eigenshapes are shown in Figure 3. The maximum displacement for these shapes is unit. It is clear that with diverse combination of such shapes, in essence, multiple disturbed can geometries can be mapped within a specified tolerance range.

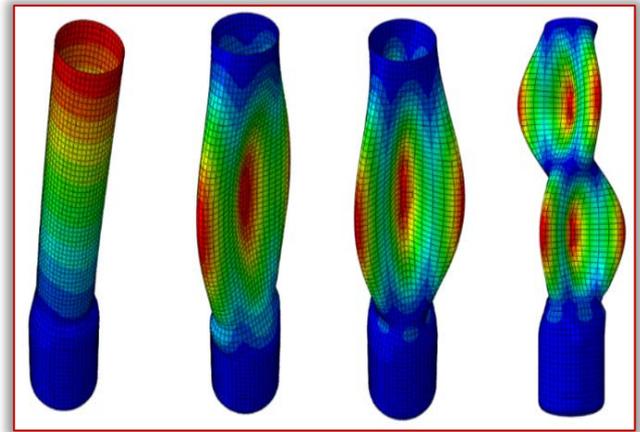


Figure 3. Some of the eigenshapes (magnified displacements)

The effect of various parameters are gathered in the diagrams of Figure 4. Here, $R=F/F_{ref}$ is the quotient of the critical force under imperfections and the reference buckling force. As it can be seen, the wall-thickness (t : ratio of the current and reference thicknesses) has clearly visible influence on R . Greater wall-thickness means greater geometrical stiffness and thus, better load bearing abilities. The plotted points can be approximated by a linear function with a good accuracy despite the nonlinear nature of the problem.

The following diagram presents the effect of the yield stress with all the other parameters left unchanged. It is the only material property having visible influence as a $\pm 5\%$ variation in the Young modulus and Poisson number have no effect at all on the can behaviour. Back to the yield stress, with y denoting the modified yield stress compared to the reference value, the overall effect is a bit less than the effect of the wall-thickness. The change is again linear.

Next, it is demonstrated what happens when the prescribed displacement at the top is not perfectly vertical but there is a small tilt in relation to the vertical axis – like the forming tool was driven askew. Letter a , this time, stands for the angle in degrees with respect to the vertical direction. With this angle, the buckling load decreases quite steeply. At, e.g., 0.5 degrees, R is 0.9 and at 1 degree, the load ratio is just 0.83.

Finally, the shape imperfection is tested with i being the maximum of the initial geometrical shape error in % compared to the wall thickness of the can. Since various eigenshape combinations are selected, the results are not constant but tend to change in a specific range – the upper and lower limits of these ranges are shown by markers in the last diagram of Figure 4. The presence of such imperfection always has negative effect on the buckling load. With i being greater, R is continuously decreasing.

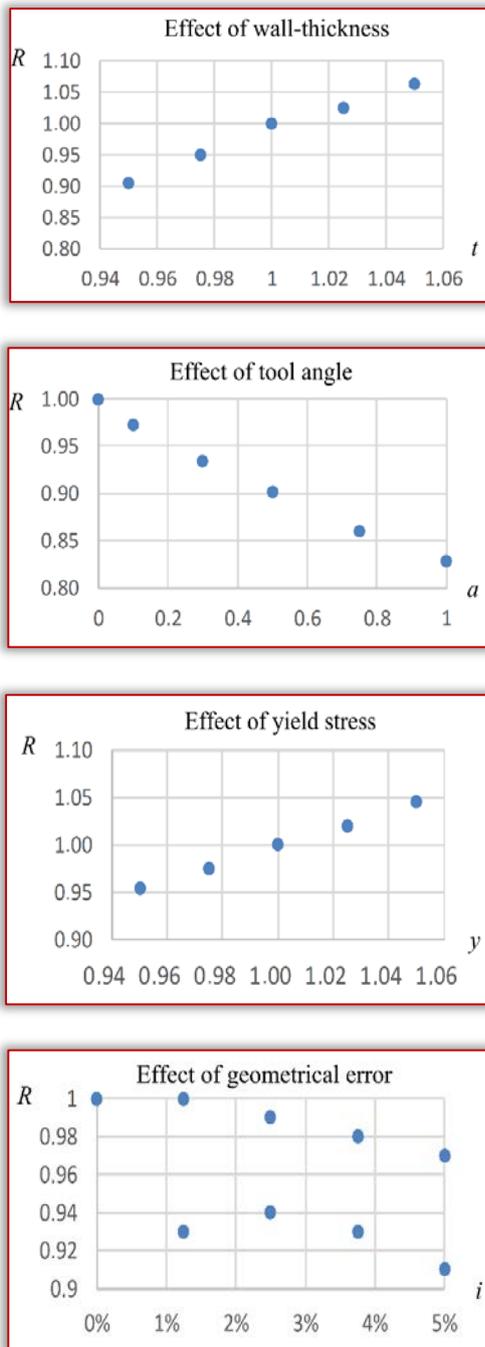


Figure 4. The effect of some properties on the buckling load

With some of these imperfections introduced, not only the buckling load but also the buckled shape changes as demonstrated in Figure 5. Meanwhile buckling still happens at the location of the radii change, the buckled geometries are not axisymmetric anymore and the critical section has polygonal shape.

Based on the above mentioned, it should be found out what happens with the buckling load when the most/least favourable values of these imperfections occur at once. Accordingly, it turns out that, the lowest possible buckling load is 4.11 kN and the greatest one is 6.37 kN. Thus, the ratio R can change in the range $[0.73-1.12]$ meaning that the potential negative effect of the imperfections is actually more

than the double of the possible positive one compared to the reference value.

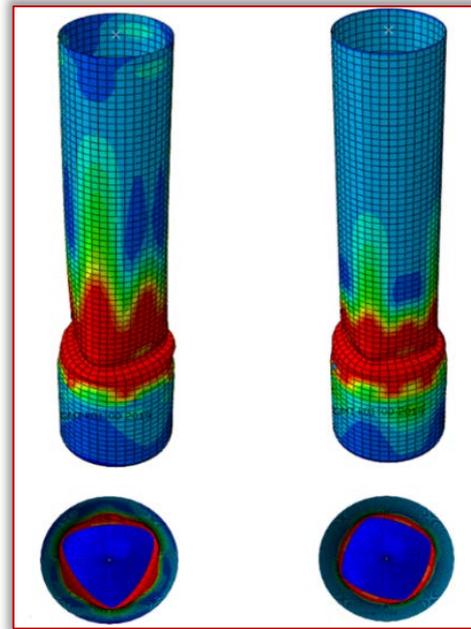


Figure 5. Possible buckled shapes with some imperfections introduced (magnified deformations)

CONCLUSION

The effect of various parameters on the load bearing ability of an aluminium can under plastic forming was investigated numerically with the commercial finite element software Abaqus. The geometry was mapped by 2D thin shell elements with nonlinearities included. It was found that small changes in one parameter have, in general, similarly rather small effects on the buckling load but if the least favourable values occur at the same time for all these parameters, the buckling load becomes significantly lower than for the reference (ideal) model. The potential negative effect is more than the double of the possible positive one. So, surely, the accuracy of the typical parameters are essential for two reasons. First, to reduce the number of waste product and second, because then it is possible to reduce the number of required forming steps to achieve the final shape of the can. Thus, the total forming time can be reduced so the mass production can become more effective.

It is also noted that it is necessary to investigate other geometries to reveal the effect of further parameters, like the radii and typical lengths. Furthermore, handling the issue as a contact problem could also make it more reliable.

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IMPLEMENTATION OF ENERGY RENOVATION OF BUILDINGS IN THE FIVE COUNTIES OF EASTERN CROATIA

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Abstract: This paper analyzes the final results of residential and public buildings energy renovation on the area of the Osijek-Baranja County as well as the beginning of energy renovation of residential and public buildings in the five counties of Eastern Croatia based on of signed contracts for energy renovation. The structure of purpose of public buildings by cities and settlements is presented an overview of the contracted projects with the number of funds for energy renovation of multi-residential buildings is given. The conclusion emphasizes the importance of energy renovation of buildings in terms of reducing energy consumption and reducing energy imports and emphasizes that energy distributors in the five counties of Eastern Croatia need to coordinate their business procurement plans for energy delivery.

Keywords: building energy consumption, energy renovation of buildings, public buildings, region of Slavonia, residential buildings

INTRODUCTION

Buildings consume more than 42.3% of total energy consumption, and in the last 30 years (due to rising standards) this share has been increasing. Most buildings in Croatia were built by the end of the 1980's and have little or no thermal insulation; such buildings consume 5 times more energy than buildings rated with energy class B, [1] [2].

The European Parliament and the Council adopted Directive 2012/27 / EU on energy efficiency [3]. Chapter 2 (Energy Efficiency) of the section 'Renovation of buildings' (Article 4) states: 'Member States shall establish a long-term strategy to encourage investment in the reconstruction of the national housing and commercial buildings, public and private (The first version of the strategy shall be published by 30 April 2014 and subsequently updated every three years and forwarded to the Commission as part of national energy efficiency action plans). In Art.5. "Public authority buildings as a model" points out "EU Member States are obliged to rebuild 3% of the total floor area of heated and / or cooled buildings owned and used by the central government under Directive 2012/27 / EU as of 1 January 2014. "The goal is to encourage the renovation of energy-efficient publicly owned buildings to reduce the cost of maintaining them and at the same time to give an example to citizens that energy renovation results not only in energy and financial savings but also in better quality of space use. [3].

Pursuant to the said directive, the Government of the Republic of Croatia adopted: "Public Sector Buildings Energy Recovery Program 2014-2015" [4], Multifamily Buildings Energy Renovation Program

2014-2020 [5] and Public Sector Buildings Energy Recovery Program for the period 2016-2020 [6] and the Environmental and Energy Efficiency Fund and the Ministry of Construction and Physical Planning have been designated as implementing bodies.

According to data from the National Energy Management Information System (ISGE), in 2010, the Republic of Croatia recorded 13.8 million m² of usable floor space of public sector buildings; and 43.9% of the surface is in heating mode. The implementation of energy efficiency measures, ie energy renovation, plans to reduce energy consumption in public sector buildings by 30 to 60%, ie to 150 kWh/m² per year and reduce CO₂ emissions by about 20,500 tons per year [7]. In 2017, the call 'Energy renovation of buildings and use of renewable energy sources in public sector buildings' was opened, which provided HRK 380 million for the energy renovation of public sector buildings. The minimum grant awarded to finance eligible project costs was 10,806 € and a maximum of 5.4 mil. €. The grants were awarded through an open grant procedure in a permanent call modality.

ENERGY RENOVATION OF BUILDINGS IN OSIJEK-BARANJA COUNTY

— Public buildings

Public buildings include public buildings - performing activities in the field of social activities (education, education, science, culture, sports, health and social care), work of state bodies and organizations, bodies and organizations of local and regional self-government, legal entities with public authority, banks, savings banks and other financial organizations, international institutions, chambers of commerce and industry and other associations,

religious communities, passengers in public transport and users of postal and electronic communications services.

- Within the Call 4c1.2 - Pilot project "Energy renovation of buildings and use of renewable energy sources in public institutions engaged in education" - one project "Energy renovation of Primary School building" was completed in the territory of Osijek-Baranja County (OBZ). Vladimir Nazor ", Đakovo [9].

- Under Call 4c1.3. - "Energy renovation of buildings and use of renewable energy sources in public institutions engaged in education" [10] - 24 projects were implemented in the area of OBŽ; thus, the buildings of three kindergartens (Belišće, Đakovo, Našice), 11 primary school buildings (2x Čepin, Dalj, Feričanci, Koška, Ladimirevci, 2x Osijek, Semeljci, Valpovo and Vuka) and six regional school buildings (Črnkovci, Kapelna, Kotlina, Kozarac, Novi Beždan and Petlovac) and four high school buildings (Beli Manastir, Đakovo, Našice and Osijek). The annual heat demand for heating per unit area of the useful floor building area- QH_{nd} [kWh/(m²a)] - before construction works was 7,150 MWh per year in these buildings, and the projected future consumption will be 2,067 MWh per year - which makes projected savings of 71%.

- The annual primary energy consumption per useful floor area unit of the building E_{prim} [kWh/(m²a)] before reconstruction works was 10,848 MWh, and the projected future consumption will be 4,237 MWh per year (Annual primary energy per unit area of the useful floor space of an Eprim building [kWh/(m²a)] includes all energy before transformation used for heating, cooling, ventilation and domestic hot water preparation.) Fig. 1.

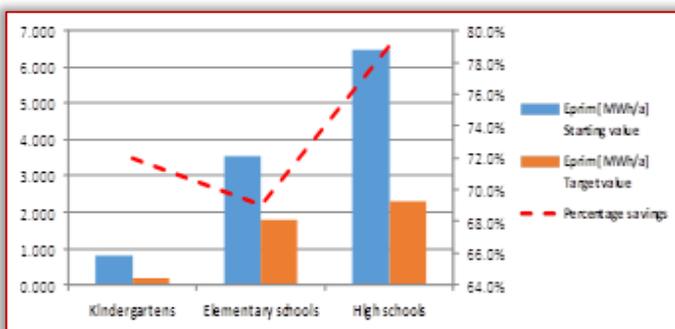


Figure 1. Required energy for heating per unit area of usable building area in energy renovated public buildings in Osijek-Baranja County [11]

- Under Call 4c1.4. (Energy Renewal and Use of Renewable Energy Sources in Public Sector Buildings) There are 11 projects in the area of OBŽ in which works have been started (in 8 settlements) or construction works have been completed (in 3 settlements). It is about energy renewal and use of renewable energy sources in buildings of voluntary

fire companies (5), buildings of sports facilities (3), community center (1), kindergarten (1) and administrative building of the local authority units (JLS) (1). The annual heat demand for heating per unit area of the useful floor area of the building - QH_{nd} [kWh/(m²a)] - before construction works amounted to 1,147 MWh per year in these facilities, and the projected future consumption will be 341 MWh per year - which makes projected savings of 70.3%

ENERGY RENEWAL CONTRACTS OF BUILDINGS IN THE AREA OF EASTERN CROATIA

—Energy renovation of apartment buildings

At the invitation of the Ministry of Construction and Physical Planning for the energy renovation of multi-residential buildings from the Slavonia region (five counties of Eastern Croatia; Fig. 2), over 100 projects (buildings) were submitted, of which 112 were accepted (from 20 settlements) for a total amount of 11.6 mil. € (Out of 648 submitted projects, 596 projects were accepted from all counties in the Republic of Croatia.) Fig. 3. The average value of the projects is 103,800 €.

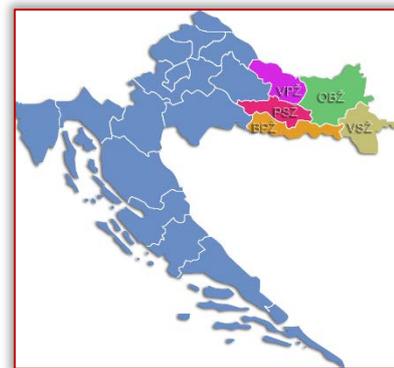


Figure 2. The five counties of Eastern Croatia

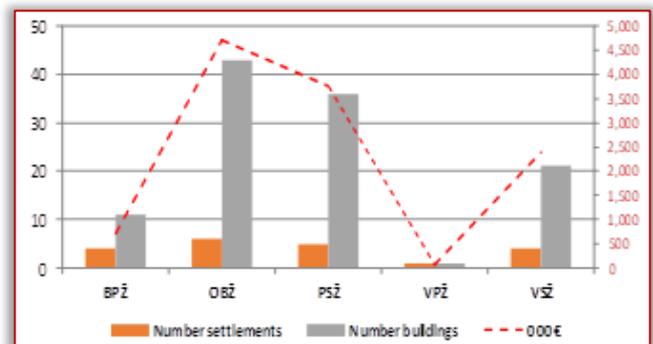


Figure 3. Number of settlements, number of buildings and amount of funds for energy renovation of multifamily buildings in the five counties of Eastern Croatia [9];

Legend: BPŽ = SlavonSKI Brod county; OBŽ = Osječko-baranjska county; PSŽ = Požeška county; VPŽ = Virovica county; VSŽ = Vukovar county;

In the case of energy renovation of multifamily buildings, construction works are undertaken to improve the thermal protection of the building envelope and to replace the exterior joinery; the projected savings for these projects are between 50%

and 70% of the heating/cooling energy per building. Table 1 shows the number of settlements and the number of apartments buildings in energy renovation by county.

Table 1. Number of settlements and number of multi-dwelling buildings under energy renovation in the five counties of Eastern Croatia, source [9]

	BPŽ	OBŽ	PSŽ	VPŽ	VSŽ
N° buildings	4	6	5	1	4
N° settlements	11	44	35	1	21

—Energy renovation of public buildings

At the invitation of the Ministry of Construction and Physical Planning for the Energy Renovation of Public Buildings from the Five Counties of Eastern Croatia, over two hundred projects were submitted, of which 195 were accepted (out of 92 settlements) for a total amount of 49.6 mil. €. The average value of projects is 253,934 €, Fig. 4.

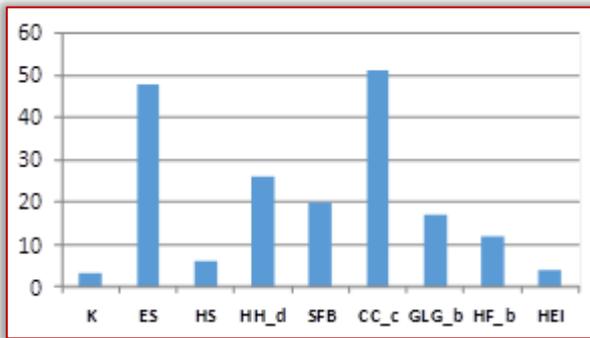


Figure 5. Number of public buildings by purpose to energy renovation on area of five counties of Eastern Croatia [9] [10];

Legend: K= kindergarten; E_s = elementary School; H_s = high school; HH_d = hospitals, health centers, dispensaries; SFB = sports facilities buildings; CC_C = community centers, culture centers, reading rooms; GLG_b = government and local government buildings; HF_b = homes of fire companies; HEI = homes for elderly and infirm

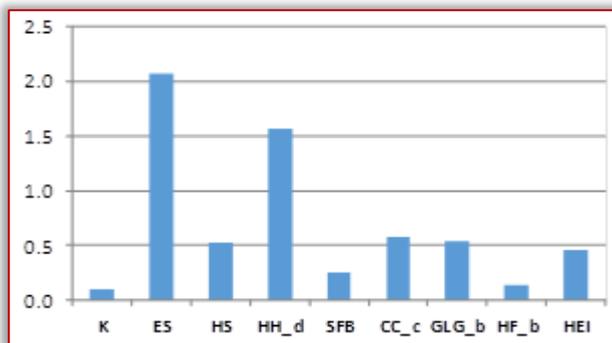


Figure 6. The value of the investment in energy renovation of public buildings by purpose in the five counties of Eastern Croatia (mil. €) [9] [10];

National currency average exchange rate for 1 € [13]

≡ Croatia = 7.4035 kuna;

- ≡ Bosnia and Herzegovina = 1.95583 convertible mark;
- ≡ Bulgaria = 1.9558 lev;
- ≡ Hungaria = 330.26 forint;
- ≡ Macedonia = 61.4893 denar;
- ≡ Romania = 4.7271 leu;
- ≡ Serbia = 117.8172 dinar;
- ≡ Turkey = 6.4594 lira

Base on the invitation from the Ministry of Construction and Physical Planning for the energy renovation the total contracted funding for energy renovation projects for apartments buildings and public buildings in the five counties of Eastern Croatia is shown in Fig. 7.

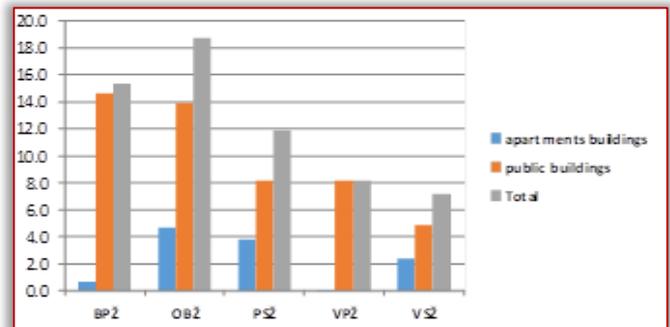


Figure 7. Total contracted funds for apartments buildings and public buildings to energy renovation projects in the five counties of Eastern Croatia (mil.€) [9] [10]

CONCLUSIONS

Following the adoption of national programs for the energy renovation of public and apartments buildings in the Republic of Croatia, grants from EU funds were secured in the preparatory phase for 3 years in the period from 2017 to 2019. Four public calls for energy renovation of public and apartments buildings were made. Within the framework of these public calls, local self-government units, counties, state bodies and public institutions (for public buildings) as building managers (for multi-residential buildings) from the five counties of Eastern Croatia applied over three hundred projects, of which 195 were accepted for public buildings in totaling € 49.6 million and 112 for apartment buildings totaling € 11.6 million. Therefore, at this stage of energy renovation of buildings in the five counties of Eastern Croatia, an energy renovation of 307 public-purpose and apartments buildings with a total value of € 61.2 million was agreed.

Most of these projects were implemented at the end of July and the rest will be completed by the end of 2019. According to projections from the contracted projects, the consumption of energy for heating/cooling will be reduced in the range from 52 to 81% for individual buildings.

The implementation of these projects is significant for several reasons:

- a) Energy consumption per unit of housing and business is reduced - which will have a positive impact on reducing the costs of family budgets and budgets of local and regional self-government units and state bodies.
- b) Imports of energy (natural gas, petroleum products, and electricity) to Croatia are decreasing - which contributes to improving the country's trade balance.
- c) CO₂ emissions are reduced - which contributes to the fulfillment of Croatia's obligations under the Kyoto Protocol, that is, to preserve the planet's climate regime.
- d) Local labor is employed in the construction sector - contributing to a reduction in unemployment and an increase in GDP in Croatia.

With regard to all of the above, we warn fuel distributors and central heating systems in the five counties of Eastern Croatia of the need for a more detailed reference to energy renovation projects for buildings to harmonize their business procurement plans for energy delivery on time [12].

Note:

This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty “Mihajlo Pupin” Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 03–04 October, 2019.

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SOME ASPECTS OF THE ELECTRICAL POWER QUALITY

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Abstract: The paper presents basic definitions, terms and indicators of the quality of electricity. Higher harmonics and their consequences are presented. Degradation of basic voltage parameters (effective value, frequency, phase shift, symmetry, etc.) as well as waveform distortion, ie short-term or long-term deviations from the sinusoidal shape (higher harmonics, short-term interruptions, voltage failures, impulse overvoltages and others) represents a low-frequency part of the conduction disturbances that most affect the voltage quality as part of the electromagnetic compatibility problem. Basic standards and recommendations for controlling higher harmonics in electrical networks are given.

Keywords: electrical power quality, higher harmonics, standards

INTRODUCTION

The concept of quality of electricity is complex [1-4], because in addition to user, ecological and commercial quality it implies technical quality as a synonym for the quality of electricity, which includes problems of reliability and security of power supply, overall stability of system operation, numerous disruptions as well as the rental ratio of the electric power system - consumer and vice versa.

The problem of the technical quality of electricity is any phenomenon that is reflected in the disturbance of the basic parameters of the voltage in the established or transient states, disturbing the waveforms of the voltage and the current, their phase shift as well as the deviation of the frequency [1-4]. Ideally, the voltage of the electrical network should be the sine waveform, the nominal frequency, the nominal effective value, while the ideal current is also sinusoidal, without harmonic distortion and in the phase with voltage [1-4]. In reality, however, the quality of the delivered electricity is impaired by various irregularities, such as: overvoltages, undervoltage, short-term voltage abnormalities, voltage peaks, flickers, higher harmonics, etc.

Non-linear consumers (electrical energy devices, electric machines, electric furnaces and others) have a dominant influence on the physical voltage quality, transient phenomena due to commutations in the system with switches, automatic re-switch, switching on / off of large consumers etc.).

The switching nature of the operation of the power electronics device and the consumption of non-ionic currents causes the appearance of higher harmonics, deforms the waveform of the network voltage, a weak power factor, causes electromagnetic interference, and hence degrades the quality of electricity.

Degradation of basic voltage parameters (effective value, frequency, phase shift, symmetry, etc.) as well as waveform distortion, ie short-term or long-term

deviations from the sinusoidal shape (higher harmonics, short-term interruptions, voltage failures, impulse overvoltages and others) represents a low-frequency part of the conduction disturbances that most affect the voltage quality as one part of the EMC problem [1-4].

Today there are extensive research of quality parameters, continuous testing and supplementation of technical regulations for limitations of harmonics and flicker levels, more stringent standards for connecting non-linear consumers are introduced. Based on the large number of research papers, and in particular the recommendations of the working groups, the relevant organizations relevant to the EMC, international and national standards are continuously updated, adjusted and improved.

BASIC DEFINITIONS, TERMS AND INDICATORS OF THE QUALITY OF ELECTRICITY

Many answers apply to this simple question. They all depend on your perspective. From the utility perspective, Power Quality has been defined as the parameters of the voltage that affect the customer's supersensitive equipment. From the power user perspective, Power Quality may be defined as any electrical parameter or connection that affects the operation of the equipment. This includes all electrical parameters, connections and grounds, whether the source from the utility, local equipment or other users. From the Power Quality market or industry perspective, it is any product or service that is supplied to users or utilities to measure, treat, remedy, educate engineers or prevent Power Quality issues, problems and related items.

Power distribution systems, ideally, should provide their customers with an uninterrupted flow of energy with a clean sinusoidal voltage at the contracted voltage level (110kV, 30kV, 10kV, 415V) and frequency (50Hz) (Fig.1). However, in practice, power systems, face a variety of challenges either

from generation, transmission and distribution or even within a customer facility which impacts the quality of power. These power quality issues can affect the uninterrupted operation of customer loads, but the safety-related issues can reduce the life of the connected loads and electrical equipment. A customer having numerous nonlinear loads can also affect the quality of power supply and the purity of the voltage waveform is lost which can affect other loads within the facility or even outside the customer facility. Apart from nonlinear loads, some system events, both usual (e.g. capacitor switching, motor starting) and unusual (e.g. faults) could also inflict power quality (PQ) problems.

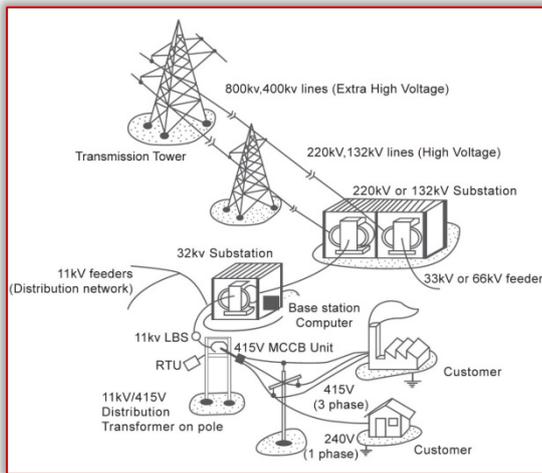
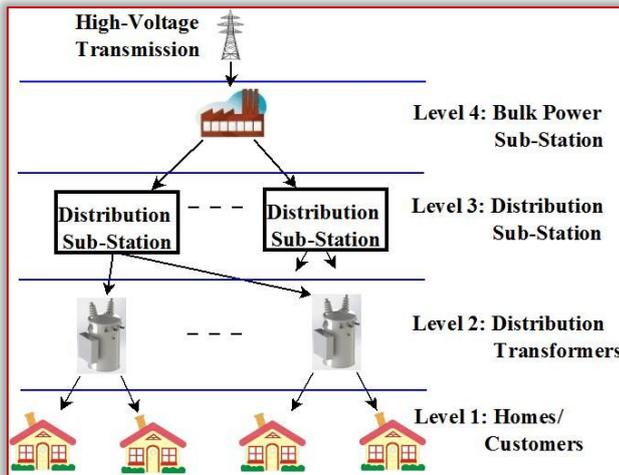


Figure 1. Typical electricity distribution hierarchy. The quality of electricity is mostly related to the quality of voltage and frequency, i.e. their deviation from the nominal value as well as the comparison of the waveforms of the current and voltage relative to the ideal sinusoid. The basic parameters and deformation of waveforms, among others, are two groups of factors that determine the quality of the used voltage [2]. The basic parameters of the used voltage include the variation of the effective value of the voltage, frequency and the occurrence of an asymmetry in the supply. The deformation of the waveforms of the voltage includes

the following states: stable states of the system (harmonics, voltage notches, flickers and noise), transient regime of the system (overvoltages, undervoltage, voltage failure, voltage overload, short-circuit breaks) and transient states (impulses and oscillations). On Fig.2 gives an overview of the factors of the quality of the used voltage.

Harmonics are sinusoidal voltages and currents at frequencies that are integers of the basic network frequency. Distorted waveforms consist of a fundamental component and components with frequencies up to 5 kHz (Fig.3).

Voltage cutouts are periodic intermittent faults that last less than 1 ms, typically 0.3 ms. The result is commutations with a network of switched converters. Typical values are in the range 10 -90% of the nominal voltage.

Noise (electromagnetic interference): corresponds to high frequency electromagnetic noise, which can, for instance, be produced by the fast switching of electronic power converters (Fig.4).

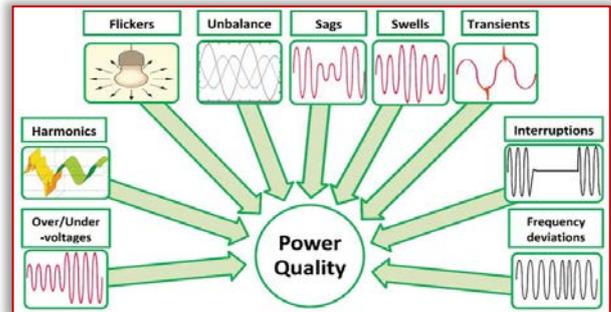


Figure 2. The common power quality problems

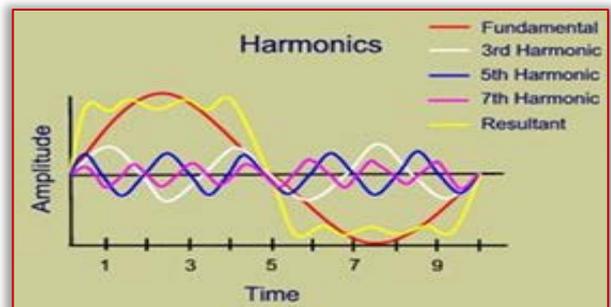


Figure 3. Decomposition example of a complex distorted signal, as addition of 50Hz fundamental and 3rd, 5th and 7th harmonics (150Hz, 250Hz, 350Hz respectively).

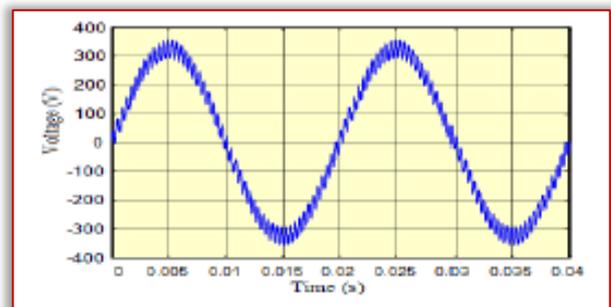


Figure 4. Noise (electromagnetic interference) [6]

Momentary interruption: occurs, for instance, when the electrical system has automatic reset circuit breakers, that opens when a fault occurs, closing automatically after some milliseconds (and is kept closed if the short-circuit is extinguished) (Fig.5.).

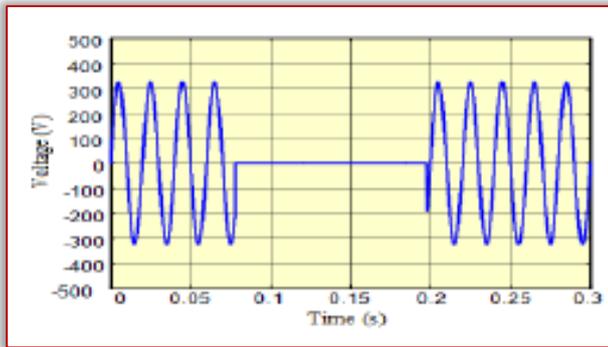


Figure 5. Momentary interruption

Voltage sag: can be caused, for instance, by a momentary short-circuit at another branch of the same electrical system, which is eliminated after some milliseconds by the opening of the branch circuit breaker (Fig.6.).

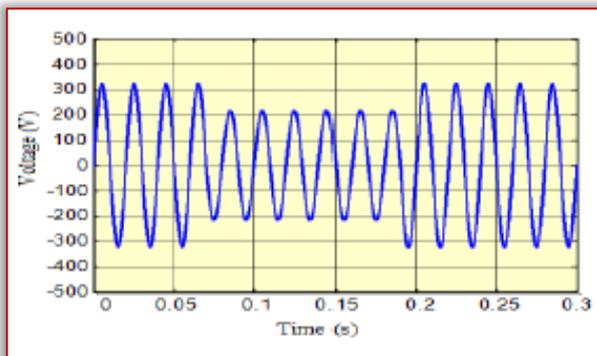


Figure 6. Voltage sag [6]

Voltage swell: can be caused, amongst other cases, by fault situations or by commutation operations of equipments connected to the electrical grid (Fig.7).

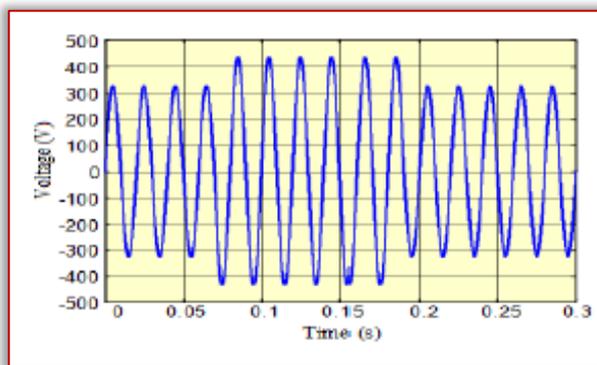


Figure 7. Voltage swell

Flicker: it happens due to intermittent variations of certain loads, causing voltage fluctuations (which results, for instance, in oscillations on electric light intensity) (Fig.8).

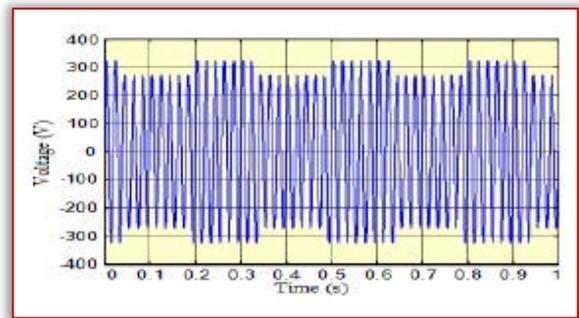


Figure 8. Flicker

Notches: Consist in small periodic cuts on the voltage waveform, which result from voltage drops on the line inductances of the electrical system. These occur due to loads which consume currents with abrupt periodical variations (like rectifiers with capacitive or inductive filter) (Fig.9).

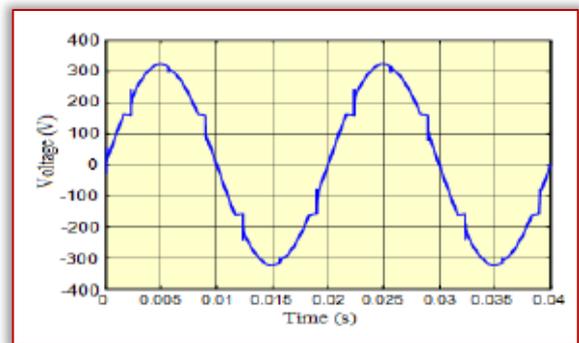


Figure 9. Notches [6]

Transients: occur as a result of transitory phenomena, such as capacitor bank switching or atmospheric discharges (Fig. 10).

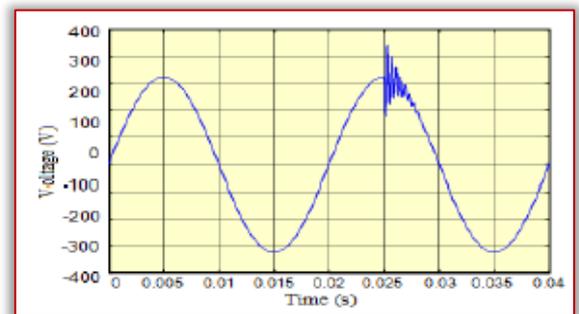


Figure 10. Transients

HARMONICS AND THEIR CONSEQUENCES

One of the definitions of harmonics is that it represents a periodic oscillation present in a complex function, the value of which is an integer multiplication of the basic frequency [2-4]. Similarly, in electrical engineering according to the IEC vocabulary, the term harmonics is a component of a Fourier order of some periodic size whose order is greater than one. Harmonics occur even in the process of electricity generation, transmission and by individual consumers.

The development of powerful semiconductor components, and a series of new topologies of power

converters, have led to their widespread use. The non-linear (switching) nature of these devices is the cause of higher harmonics of voltage and current in the network to which they are connected, and when it comes to the high power of these devices or a larger number of devices, less power makes them the main cause of the disruption of the quality of electricity.

Higher harmonics cause a variety of side effects. These are interruptions in the operation of computers, faults in the operation of protective equipment, measurement errors, overvoltages, interference with communication and signaling devices, additional heating of electrical machines, etc. All of these effects can have very serious technical and economic consequences, so today special attention is paid to the problem of eliminating higher harmonics from the network.

The current modern electrical and electronic equipment should be designed to work reliably even under "polluted" conditions, since any limitation of the higher harmonics level must respect real technical, technological and economic conditions, since the complete elimination of higher harmonics is practically impossible [2-5].

For complete processing and analysis of higher harmonics, it is necessary to gain insight into different aspects of their appearance, influence, measurement (measuring size, places and methods of measurement), monitoring methods, standardization (standards, recommendations, instructions, harmonization of regulation) and, ultimately, effective elimination of harmonics [2-4]. All these aspects of higher harmonics are processed as part of a comprehensive topic of electromagnetic compatibility (EMC).

According to the frequency range, four types of harmonics are distinguished:

1. subharmonic - the frequency that is part of the basic, i.e. $f_n = f_1 / n$ where:

f_1 - basic frequency (50 or 60 Hz),

n - natural number (2, 3, 5 ...)

The effect of the subharmonic is reflected in the flicker of light (flicker). The biggest "producers" of the subharmonic are the electric furnace furnaces.

2. low-frequency harmonics-frequencies that are multiply basic, i.e. $f_n = nf_1$

In this case, the value is usually less than 100. Low-frequency harmonics are those most commonly called "higher harmonics". In the analysis, most often go to the 25th harmonica, and recently to 50. Their most common source is rectifiers, inverters, cyclone converters, saturated transformers, rotary electric machines, electric furnaces, etc.

3. interharmonic - fractional harmonics or asynchronous harmonics, frequencies that are not

integer multiples of the basic frequency (f_1), f_n less than 10 kHz. They are mainly connected to the operation of the electric motor drive with speed control by means of a converter coupler adapter - inverter. Negatively affect systems for tone-frequency command and telemetry, which use power lines for signal transmission.

4. high-frequency harmonics - often called radio interference, frequencies exceeding 10 kHz. The result of commutation transitions in energy switching components and negatively affect telecommunication signals as well as the operation of microcircuits in computer systems.

Higher harmonics are one of the main parameters of the quality of electricity, and most often appear as a result of the work of a large number of non-linear consumers. Since equipment and consumers need to show a certain degree of tolerance or immunity to multiple harmonics, from this aspect higher harmonics appear as part of the problem of electromagnetic compatibility, as high-frequency conductive disturbances [2-5].

The vast majority of the problems that occur on electrical systems have its origins on the excessive distortion of the currents or voltages near the final consumer. The main cause for this phenomena, which can be regarded has a sort of electromagnetic environment pollution, is due to the growth of the usage of electronic equipment fed by the electrical grid, such as computers, printers, television sets, electronic ballasts for gas-discharge lamps, electronic controllers for different varieties of industrial loads, etc. Almost every electronic equipments, single-phase or three phase, embodies a rectifier circuit at its entrance, followed by a commuted converter of the type DC-DC or DC-AC. One of the most usual rectifiers for low-power equipments is the single-phase full wave rectifier with capacitive filter, which has a highly distorted current consumption, as it can be seen on figures 11 and 12.

The current's high harmonic content distorts the voltage on the loads due to the voltage drops in the electrical systems impedances. Phase fired controllers, widely used to control power consumption of heating systems and to adjust luminous intensity of lamps (dimmers), also consume currents with substantial harmonic content and with high-frequency electromagnetic interference. Even the ordinary fluorescent lamps contribute significantly for the presence of harmonics in the electrical grid, due to the non-linear behavior of the electrical discharges on the gaseous environment, and also to the ballast's magnetic circuit, that can operate on the saturation region.

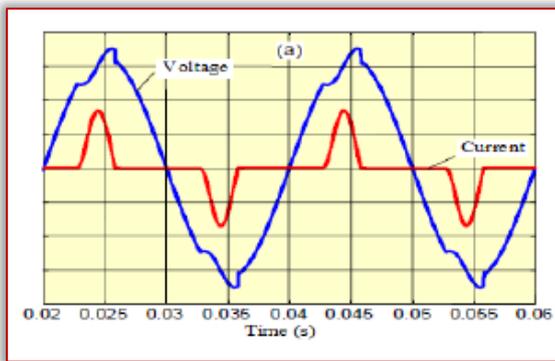


Figure 11. Voltage and current in a single phase rectifier with a capacitive filter [6]

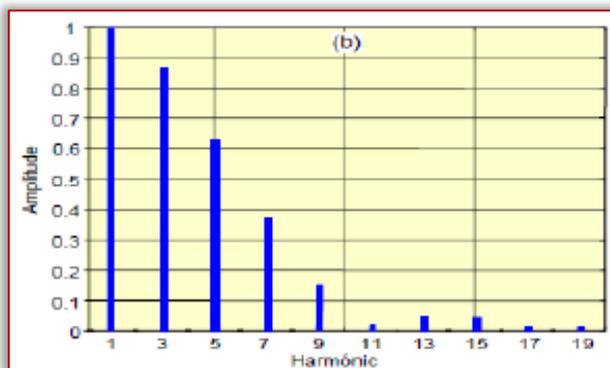


Figure 12. Harmonic of the current in input [6]

OVERVIEW OF IEC STANDARDS ON HARMONICS

The International Electrotechnical Commission (IEC), currently with headquarters in Geneva, Switzerland, has defined a category of electromagnetic compatibility (EMC) standards that deal with power quality issues. The term electromagnetic compatibility includes concerns for both radiated and conducted interference with end-use equipment. The IEC standards are broken down into six parts [7]:

- **Part 1: General.** These standards deal with general considerations such as introduction, fundamental principles, rationale, definitions, and terminologies. They can also describe the application and interpretation of fundamental definitions and terms. Their designation number is IEC 61000-1-x.
- **Part 2: Environment.** These standards define characteristics of the environment where equipment will be applied, the classification of such environment, and its compatibility levels. Their designation number is IEC 61000-2-x [7]:.
- **Part 3: Limits.** These standards define the permissible levels of emissions that can be generated by equipment connected to the environment. They set numerical emission limits and also immunity limits. Their designation number is IEC 61000-3-x.
- **Part 4: Testing and measurement techniques.** These standards provide detailed guidelines for measurement equipment and test procedures to

ensure compliance with the other parts of the standards. Their designation number is IEC 61000-4-x.

- **Part 5: Installation and mitigation guidelines.** These standards provide guidelines in application of equipment such as earthing and cabling of electrical and electronic systems for ensuring electromagnetic compatibility among electrical and electronic apparatus or systems. They also describe protection concepts for civil facilities against the high-altitude electromagnetic pulse (HEMP) due to highaltitude nuclear explosions. They are designated with IEC 61000-5-x.
- **Part 6: Miscellaneous.** These standards are generic standards defining immunity and emission levels required for equipment in general categories or for specific types of equipment. Their designation number is IEC 61000-6-x.
- Unlike the IEEE standards on harmonics where there is only a single publication covering all issues related to harmonics, IEC standards on harmonics are separated into several publications. There are standards dealing with environments and limits which are further broken down based on the voltage and current levels. These key standards are as follows:
 - **IEC 61000-2-2 (1993):** Electromagnetic Compatibility (EMC). Part 2: Environment. Section 2: Compatibility Levels for Low-Frequency Conducted Disturbances and Signaling in Public Low-Voltage Power Supply Systems [7].
 - **IEC 61000-3-2 (2000):** Electromagnetic Compatibility (EMC). Part 3: Limits. Section 2: Limits for Harmonic Current Emissions (Equipment Input Current Up to and Including 16 A per Phase).
 - **IEC 61000-3-4 (1998):** Electromagnetic Compatibility (EMC). Part 3: Limits. Section 4: Limitation of Emission of Harmonic Currents in Low-Voltage Power Supply Systems for Equipment with Rated Current Greater Than 16 A.
 - **IEC 61000-3-6 (1996):** Electromagnetic Compatibility (EMC). Part 3: Limits. Section 6: Assessment of Emission Limits for Distorting Loads in MV and HV Power Systems. Basic EMC publication.

CONCLUSION

The quality of electricity is mostly related to the quality of voltage and frequency, i.e. their deviation from the nominal value as well as the comparison of the waveforms of the current and voltage relative to the ideal sinusoid. There are a number of electrical devices that have nonlinear operating characteristics i.e. even when the applied voltage is sinusoidal in nature, the current drawn by the device is nonsinusoidal in nature. These nonlinear devices used in power distribution circuits create nonlinear

currents and which subsequently causes voltage distortions. These nonlinear currents and voltages have been generally referred to as harmonic currents and voltages. The proliferation of electronic switching devices in modern equipment has resulted in a significant increase in the amount of harmonic pollution in the electrical distribution systems. Harmonic currents and voltages can cause many unfavorable effects on the power system itself and the connected loads.

Note:

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EXPERIENCE IN THE USE OF OIL-MINERAL AGGREGATION FOR LIQUIDATION OF EMERGENCY OIL SPILLS IN ICY SEAS

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Abstract: The influence of the process of oil-mineral aggregation on the emulsification of oil and dark oil products in world practice has been known since the end of the last century. Despite a significant number of studies indicating the applicability of this process for cleaning coastlines from accidental spills, the effectiveness of oil-mineral aggregation in the elimination of oil slicks in open water and in ice conditions of the shelf zone is not well understood. Of particular interest is the study and evaluation of the effectiveness of this process from the point of view of bioremediation, hydrometeorological conditions, physico-chemical properties of the spilled product and the technology of work. This paper provides a brief overview of world studies on the study of the oil and mineral aggregation process to assess its applicability as a response to emergency oil spills in ice seas.

Keywords: oil-mineral aggregation process, oil spill response, icy seas, clay-oil flocculation

INTRODUCTION

Since the widespread use of dispersants as a means of responding to emergency oil spills in ice seas is constrained by a number of factors [1, 2], there are few examples in the world practice of using the oil-mineral aggregation process for these purposes [3]. The process of oil-mineral aggregation (OMA) involves the interaction of oil globules and fine particles of sedimentary rocks, which leads to the formation of new compounds - microaggregates, the structure of which prevents the re-coalescence of oil. Thus obtained oil-mineral microaggregates (OMM) allow, under certain conditions, to disperse oil spills to concentrations below threshold toxic levels, as well as accelerate the natural processes of their biodegradation.

In theory, with sufficient wave energy of mixing, the oil slick disperses in the aqueous phase in the form of micron-sized oil globules (Fig. 1), stabilized, as a rule, on the surface with finely dispersed mineral particles.

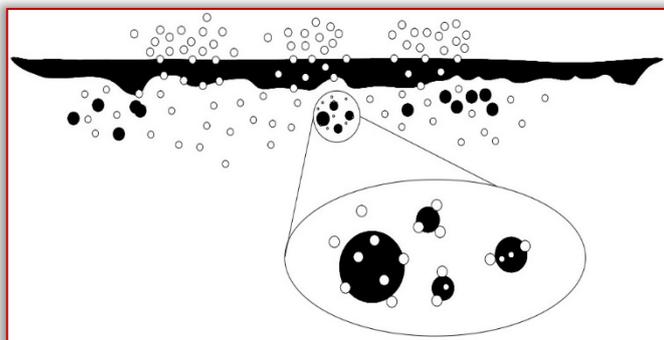


Figure 1. Dispersion of oil slick in the water column by OMA

The resulting petemineral microaggregates reduce the adhesion of oil to solid surfaces, promote the formation of stable globules, preventing re-coalescence of oil, which leads not only to its

dispersion in the liquid column, but also to an increase in the rate and degree of microbiological degradation due to an increase in the oil-in-water interface compared to oil slick [4].

The most common type of OMM is an oil globule stabilized over the surface of fine particles of sedimentary rocks. However, the authors of [5] described OMMs, which are a core covered by a layer of oil from a rock particle, as well as large OMMs of a membrane structure. Observed by the authors of the OMM oil-covered clay had an oblong, curved or even branched shape. Membrane OMMs reached several millimeters in length, had a flaky shape (Fig. 2) and positive or neutral (zero) buoyancy.



Figure 2. Flake-type membrane OMM [5]

MATERIAL AND METHODS

— Clay-oil flocculation

A prerequisite for using the OMA-process as a response to emergency oil spills in offshore areas was the Exxon Valdez tanker accident in March 1989.

As a result of the release of oil from an Exxon tanker off the coast of Alaska, about 260 thousand barrels of

oil spilled into the water of the Prince William Strait with the formation of a spot with an area of 28 thousand square kilometers. The inaccessibility of the accident area made it impossible to timely localize the oil spill, which led to the spread of the stain to the prince Wilhelm Strait. A day after the accident, a spot on the surface of the water was treated with dispersant sprayed from an airplane, but due to the lack of disturbance at sea, there was no significant effect (only 1% of the volume of spilled oil was transferred to the bottom layer). Incineration measures also did not take effect due to weather conditions. The work of skimmers was limited by the thickness of the slick film and by the fact that the oil managed to mix with brown algae in the water per day. Thus, about two thousand kilometers of the coastline were polluted.

A few years after observing the ecosystems of contaminated territories, researchers [6] found that some of the methods and tools used after the Exxon Valdez tanker accident to eliminate the oil spill on the coastline could be more harmful to the environment than their lack of. At the same time, the researchers for the first time noted the effect of “self-cleaning” of beach areas composed of sedimentary rocks.

A similar effect was observed and was used in response to the emergency spill in Tampa Bay (USA), when on August 10, 1993, as a result of the collision of the ocean-255 tanker barge, the B-155 tanker barge and the Balsa 37 cargo ship South of the Mullet Key Island in the Gulf of Mexico, about 1,000 barrels of diesel fuel and 10,500 barrels of fuel oil were dumped into the water. Most of the resulting hydrocarbon mixture, drifting along the surface of the water along the coast, contaminated almost 21 km of the sandy beaches of Pinellas Park (Florida). [7]

A probable explanation for this “natural self-cleaning” was given by the authors [8, 9] at the XVII Arctic and Marine Oilspill Program (AMOP) in 1994, and the process of the interaction of oil and fine particles of sedimentary rocks was originally called “clay-oil flocculation”.

— Wave washing

When liquidating a spill on the coast of the Tampa Bay, an attempt was first made to use the “clay-oil flocculation” process as an additional measure to combat pollution. After excavating 39827 cubic yards of oil-contaminated sand, the remaining soil was mixed and transferred from the upper littoral and supralittoral zone to the lower. Since during the operations the wave action in the surf zone was minimal (breakers with a height of less than 10 cm), the recorded accelerated removal of oil from the soil was associated with the interaction of oil and mineral particles, and not with physical abrasion [7]. These observations were correlated with the results of field tests previously carried out by researchers [10, 11] on

beaches with low wave energy surfs, as a result of which it was found that mechanical mixing procedures increase the rate of dispersion of oil from contaminated soils.

Thus, the prerequisites were created for the emergence of a new approach to the elimination of emergency oil spills in coastal environments with insufficient hydraulic energy, which could be used in addition to the traditionally used excavation and mechanical mixing and on rocky beaches.

This method, which consists in transferring oil-soaked soil forming a coastal surface to the surf zone, where a wave action stimulates the formation of oil globules, resuspension of sedimentary rock particles and the formation of OMM (Fig. 3), was called “wave washing” (or “washing of beaches”) and was successfully tested in the aftermath of the Sea Empress tanker accident. [12-14]

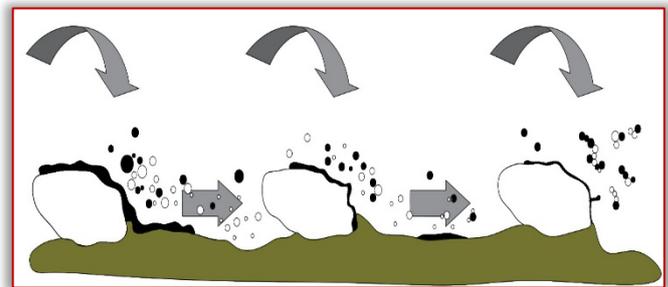


Figure 2. “Wave washing” of pebble contaminated with oil while moving it to the sandy bottom in the surf zone

On February 15, 1996, the Sea Empress tanker ran aground off the southwestern coast of Wales (UK). As a result of the accident, about 73 thousand tons of crude oil spilled onto the water surface and, after the drift of the spot, 201 km of the coastline were polluted, including the territory of the Pembrokeshire National Park and the resort beach Amrot.

Studies of water samples from rocky beaches contaminated during the Sea Empress tanker accident confirmed the presence of natural oil and mineral aggregation. Active wave washing operations on Amroth Beach helped to remove oil not only due to abrasion associated with high waves and surf, but also by stimulating the interaction between oil and fine mineral particles under pebble, which was mechanically mixed excavator and transfer to the surf zone.

The results were so significant that after four days of treatment, the cleaning operations were stopped, since the concentration of the oil emulsion on the pebble was reduced from 15.2 g / kg to 0.94 g / kg. Visual observations showed [13] that 50% of the oil was extracted from the pebble in the form of dispersed drops of oil stabilized by mineral fine particles. The rest of the oil was extracted in the form of a condensed mass, according to the authors [13], obtained due to

physical abrasion, weathering and, possibly, with the assistance of some mineral particles in the oil emulsion.

After achieving such significant positive results when cleaning the Amrot beach from oil using the “wave washing” method, it was approved for use on a more environmentally vulnerable and difficult to restore territory - Marros Beach of the Pembrokeshire Coast National Park, where the contaminated soil was transferred to the surf zone manually without application of technology [13, 14].

In the summer of 1997, in the course of field trials to assess the effectiveness of the selected methods for cleaning the coastline with a mixed soil type (sandstone, clay, and pebble) from accidental spills on the Spitsbergen archipelago (Svalbard), Norway, an IFO 30 fuel oil spill was conducted. In total 5500 l of fuel oil was applied to a preformed soil roll 3 m wide in the upper littoral zone of the three experimental sections of the coastline.

A week after the spill, the soil of the contaminated areas was subjected to mechanical mixing (plowing) and “wave washing” for bioremediation. The tests were carried out at water temperatures of $0^{\circ}\text{C} - 2^{\circ}\text{C}$ during the absence of ice and low wave energy (the wave height during the tests was less than 0.3 m).

Monitoring of the amount of oil remaining in the soil samples taken from the experimental plots was carried out six times, the latter was carried out 60 days after the “wave wash”. The authors of [15, 16] noted that a sharp decrease in the amount of fuel oil was observed during the first five days after soil transfer to the surf zone, as well as the presence of oil-mineral microaggregates in the samples.

— Accelerated biodegradation of oil

Since the total oil-water interface in oil-mineral microaggregates significantly exceeds the same slick area of the same oil volume, the authors of [17, 18] made an assumption about an increase in the rate and degree of microbiological degradation of oil in the presence of oil-mineral aggregation.

Confirmation of an increase in the degree of biodegradation of oil in the presence of fine particles of sedimentary rocks was obtained from field observations of both the natural restoration of contaminated beaches [8, 9] and the results of “wave washing” [12], while monitoring was carried out, including in arctic conditions.

Thus, according to the results of observations in May 1980 - August 1983, after the pilot oil spill response of the BIOS project in the area of Baffin Island, Canada, it was found that in the long term, in most cases, natural cleansing of the coastline of Arctic beaches is observed [19]. It is worth noting here that the author has not yet associated the observed effect with the influence of oil-mineral aggregation. However, the Svalbard field trials, during which

“wave washing” was tested under arctic conditions, confirmed the presence of intangible organic matter and its effect on increasing the rate of oil biodegradation [15, 16].

Within the framework of exploratory research under the Canadian Coast Guard program (CCG), aimed at developing methods and means of eliminating spills in the water area of the mouth of the St. Lawrence River, the authors of [20] evaluated the effect of oil-mineral aggregation on the biodegradation rate of oil emulsified using OMM.

The finely dispersed mineral particles used in the experiment were separated in sedimentation columns from sedimentary rocks taken from the Laurentian Depression at the mouth of the St. Lawrence River. X-ray diffraction analysis revealed the main composition of the selected particles: 90% clay with a size of less than 2 nm) and 10% sludge with a size of 2 to 63 nm (including 38% quartz, 22% feldspars, 20% illite and 10% chlorite). Prior to testing, Terra Nova crude oil produced from a research well off the Atlantic coast of Canada was pre-weathered by evaporation for 18 hours.

500 ml Erlenmeyer flasks were filled with 300 ml of seawater with a salinity of 28 ‰, taken from the St. Lawrence River in the area of the proposed OSR works. Then, equal amounts of weathered oil and Bushnell Haas broth were added to each flask (the broth was introduced weekly throughout the experiment). Then, in all flasks, except for the control ones, finely dispersed mineral particles were introduced in a ratio of 1 to 3 with respect to oil, after which the flasks were placed on a horizontal shaker to break the surface tension and ensure the formation of oil-mineral microaggregates. Shaking lasted 24 hours.

Then the flasks were incubated in the dark at a constant temperature of 10°C on a rotary shaker. The experiment lasted fifty six days, with oil biodegradation control samples taken from Erlenmeyer flasks on the first, seventh, fourteenth, twenty-eighth and last day of the experiment. For each sampling interval, the flasks of both groups (with and without finely dispersed mineral particles) were randomly selected for detailed chemical analysis. To assess the effect of the interaction of oil with mineral particles on the adhesion of oil to solid surfaces, such as laboratory glassware, samples from each sampling were divided into the fraction of the aqueous phase (dispersed oil, free-floating oil and OMM suspended in the water column) and solid phase fraction (oil particles and / or mineral particles adhering to the surface of glassware).

Changes in the concentration and composition of the aliphatic and aromatic fractions of residual hydrocarbons were determined by gas chromatography and mass spectrometry (GC-MS).

Samples were introduced into a Hewlett-Packard 5890 Series II gas chromatograph equipped with an HP 5972 mass selective detector (MSD). The device worked in selective ion monitoring mode for the quantitative determination of specific components of saturated hydrocarbons and polycyclic aromatic hydrocarbons (PAHs). The concentration of specific compounds was determined by comparing the peak heights with the values of the recovery standards during extraction.

RESULTS AND DISCUSSION

Direct observations of samples from experimental flasks using UV-epifluorescence microscopy confirmed the presence of oil-mineral microaggregates consisting of oil droplets stabilized by mineral fine particles. The decrease in the adhesion of oil to the surface of glassware observed during the experiment was not taken into account by the authors of [20] when evaluating the results of chemical analysis, and they note that such dynamics can be explained by the presence of finely dispersed mineral particles in the flask.

Analysis of samples of the aqueous phase showed that mineral particles scattered oil into the aqueous phase (components > n-C25) and enhanced biodegradation (components < n-C25), and analysis of the dynamic series of samples during the experimental period showed that the addition of mineral fine particles increased the rate biodegradation of common aliphatic components.

As a result of analysis of samples on the seventh day of the experiment, the researchers found that the interaction between oil and mineral particles contributes to the start of the biodegradation of oil: 42.2% of the total amount of n-alkanes (from n-C13 to n-C35) decomposed in flasks with oil, treated with fine mineral particles. In the corresponding control flasks (without mineral particles), the same degree of biodegradation was achieved only on the twenty-eighth day.

During the experimental period, the authors of [20] found that the interaction between oil and mineral particles enhances both the rate and degree of biodegradation of oil.

The authors of [20] propose a quantitative increase in the biodegradation rate by statistical analysis, since oil concentrations exponentially decreased over time, but note that a significant increase in the overall rate of loss of n-alkanes was observed only in flasks with oil-mineral microaggregates.

In addition, the authors of [20] note that, contrary to the results of studies conducted earlier [4], the degree of biodegradation of oil during oil-mineral aggregation is not limited to aliphatic components, because their analysis of GC-MS revealed a similar trend in biodegradation and aromatic components.

CONCLUSION

Despite the fact that a number of laboratory studies and field observations indicate a positive effect of oil-mineral aggregation on the removal of oil from contaminated coastlines, including in the Arctic latitudes, the use of this physicochemical process as a separate measure to combat open water spills and with the presence of ice in the ice seas of the Arctic region, it remains today a matter requiring detailed study.

Of particular interest is the study and evaluation of the effectiveness of this process from the point of view of bioremediation, hydrometeorological conditions, physico-chemical properties of the spilled product, production technology, as well as solving the question of the potential for controlling the oil-mineral aggregation process to obtain the required efficiency under certain conditions.

Note:

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THE IMPORTANCE OF RAISING AWARENESS OF ENVIRONMENTAL BEHAVIOR, ENVIRONMENTAL PROTECTION AND CLIMATE CHANGE IN THE APV

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Abstract: In the Republic of Serbia, education on environmental issues in elementary school is very scarce. Environmental protection theme is part of subject’s knowledge of nature and/or society, i.e., biology, chemistry, geography, and physics. Also, awareness on the necessity of environment protection among adults should be improved. Thus, the authors of this paper proposed an educational programs on climate change for adolescents that will indirectly transfer their knowledge on their parents or guardians. The educational program will be provided among elementary school children (1-8 grade). The program will cover climate change issues with the focal point on renewable energy resources. The effect of education will be analyzed throughout the survey before and after the program. The effect will be measured both in children and parents. The result should highlight the improvement in knowledge on climate change and raising awareness on this significant issue.

Keywords: climate change, education, renewable energy resources

INTRODUCTION

The Industrial Revolution has ushered in a new era in the history of humanity, not only in terms of progress and development but also in terms of the effects and consequences of the dizzying impact on the human environment. Improved processes have facilitated production processes and made products more diverse and accessible, which has greatly influenced the increase in living standards and, consequently, the multiplication of world half-population.

The principles of the production and growing civilization with increasing demands for energy exclusively produced from fossil fuels led to a sharp increase in the concentration of GHG (greenhouse gases), which consequently provoked many adverse effects known under the name of climate change. Surveys show that over the last 200 years, the global atmospheric temperature has increased by 1.1°C, with an increase of tentatively and estimates that by 2100 it will increase by 2.7 °C [1].

Recognition of global warming issues, expert empowerment seeks to raise awareness of the growing problem by pointing out the complexity of the problem and the need for a multidisciplinary approach. Tackling the issues of global warming is reflected in systematic policy-making and problem-solving strategies.

The history of climate change policy development began in the mid-1970s with the Convention on Long-range Transboundary Air Pollution [2], through the Vienna Convention on the Protection of the Ozone Layer [3] and other Significant Protocols [4], [5]. However, the basis of the policy lies in the UN

Framework Convention [6] with the Kyoto Protocol [7] defining developed country targets for reducing emissions through three types of carbon dioxide trading mechanisms, as the primary GHG. Continuity of action at the global level is reflected in the last Paris Agreement which establishes the ultimate goal of reducing GHG gas emissions, leading to a reduction in global temperature rise below 2°C during this century [8].

Although the concerns of climate change scientists are serious, reducing catastrophic consequences requires prompt collective action. However, public opinion on climate change as a result of the politicization of this, one of the most significant and real global environmental problems is polarized [9].

On the other hand, the formation of attitudes about environmental problems in adults is guided by the political beliefs and ideals in adolescents it depends most on the views, knowledge, and behavior of adults, that is, parents and educators/teachers [10]. As the perception of climate change in children is not yet formed and it’s not influenced by global controversy and discussion, it is possible that adolescents with acquired knowledge of this complex topic affect the awareness-raising in adults, primarily of their parents/guardians [11].

In developed countries, although environmental education occupies an important place in the early childhood education system [12], [13], [14] among teaching staff, there is confusion about the causes of climate change [15].

Environmental education has relatively recently become part of teaching in Serbia. Depending on age,

environmental protection education is part of activities in preschool institutions, or subjects knowledge of nature and/or society, i.e. biology, chemistry, geography and physics [16].

The results of a survey conducted in South Backa indicate that only 35% of teachers are ready to introduce environmental-related activities [17].

Previously, a preliminary study conducted in Novi Sad among children aged 6-12 years found that there was a specific awareness of environmental protection, reflected mainly through the waste recycling, water, and energy savings. However, there were no responses in children's free responses regarding wastewater and water pollution, as well as air pollution due to traffic and industry [18].

This indicated the necessity of expanding theoretical and practical activities that would expand the awareness of children in some segments of environment protection, especially concerning the causes of climate changes. The aim of the project, financed by the Autonomous Province of Vojvodina, is to raise awareness of elementary school students about climate changes in order to adopt specific models of environmentally friendly behavior, with the emphasis that their acquired knowledge indirectly affects teachers and parents, as well as others family members.

PARTICIPANTS

The educational program of inter-generational learning will be provided among elementary school children. The size of the sample will be determined after the consultation with the teachers.

Schools that are willing to take part in education are located in different regions of the province of Vojvodina (South Backa county, North Banat county, and Middle Banat County). During a preliminary survey on interest in participating the education, we encounter a great deal of attention.

CONCEPT OF THE RESEARCH

The research would be conducted in several stages. The first phase will cover preliminary activities, such as consultation with the teaching staff about the content of the program and the selection of training groups. In order to determine the effects of the implemented project activities, two groups will be set: a reference group and an experimental group. Both groups will include school children, their parents/guardians, and senior family members, as well as teachers/teachers.

The preliminary survey, which will include both groups of respondents, adults, and students, will contain general questions on age, gender, education, to analyze conceptual approaches to the concept and problem of climate change among groups of different ages. Within the group of students as respondents, these questions play a crucial role in looking at the

impact of different ages and genders on older people [19].

For the group of teachers, the questionnaire will pay particular attention to the scientific area that teachers teach, as well as the volume of materials devoted to the topic of climate change under the program, as well as additional activities that teachers self-initiated to address climate change.

For adults (parents/guardians and teachers), questions will be raised within this group regarding their personal views on climate change, their religious commitment as well as nationality [9]. Specific questions will include self-evaluation questions as well as questions that will explicitly indicate knowledge of the field and will be specially formulated and adapted for adults and children (Table 1).

Table 1. Questionare concept

General questions	P	K	T
Gender/Age	x	x	x
Education (Field and degree)	x		x
Scientific subjects (no od lectures dedicated to the climate change, personal contribution)			x
Personal attitude to the climate change issue	x		x
Political orientation (liberal, "left", "right") /religious (yes or no)	x		x
Nationality		x	
Specific questions			
Self-evaluation concerning knowledge in the field of climate change issues	x	x	x
Specific question concerning climate change issues and alternative energy resources	x	x	x
P stands for Parents, K for kids and T for teacher			

The second phase of the research will cover Theoretical and practical teaching, which will be implemented according to the detailed curricula formed. Classes will be implemented through two thematic units:

1. Climate change: defining the concept of climate change, causes of landfill climate change, industry, thermo-energy plants, consequences as well as the mechanisms of adaptation to climate change..
2. Energy and the environment: personal contribution and environmentally friendly behavior with an emphasis on energy efficiency, energy conservation, and the use of renewable energy.

Theoretic teaching will include educational pedagogical tools to bring the complexity and scope of the problem as clear and detailed as possible to a relatively small amount of lessons.

Practical work will focus on renewable energy sources. The realization will be carried out through

workshops in which students will have the opportunity to solve specific problems, design and realize individual projects that accompany theoretical instruction (windmills, digester for the production of biogas, green roof models, etc.).

Also, students will have the opportunity to express their views, impressions, and concerns about climate protection change as well as their vision of personal contribution to the advancement of this field through individual creative work, artworks or competitive projects.

CONCLUSIONS

The results of decades of popularization of environmental behavior in developed countries have yielded results over the last few years.

The implementation of the model of intergenerational knowledge transfer can improve the situation in Vojvodina as it affects three generations simultaneously, because adolescent children can adopt environmentally friendly behavior models without prejudice, which adults have, which ensures long-term results.

On other hand, adults with their preconceived notions and unwittingly developed bad habits are not ready for the direct acquisition of new environmental and energy-saving knowledge.

Intergenerational knowledge transfer will enable indirect action on parents, family members, and teachers taught their kids.

Preliminary monitoring of the development of awareness of environmental behavior, environmental protection and climate change in the territory of the APV to take concrete measures and activities for long-term planning and improvement of school programs at the level of the Republic of Serbia.

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Note:

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AN ANALYTICAL STUDY OF IOT BASED APPLICATIONS

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Abstract: These days, the Internet of Things (IoT) gets an incredible amount of thought from analysts as it transforms into significant innovation that guarantees a person's life, brings together things, machines and everything. By allowing the exchange of IoT, we talk about frameworks that incorporate objects into reality and sensors are connected or integrated with those components, which are associated to the Internet through wired and external system architecture. IoT sensors can use a variety of organizations, such as RFID, Wi-Fi, Bluetooth and ZigBee, despite allowing a wide range of networks that use multiple fields, GPRS, GSM, LTE and 3G. The IoT powerful object will share data on the location of the objects and the location of individuals, programming frameworks and different machines. In this paper, we take a look at some IoT applications

Keywords: Smart Home and Building, IOT, Smart Transportation and Mobility, Smart Health, Smart Cities, Smart Environment, Smart Energy and the Smart Grid

INTRODUCTION

The Internet of Things (IoT) is also known as Internet of Objects, will change entirety, with itself. The Internet impacts training, communication, professional, science, administration and humanity. Obviously, the Internet is a very important and wonderful appearances of all human past, and nowadays with the concept of a website, the web is worth more in every aspect.

Internet of Things is another innovation found by the Internet. With their Internet of Things, things understand themselves and gain a sense of behavior by accepting or strengthening relevant choices to think about how they can share data about themselves. These things may receive data collected from different sections, or may be included in different administrations. Figure 1 explores that with the web, the web is ready to share everything, anytime and anywhere with any system to manage.

IoT With the latest models, it will be very close to meeting current conditions in 2020 for testing and shipping. Soon there will be unparalleled storage and mailing incentives: remotes, wired sensors related to individuals, machines, inventions, spaces and levels, along with RFID gadgets for M2M gadgets. Interconnected.

In IoT, correspondence will be set up at various conferences working on opposite situations and levels. In this setting, IoT is a non-specific word and you can view all articles that actively participate in their communication with the Internet by creating excellent conditions where the content of the Internet has changed.

LITERATURE REVIEW

In literature [27], IoT indicates intelligence from connected devices and system related data integrated devices and controllers and other corporal

components. The new IoT is expected to grow quickly in the upcoming years elements of services that develop the quality of life unlock user and business productivity opportunities.

The authors of [28] describe the term sensory a network that is made to be merged with one another Micro Electrical-Mechanical Systems, Wireless Communication. First, the sensors do a network of applications and sensory functions are reviewed and accordingly review the factors affecting the design of the sensor network delivered. Then developed procedures and protocols for it every layer and communication design for the sensors the network is described.

In [29] the authors developed electronically information board system. Now they are using sms-based method but otherwise. The system is intended to effort without any humanoid operative needed and independent when a user or worker wants information, they do so must to send SMS to this system that will reply information mandatory by the user. Various technical societies are looking for brilliant research materials that promote IoT.

In [30], the purpose of the investigation is to know the possibility of IoT in the bus transport system in Singapore. Which is technically very innovative but still it is a measure of progress in the transportation system create a system for consumers using IoT efficiently understand and evaluate various bus options is the way. Detailed studies were used to predict the coming time for buses as well as people inside each bus.

STUDY ON IOT AND ITS APPLICATIONS

The Internet of Things guarantees various uses in life, easy life, fast, smart and safe. There are several applications, such as smart city, smart home smart transport, energy costs and smart atmosphere.

SMART CITIES

In any case, agile urban communities can be considered urban boundaries without boundaries and luxurious living, and with the rate of progress that makes today's sharp civil societies, there is a high probability of IoT innovation in urban improvement. Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.

Healthy urban organizations, with the help of government statements, are asking for caution at every step that individuals should realize on every corner of the site. With IoT, improving the framework, improving open traffic that reduces business security and protects the population, the Internet remains solid and busy. Figure 2 shows that with organizations, all the structures of civil society such as transport framework, human services framework, climate control framework, etc., provide access to transmit data for access to airports, railways, and transit data from local sites. General Chat Lounge According to some agreements, metro areas will be eliminated by the ways of the Internet.



Figure 2. Smart City [18]

SMART BUILDINGS AND HOME

Improvements to Wi-Fi internet in the domestic computer business are largely due to the integrated view of access devices where electronic gadgets, such as TVs, mobile phones and others are usually connected to Wi-Fi. Wi-Fi is starting to eradicate some part of national IP management and due to the growing frequency of welcome for multilingual registry devices such as advanced compartments, tablets and more. For example, a webmaster or system administrator to allocate home systems may consider controlling the use of the gadget on the system. Mobile phones ensure while customers have access to a convenient "operator" for machine-related hardware. Two types of devices can be used as doors for IoT

applications. Many organizations are thinking about the construction stages that combine the robotics of buildings, human service inspection, life inspection and remote sensing research and the status of homes and buildings. With the Web in mind, many devices and questions can work very well in homes and structures, with sensible lighting, sensible environment and media, air control and movement, the most complex use of IoT in bright homes and structures. Powerful administration and safety as shown in Figure 3.

Along with innovative Internet of Things, wireless sensing systems (WSNs) will provide smart management of problems despite their financial and natural combinations. In conjunction with the framework of the Institute of Biology, the web provides an opportunity to obtain life-long data and manage the framework of frameworks ranging from cellular data to salvaging data on individual structures and anywhere on earth. The future of things. The internet will provide a smart building management framework that can be a very important big data source that office managers use to monitor the use and energy of structures and maintain the framework of structures.



Figure 3. Smart Building and Home

SMART GRID AND ENERGY

A smart grid is notorious by a data and controller and is designed to create a wonderful life energy. A smart grid, which incorporates information and communication technology (electronic information technology) into the electrical system, will strengthen continuous, two-way exchanges between suppliers and buyers, making them a unique connection to the system's system. Will help change the power more and more logically.

The key elements of innovation in data and matching will include identifying and monitoring progress for management streams; A computerized base station for transmitting information over the Internet; Backyard courtyard with exhibit at home to educate the living energy; Coordinate, manage and compute the Computer Transition Framework to integrate and

process different information and create unique intelligent, responsive power. Many applications can be made due to the clean array, such as modern, solar powered, nuclear, vehicle, health centers and the web for urban management. Figure 4 shows that a critical application can be rendered by the web as a clever viewpoint. The existing framework is very reliable and can control the general conversion of electricity and will support the use of low carbon energy, allowing for integration between sustainable energy sources and green growth, and allowing consumers to use energy at home. Investment offers a number of benefits to the funds.

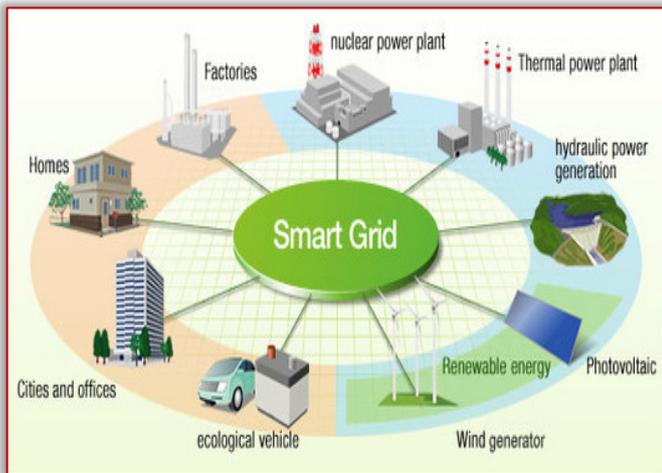


Figure 4. Smart Energy and Grid [19]

SMART HEALTH

An idea in the area that is important for patients in a hospital who constantly need to monitor their physical condition can always be done with the IOT test. For deeper exercise, sensors are used to collect all physical data and user portals and the cloud to test and store data, and send remote information for later testing and review. Sponsors can be sent from. This alters the approach of getting good health at regular intervals to check the basic characteristics of the patient, but not to prevent the compression of transmitted data. In this way, it increases the nature of caring with constant thinking and lowers the cost of care by reducing the cost of traditional brain operations despite intelligence and observation.

Many people in the universe experience terrible health because they do not have access to good health screenings and they may be suspected of having basic medical conditions. As it is, horses with intensive, intensive remotely associated with IoT are currently able to monitor these patients. This mechanism can be used to secure reliable health information from sensor distribution, apply complex calculations to break information and subsequently share it with physicians through remote networks as shown in Figure 5. Ease of wellbeing can provide information.

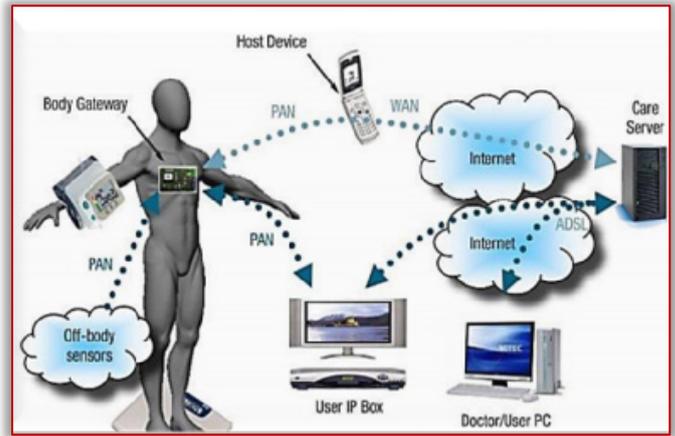


Figure 5. Smart Health

SMART MOBILITY AND TRANSPORTATION

The growth in traffic is one factor which shows the prosperity of the country. Street positions that are monitored and ready for application are prominent among the important IoT applications. The idea behind the concept of smart transport and capacity is to apply the standards of purchase and research participation. This procedure was initiated by the client disagreeing with course preferences and outlining some of the emphasis on fraudulent intelligence program disguises.

Excellent performance is managed by three primary sources, that is, transportation, transport management and vehicle networks in a systematic manner. Logical transport speaks when development predictions and signs of symptoms are examined. Figure 6 shows that vehicle control and speed control, in addition to speed control, are known as traffic control, by all means, which they have fully analyzed by vehicle network method (V2X correspondence). Diversity is represented by distribution. Likewise, IoT can be used where a portion of the traffic is electric vehicles, which are needed to reduce fuel costs and the impact of hazardous environmental conditions has significantly increased the regard for drivers.

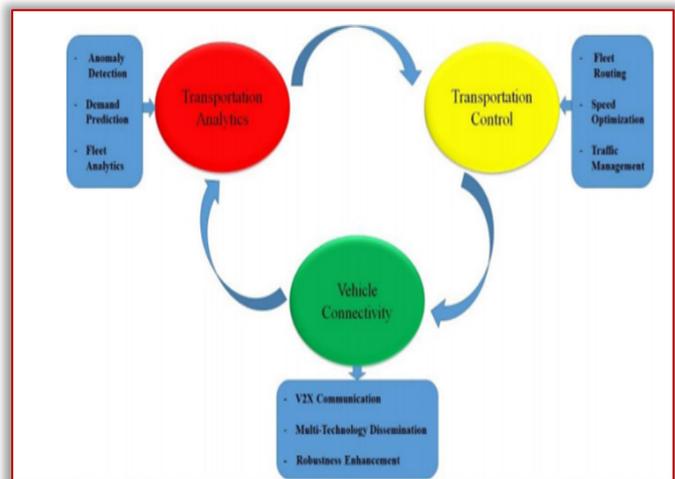


Figure 6. Smart Mobility and Transportation

In many countries, the government has investigated that framing inquiries have been supported for screening of vehicles being applied to lithium-ion batteries of electric vehicles. The purpose of the frame shown was to analyze the aspects of the lithium-Particle (Li-on) control battery by obtaining driving conditions from the driver's working conditions wisely. This arrangement was implemented with a variety of capabilities, for example, testing for the implementation of Li-on batteries, remote control with troubleshooting online troubleshooting, and a fault-free ad that covers support costs. And reduce the risk.

SMART MANUFACTURING AND SMART FACTORY

The Smart Factory also assists in integrating other features, including computer-based logic, machine learning and computer tracking information tasks and coordinating the assembly process with M2M correspondence. The Smart Factory will really change what is imagined, imagined and transmitted. In the meantime, it will increase the safety of workers and ensure that the earth is strengthened by producing small, temporary and minor incidents.

How they progress is how machines and different articles are transmitted and in this way a leader is moving from the people to the particular framework that holds them together. New actions; The versatility of automation, self-control and self-management are all methods of smartphone production. The M2M keys selected by the "Mechanical" sections of the section will place a heavy emphasis on smart factory line and key data concept concepts. Mechanical processes, less support time support, less darkness and less spare efficiency.

Business and volatility these days ended prominently with some of the most advanced developments, the growth of business development took many ages. Originally identified by mechanical machines in spite of water and electricity management. The second commercial era manages large-scale manufacturing, mechanical production systems and. Until the end of the last century, companies operated under the control of computers and automatic, which were considered in the third round of companies.

Industry, which is the fourth term efficient business. As called, depends on a numerical framework that can be configured to connect to the web as shown in Figure 7. The General Forum emphasizes the use and progress of the nation, presenting the latest approach, selecting projects, along with logical and innovative reforms to 2020.

The environment has a significant impact on human life. Individuals, even animals, cool animals, fish, and plants can be affected by unwanted conditions. Numerous inquiries have been made on efforts to address natural pollution and waste issues. Creating a reliable domain name is not easy in terms of tasks and

transport, without interruptions, human exercise is a common factor that harms nature. Nature requires smart methods and actions to monitor and control.



Figure 7. Smart Manufacturing and Factory
Given the ultimate goal of assessing the current state of the earth, it is important to examine the land, redirecting the life options outlined by gathering information from choices and management to utilizing and utilizing profitable assets. Non-reducing factories and caravans. The General Forum provides a great deal of information about the management of waste and management of waste, the protection of individuals and situations, and the good quality of government or public health organizations to prevent or prevent from catastrophic events. The main situation is one of the most important innovations in our regular daily existence, which includes many environmental functions, such as water and air pollution, climate and radiation monitoring, lost management, catastrophic events, and many other states and all signs. Does. Can be connected to anyone organized in the home.

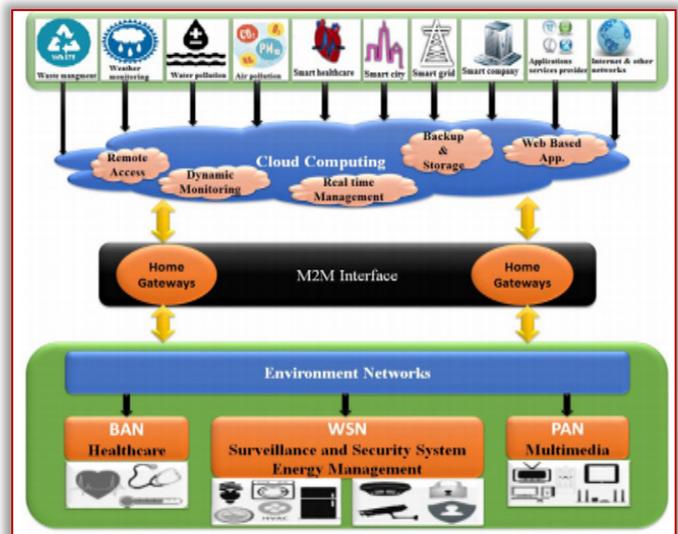


Figure 8. Smart Environment
Figure 8 shows the latest sophisticated (IoT) capabilities designed for analyzing the state of things

and analyzing their location, which provide an eco-friendly world and potential life benefits. There are various Internet of Things in the state that can be accessed and can be classified into two main categories: Natural Property Management and Eco-friendly Quality and Security Management. Property management identifies each common property, including animals, airplanes and forests, feathers and fish, coal, oil, grain, fresh water, wind and gold, copper and iron. All of these assets are likely to be completely reduced or affected by many companies, in addition pollution, waste, and faults.

IoT research can provide a compelling method for communicating the resources of each of these sensors and emphasizing the choice of appropriate alternatives to these use sources. Fixed assets have daylight and, likewise, can be monitored and analyzed for optimal use on some, for example, provision of sustainable energy resources. The IoT can manage these resources and utilize them for a variety of down-to-earth needs.

IoT innovation can provide the monitoring and management of air quality and gather information about the city from distant education teachers and provide full geographical scope for better management of urban areas in important urban areas. Radiation is clearly one of the six most difficult problems on Earth. IoT will provide a way to prove gardening and extraordinary opportunities, including property savings.

In addition, using a sensory system, the development of logical databases of plants, plants and other agricultural compositions requires vegetables and natural products that can be examined and the management of multiple assets as a generation. Is done, for example. Weather, water and daylight. Likewise, for environmental investigations, IoT can help in estimating the emissions of plants by processing firewood flames remotely or assist in agriculture.

CONCLUSIONS

Internet of Things is another innovation that provides many applications for connecting things to people and the web. You can analyze every conflict on earth and choose yourself to have a website linked to. All mail systems and enhancements are used as part of building a web of ideas for things like innovative portable imaging, RID, remote sensors and integrated frames, administrative forms and counting applications. Regardless of the information and security issues.

The IoT requires a structured approach to design, accreditation certification programs, conferences and events, each focusing on a single and specific use. The web makes many interesting applications in our lives worthwhile, enabling us to reach and interact with everything, even with offices in many important lives,

such as Smart Healthcare, Smart Home care, Smart Energy Free, Smart Cities., And an ingenious environment. The Internet of Things can tackle two important problems, with the ultimate goal of securing a favorable system; The key is to identify which unique systems are interconnected today and the second issue is identified by the wide IoT size. Other issues currently in place, such as address restriction, programmable address, security capabilities, such as authentication and encryption, and the ability to effectively voice and video flags, with the continuing web of things, could continue to evolve. Will be efficient to deliver. Mechanical improvements will survive these difficulties.

The Internet of Things guarantees new developments in the future when highlighted by cloud, fog and solid processing, large data and security issues. By integrating each of these issues with the webpage, faster applications will gradually be developed. This essay covers one of perhaps the most important IoT users with a special focus on what has actually been done despite the difficulty of using Web of Things, and whether other innovations in the future disseminate IoT ideas.

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A REVIEW ON ANTI ODOR FINISHING OF TEXTILES, ITS APPLICATION METHOD AND COMMERCIALIZATION

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Abstract: Nowadays, odor has become a substantial factor. While odor in a human body is inelegance and gawkiness, that everybody would have faced. Sweat and dirt may put a person in discomposure; on the other hand, people look for cloth, which smell good and remain refreshing for longer time, thereby thriving their self-esteem. Therefore, in recent years most people ardent to wear the finished cloth that can reduce the body odor. This finish is called anti odor or novel finish. This study, discuss the different types of noisome that can be created in textiles fabrics, how this odor can be removed from fabric or what is the way to inhibit the bacterial growth to textile substrate which is responsible for producing stingy on clothing. As well as this review paper also emphasize the commercial company who have already initiated this strategy of manufacturing odor free clothing for its consumer.

Keywords: Microorganism, anti-odor, textiles, finishing process

INTRODUCTION

A wide range of micro-organism co-exists in a natural symmetry that is both in the human body and environment. This rapid and uncontrolled multiplication of non-pathogenic microbes can seriously affect the health standards.



Figure. 1 Odor in a textile cloth

The term body odor means odors generated as a result of natural functioning of human body. Odor produced by microorganisms of the skin through decomposition of skin secretions, urine and other body odor. Such odors are mainly organic compound, which contain different functional group and chemical structure. Such as amine, alcohols, aldehyde ketone phenols etc [1].

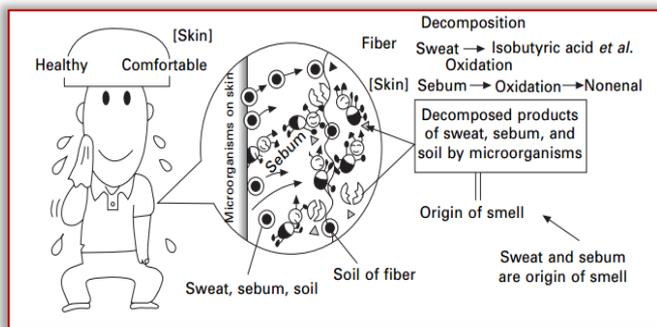


Figure 2. Odor produced in our body [2]

Table 1. A list of bad smell that creates odor in human body [1]

Origin of bad smell	Main component of bad smell	Major causes of bad smell
Bad breath	Methylmercaptain hydrogen sulfide	Bad breath of leftover fermentation by bacteria
Body odor	Trimethylamine Acetic acid Caproic acid	Decomposition of sweat constitution of microbes
Excrement	Ammonium Skatole Indole Hydrogen sulfide	Smell of feces and urine, and decompositions of feces by microbes.

CAUSE OF ODOR ON TEXTILES

- # Odor is often introduced on textiles from an outside source such as dirt/soil, cigarette smoke, garlic.
- # Most often, odor is the aftermath of bacterial growing and metabolizing on the fabric
- # These bacteria have migrated from the skin and uses the nutrient delivered in sweat as a food source
- # These metabolites are volatile and can be free from the textile itself as “offensive odors [3].

ANTI-ODOR FINISH

The finishes, which subdue or inhibit the spreading of odor or bad smell by preventing bacterial growth or neutralized the bad smell in the textile substrate. This finishing process eliminates foul smelling odors caused by pathogenic bacteria and keeping the fabric and the wearer fresh and comfortable.

The finish fabric conveys the arrest of metabolism of microbes in order to reduce the order. Additionally, the fabric does not lose its effectiveness, finishing

outcome and will continue functional virtually lasting throughout lifetime. The main chemical imparted is non-toxic and wearer friendly [5].

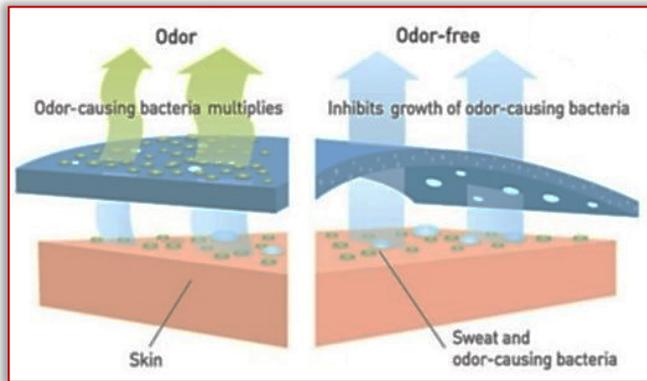


Figure. 3 Odor and odor free surface

OBJECTIVE OF ANTI-ODOR FINISHING

- # The medical textiles, such as fabric liners for prosthetics and casts, necessitate odor control.
- # The conditions (sporting, exercise, hardworking which create sweat) that damp and inclined to bacterial growth, which causes odor. Anti-odor finishing agents needs power, speed, and durability to deal with those odors.
- # The increasing need for incontinence odor control is not just restrain to garments, but also is required for bedspreads, linens and upholstery [6].

WAY OF CONTROLLING ODOR ON TEXTILES

- # Capturing Odors (Passive Approach)
- # Stop the Growth of Microorganisms (Active Approach)

— Capture Odors (Passive Approach)

This odor controlling method is also called passive method but it is more than 90% efficient method where odor producing component especially moisture and gases are absorbed by the zeolites or activated carbon like odor absorbers.

Once the capture capacity of these materials is reached they can be renewed by drying at a high temperature. The odor capture measurements of the textile products are generally determined by the purity, size and amount of used absorber [7].

— Stop the Growth of Microorganisms (Active Approach)

This technique measuring the textiles ability to hinder or reduce the growth of bacteria (biostatic) or to kill surface applied bacteria (biocidal) [8]. Controlling microbial growth reins the cause of most textile odors that is unwanted bacterial growth. This lesson the formation of biofilms of bacteria on textiles that ensure the more comfort and also controlled the odors.

Silver and nano-silver are worked on this basis of technique that reduces the occurrence of unpleasant body odors and other unpleasant smells by inhibiting

the replica of bacteria, mites and fungi that cause odors [9]. This confirms that textiles remain hygienically fresh.

ANTI-ODORANT AGENT

— Natural anti odorant material

Bamboo fabrics are factory-made from the fibers, which is converted to fiber from the stalks. It is regarded as an eco-friendly substantial because of its remarkable attributes.

It is environmentally friendly and can be considered as a possible substitute of conventional cotton fibers. Bamboo fibers are 100 percent biodegradable. It withdraws moisture away from the body so that it can evaporate easily. It also diminishes the bad odor in the wearing material. This fabric is anti-static and holds to the skin in a perfect way.

It is a perfect type of clothing for people who are prone to skin problems and allergies [10]. Which can be extensively used as sanitary clothing for its anti-odorant and anti-bacterial properties. Not only has that it also avoided skin problems and allergies [11] along with reduction of bacterial multiplications.

— Chemically anti odorant materials

Over the decades, new technologies have emerged which hold the potential of delivering more effective protection against odor in clothing. Most anti-odor technologies for clothing are based on chemical treatments. Things such as zeolite, engineered polymers, cyclodextrine, activated carbon and silver are the chemically anti odorant agent.

— Zeolite

Anti-odor technology binds the power of Zeolites are mineral-based substances originating from volcanic ash that have the power of binding odorous material and keep products smelling fresh. Enormous surface area of zeolite carriers entices and adsorb odor molecules on products. These odor molecules are then released during laundering, after which the technology regenerates. Next-generation equipment of zeolite not only attracts and adsorbs odor molecules, but also degrades them. This enables self-regeneration of the technology without laundering [12].

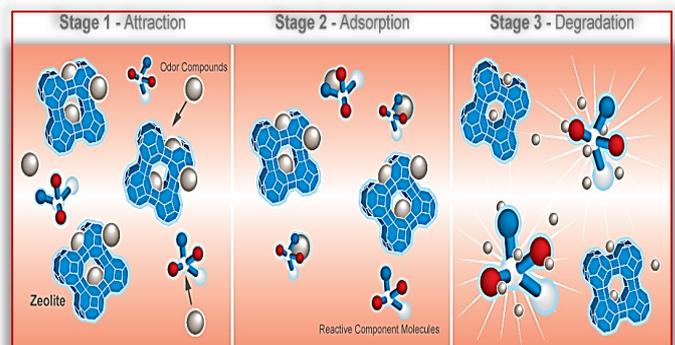


Figure. 5 Mechanism of zeolite in case of anti-odor finishing

— **Engineered Polymers**

Engineered polymer is one kind of resin that traps human odors. It is a synthetic material, which is fused to the fabric particularly in the scent blocker garments, contains macro pores that provide a large surface area for human odor molecules to enter and micro pores to trap them.

— **Cyclodextrin**

The cyclodextrins (also called Schardinger dextrin, cycloglucose, cycloamylose, cycloglucoamylose) are non-reducing cyclical oligo- saccharin, consisting of 6 to 12 (sometimes even 26) α - D (+)-glucopyranosic groups bound to α -1,4 glycosidic [13]. Which has a cone trunk structure with a cavity in its center, inside part of the cone is hydrophobic and outside portion are hydrophilic. Cyclodextrins contain several number of glucose units in its structure. The common cyclodextrins contain 6,7 and 8 number glucose units to form α -CD, β -CD and γ -CD respectively.

form inclusion complex with a variety of guest molecules such as aromatics, alcohols, fatty acid and esters. The hydroxyl group can link with cross-linking agent, which can provide strong linkage with hydroxyl group of textile material. The hydrophobic cavity of CDs can accommodate odors molecules from sweat and environment. The CDs can also be scent release finish.

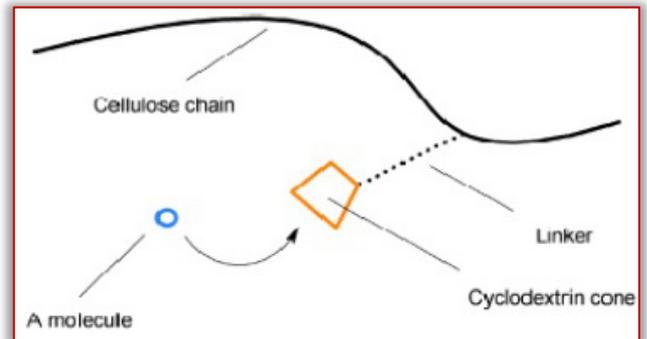


Figure 7. Cyclodextrin linking to cellulose backbone

— **Activated carbon**

The term “activated” means the carbon is treated to have a surface area that is covered with tiny pores that chemically adsorb or trap, odor molecules surrounding them. The surface of activated carbon granules is enclosed with so many microscopic pores that just one gram can have a total surface area of 500 square meters.

Activated carbon which is resulting from coconut shells, where carbon particles are modified to enhance adsorption of specific odor molecules. [14]

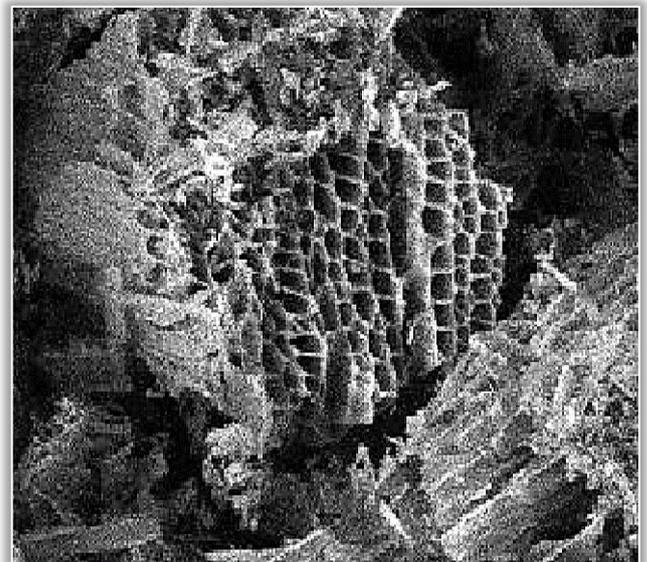


Figure 8. Activated Carbon

— **Silver**

Silver finish obstructs the growth of odor causing bacteria and provides reliable antimicrobial protection, ideal for clothing worn in everyday life, sport and travel. Improvement-silver finish is an antibacterial finishing technology using active silver ions. Silver has been known for centuries to be a

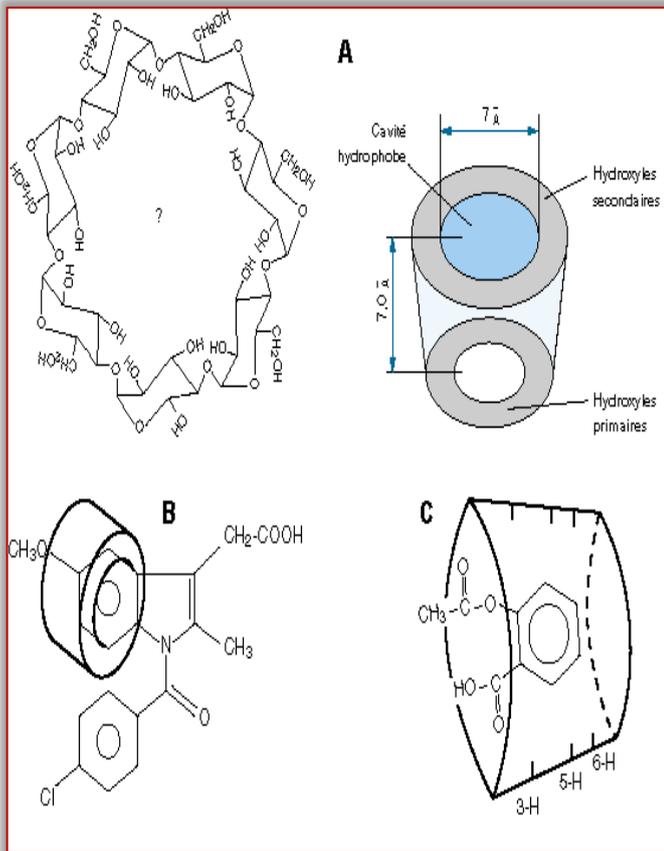


Figure 6. Structure of cyclodextrin

— **Odor controlling mechanism of Cyclodextrin**

The cyclodextrins are synthesized by enzymatic degradation of starch, maize and corn. All the hydroxyl groups in the cyclodextrins are oriented to the outside of the ring, while the glucosidal oxygen and two rings of the non-exchangeable hydrogen atoms are directed towards the interior of the cavity. This combination gives cyclodextrins a hydrophobic inner cavity and hydrophilic exterior. The hydrophobic inner cavity provides the capacity to

natural agent to reduce the growth of bacteria and fungus. The finish is long lasting and wash resistant. Silver particle minimize odor providing fresh feeling besides any demagogical adverse impact.

Mechanism of silver as an anti-odor finishing

- Silver ions may bind non-specifically to cell surfaces, causing some disruption to the cellular membrane function and permitting the silver ions to penetrate the microbe structure.
- Silver ions are highly reactive and readily bind to electron-donor groups, prime targets being the thiol groups (-SH) which are commonly initiate in enzymes within the microbe.
- Silver ions react with the base pairs of DNA thus preventing DNA replication of odor producing microbes [15].

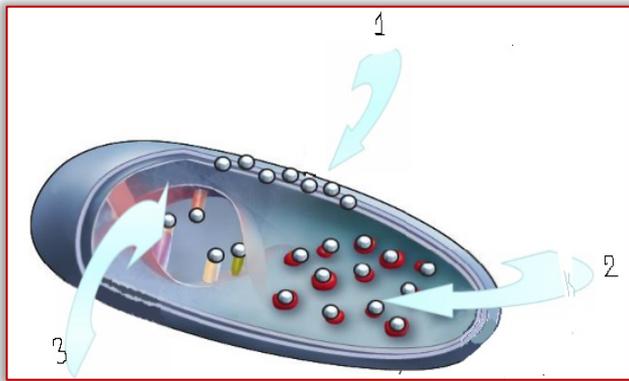


Figure 9. Working procedure of silver as anti-odor finish

— **Application methods of anti-odorant**

- a) Physical incorporation of solid particle using padding technique.
 - b) Using cross-linking or cross-binding agents.
 - c) Chemical bonding
 - d) Microencapsulation.
- # Physical incorporation of solid particle using padding technique

The vast majority of treatments for creating anti-odour textiles are applied using a dip-pad-dry-cure process. This process is used to the textiles in roll format before construction of the garment or product. Complex chemical formulations are used, which not only contain the chemicals obligatory on the textile.

Using cross-linking or cross-binding agents
This method depositing of anti-odorant particles into the textiles substrate and permanently binding the of solid particles to the textile product such that it enhances the anti-odorant performance of the textile materials.

Chemical bonding/chemical treatment

Most anti-odor technologies have relied on chemical treatments with their antimicrobial component.

Microencapsulation Method

Microencapsulation is one of the novel methods of accomplishment functional finishes on textiles. The

anti-odorant agents reside in colloidal suspension with the amorphous zone of the polymeric binder so that a reservoir of agent is present in solid/ solution within the polymer matrix.

TEST METHOD FOR DETERMINATION OF ANTI-ODORANT FINISHING

Efficacy against odor producing bacteria

Based on the standard test method DIN EN ISO 20743 (Determination of anti-bacterial activity of anti-bacterial finished product) the antibacterial activity is quantitatively tested against the skin specific microbes of the genera staphylococcus and Corynebacterium after 4 hours of incubation. [11]

Binding capacity of fabrics for sweat odor molecules

A special sweat odor stimulates (artificial sweat), which contains radioactively labeled lead substance of odors sweat, is applied on the sample under defined conditions of temperature and humidity. After an incubation period, remaining odor molecules in the fabrics are quantified.

Odor field tested:

Samples are worn by five test persons in an application specific activity. Odor intensify is then evaluated in comparison to a reference fabric. The field test can thus prove an anti-odor effect from the consumer's point of view and compromises the sum effect of all modes of action for example an improvement of ventilation effects, anti-odor finishing and construction effect [16].

APPLICATION AREA OF ANTI-ODOR FINISHING TEXTILES

Clothing with anti-odor properties is one of the fastest emergent segments of the performance of today's textile sector. Which dazzling the desire of consumers for hygiene, freshness and a general sense of well-being particularly in certain apparel categories such as:

For clothing section

In sportswear, outdoor garments, partywear, socks and footwear and intimate garments.

In case of home & hospitality industry

In fitted bed sheets, pillows cover and duvets, bathroom textiles, terry towels, table cloth, curtains and other upholstery items.

In healthcare Industry

Finishes can be applied in bed Sheets, doctor aprons and patient apparels.

COMMERCIAL EEXAMPLES OF ANTI-ODOR FINISHED FABRIC

SmartSilver™

SmartSilver is developed and produced by Nano Horizons Inc. entirely in the USA and is commercially used in the textile, health care, coatings, and plastic industries. SmartSilver is a global brand that optimize the natural anti-odor properties of silver through

superior chemistry. SmartSilver additives can be applied at the molecular level into natural and synthetic fibers and fabrics, coatings, foams and polymer applications to provide antimicrobial protection against odor-causing bacteria that lasts the expected life of the product. The active ingredient in Smart Silver is EPA registered and is certified as being free of harmful substances according to the Oeko-Tex® 100 standard [17].

SPORTINGTEX ®

SPORTINGTEX ® is a knitted fabric which provide deodorant properties of fabric. The main application of this fabrics, such as Sports Wear, Casual Wear, Outdoor Wear and Accessories etc. The main feature of this cloths is preventing the evolution of bacteria & mildew that may cause itching and unpleasant odor, safety and durability and washable, without dropping its performance after many times washing. Maintain hygiene & comfort to the human body [18].

CAVATEX

CAVATEX is fabric under the manufacture of Germany who produce cyclodextrin coated finished fabric which can capture odors and release active ingredients in cycles, which are refreshed through washing.

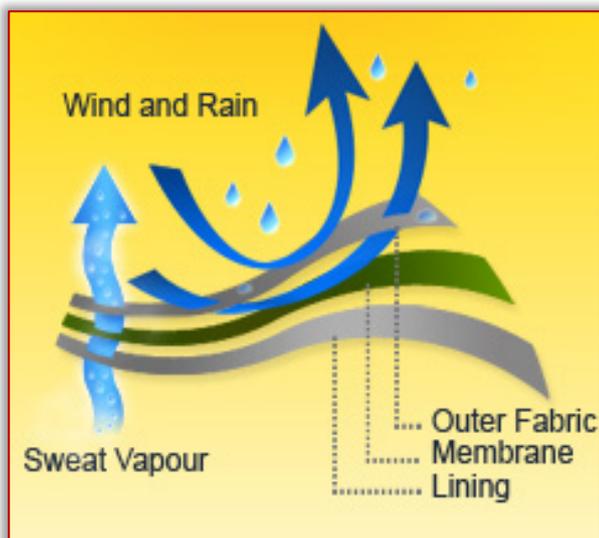
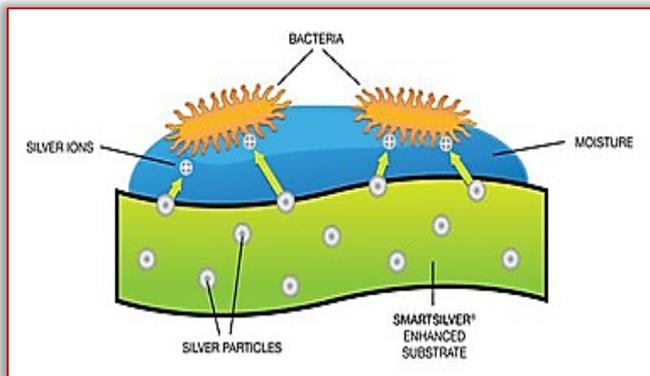


Figure 10. Commercial anti-odor finished clothes (Left: SmartSilver Right: SPORTINGTEX)

CONCLUSION

Anti-odorant molecules in textiles control the growth of odor-causing bacteria arising in clothing that are used as daily basis. Normally these bacteria would generate unpleasant odor, but by controlling their growth, treating with suitable chemicals, prevents the formation of these odors and keeps fabrics fresher longer. More specifically, these chemicals can be applied at the manufacturing level which create bonds into fabric or just bind with fabric by coating. It then kills bacteria by puncturing their cell membranes.

Once the bacteria are dead they can no longer produce any kind of noisome smell that enable fabrics to ascertain their freshness. By following the odor resisting technique many commercial manufacturers produced especially sportswear or children wear that are adorable and highly acceptable to consumers.

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DESIGN AND IMPLEMENTATION OF ADVANCE ENVIRONMENTAL MONITORING

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Abstract: A savvy city empowers the powerful usage of assets and better nature of administrations to the nationals. To give administrations, for example, air quality administration, climate observing and robotization of homes and structures in a savvy city, the fundamental parameters are temperature, moistness and CO₂. This venture exhibits a modified plan of an Internet of Things (IoT) empowered condition checking framework to screen temperature, light force and CO₂. This framework is a headway to make the earth checking in simple way. Framework utilizes distinctive sensors, for example, temperature estimation sensor, light power indicator, PH esteem, carbon dioxide sensor for estimating condition parameters. Every sensor is independently associated with the each WeMos D1 Mini goes about as hub. Sensor information from WeMos D1 small is send to raspberry pi. From raspberry pi every one of the sensors information is send spared into cloud. For client self control the information spared into database is appeared on electronic GUI with the goal that client can screen condition parameters effectively.

Keywords: Internet of things, Light Dependent Resistor, MQ7, PH Sensor, Pressure Sensor

INTRODUCTION

Air contamination is the most concerning issue of each country, regardless of whether it is created or creating. Medical issues have been developing at quicker rate particularly in urban territories of creating nations where industrialization and developing number of vehicles prompts arrival of parcel of vaporous toxins.

Destructive impacts of contamination incorporate gentle unfavorably susceptible responses, for example, disturbance of the throat, eyes and nose and in addition some significant issues like bronchitis, heart infections, pneumonia, lung and exasperated asthma. As per a study, because of air contamination 50,000 to 100,000 unexpected losses for each year happen in the U.S. alone while in EU number compasses to 300,000 and more than 3,000,000 around the world[2].

Different sorts of anthropogenic emanations named as essential poisons are drawn into the climate that experiences synthetic response and further prompts the arrangement of new toxins ordinarily called as optional contaminations. For example, as indicated by the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[4], almost all atmosphere adjusting contaminations either straightforwardly or in a roundabout way (by adding to optional toxins in the air) are in charge of medical issues.

Relatively every subject invests 90% of their energy in indoor air.[10] Outside air nature of the urban communities of created nations enhanced extensively in late decades. As opposed to this, indoor air quality debased amid this same period due to numerous variables like diminished ventilation, vitality preservation and the prologue to new sources and

new materials that reason indoor pollution. The significance of condition checking is existed in numerous angles. The conditions condition are required to be observed to keep up the sound development in crops and to guarantee the protected workplace in enterprises, and so forth. Because of mechanical development, the way toward perusing the ecological parameters wound up simpler contrasted with the previous days.

The sensors are the scaled down electronic gadgets used to gauge the physical and natural parameters. By utilizing the sensors for checking the climate conditions, the outcomes will be exact and the whole framework will be quicker and less power expending.[3] Condition checking is one of the real utilization of remote sensor organize. WSN comprise of various sensors which are broadly disseminated to screen diverse condition parameters like temperature, moistness, gases, weight, wind speed and so forth. The utilization of remote encompassing sensors can prompt more vitality productive structures. WSN comprises of sensor hubs which are minimal effort gadgets with constrained power.[5]

The present framework used to screen the environmental parameters for example, temperature, carbon dioxide, light intensity also it measure the water ph esteem utilizing sensor. This framework is solid to screen the everytime changing parameters of condition effortlessly on electronic GUI. Framework in light of IoT stage so it will help client to screen condition parameters effortlessly anyplace, whenever inside the world[8].

The Motivation of Project is advancements in remote and smaller scale sensor innovations have given establishment stages to think about the improvement of compelling secluded frameworks. They offer the

possibility of adaptability being used, and organize versatility. The Raspberry Pi has ended up being perfect as the center of such a framework. There are numerous other viable uses for nature screen including observing of temperature and stickiness in a home, storehouse, nursery, or even an exhibition hall Although this has been intended for uninvolved checking it is conceivable to have this utilized for currently informing somebody of a temperature change, turning on warming.

RELATED WORKS

The correspondence between the framework's segments is per-shaped utilizing the existent remote foundation in view of the IEEE 802.11 b/g measures. The came about arrangement gives the likelihood of logging estimations from areas everywhere throughout the world and of imagining and breaking down the assembled information from any gadget associated with the Internet.

This work includes the total arrangement, a digital physical framework, beginning from the physical level, comprising of sensors and the correspondence convention, and achieving information administration and capacity at the digital level. The exploratory outcomes demonstrate that the proposed framework speaks to a feasible and direct answer for natural and surrounding checking applications [1].

This framework gathers and screens data identified with the development condition of yields outside and inside nurseries utilizing WSN sensors and CCTV cameras.

The temperature and dampness sensors are produced in-house and the two sensors are exceptionally solid. Moreover, the framework permits programmed control of nursery condition remotely and along these lines enhances the efficiency of yields. This venture presents equipment design, framework engineering and programming process control of the horticulture condition observing framework [2].

PROPOSED ARCHITECTURE

Environment monitoring is an IOT application which helps to monitors the environment condition of any locality or surrounding and the condition can be viewed by everybody with the help of internet. This application is more effective, rapid in providing environment conditions. It helps the individuals or government to take remedial actions if the condition of the environment becomes abnormal.

Environment condition monitoring system provides a method to verify the condition and changes happens over the surrounding. We use raspberry pi and We MOS D1 Mini, Gas sensor, Temperature Sensor, LDR, IOT module in this system. The temperature sensor will monitor and provides the details about the present environment temperature changes. It is useful to know each and everyone the present surrounding temperature. The gas and PH value

sensor is used for monitoring the pollution over environment and water.

Nowadays, air and water pollution makes the environment more vulnerable. Using this module we can detect the polluted area and build awareness to the people for living in the pollution expressly. Changes in the climatic system cannot be defined accurately and it may accidentally defined sometimes but using an IOT module we can characterize more approximate change of an environment and it can be updated in the cloud.

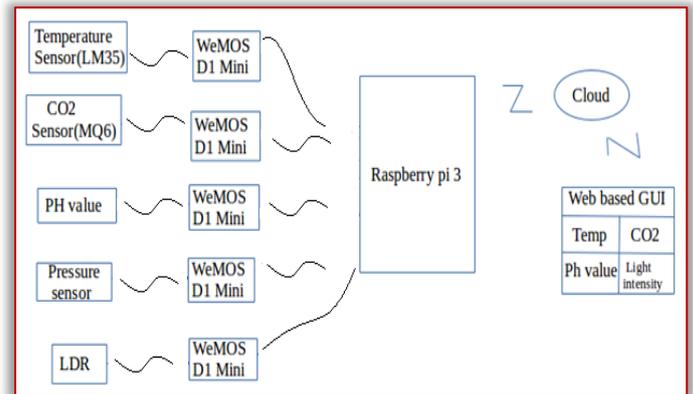


Figure 1 – System Block diagram

Above figure shows the blovk diagram of aIoT based weather monitoring system.

In this project we design the system which is useful for the Weather forecast center. The temperature/ umidity sensor i.e LM35, Co sensor i.e MQ7, and light intensiyi.e LDR, ph value should be used to detect environmental parameters.

EAC sensor is connected seperately to each We MOS D1 mini. Each WeMOS D1 mini is connected to raspberrry pi. Raspberrry pi gather the sensors data from sensors connected to each WeMOS D1 mini. Raspberrry pi send the gathered sensors data to web server. From web server this data is fected into web application. User can see the monitored environment parameters easily using web application.

SYSTEM ALGORITHM

A. Algorithm

- Step 1. Initialize the system
- Step 2. Get environment parameters using sensors such as using temperature sensor, light intensity detector, CO2 detection and Ph value.
- Step 3. Each sensor are seperately connected to the WeMOS D1 Mini acts as node.
- Step 4. Each sensors data get by each WeMOS D1 Mini.
- Step 5. From all node i.e WeMOS D1 mini with sensor data is send to the raspberrry pi3
- Step 6. Raspberrry pi3 get the each sensors data from each WeMOS D1 mini.
- Step 7. Sensed environment parameters are saved into database.

- Step 8. Database will maintain all the environment parameter along with the table.
- Step 9. Stored environment parameters are fetched into web based GUI.
- Step 10. User or viewer can see the environment parameters on web based GUI using browser.
- Step 11. Stop

RESULT

— GRAPH PLOT AT NARHE

Explanation -The graph has been plotted at Narhe. The above graph shows the variation between the parameters such as temperature, CO, CO₂, Pressure, LDR. There is drop in temperature from 32C at 10am to 31C at 6pm in average.

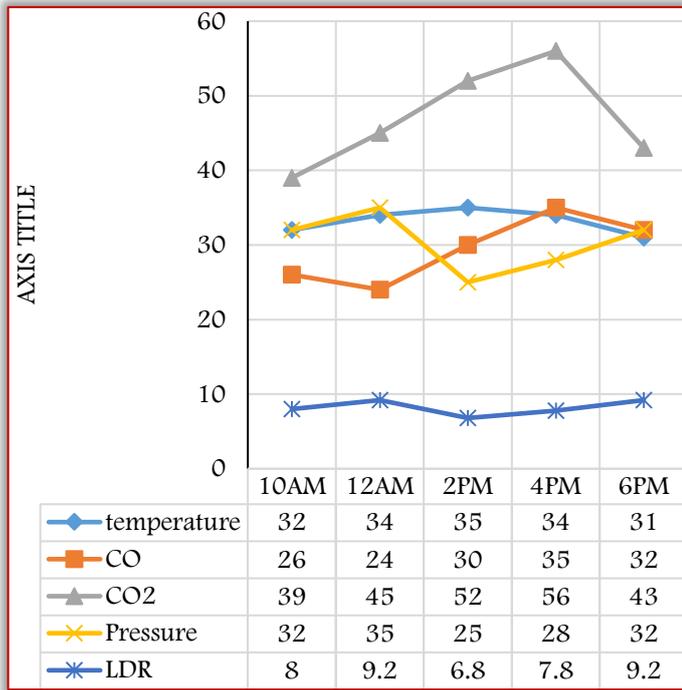


Figure 2- Graph plot at Narhe for various parameters.(Location 1)

There is rise in CO from 26 at 10pm to 32 at 6pm. Also there is rise in CO₂ from 39 at 10am to 43 at 6pm.

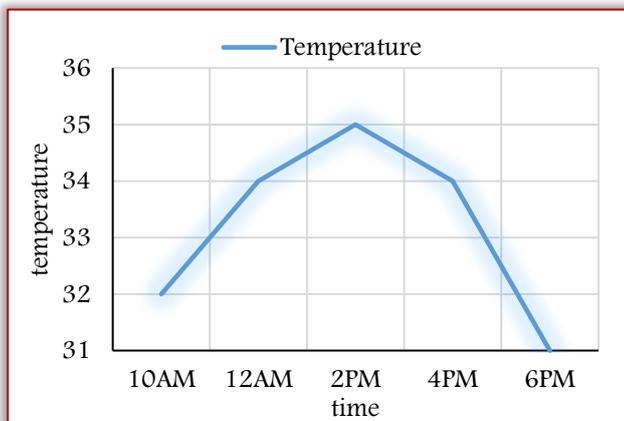


Figure 5.1.2- Above figure represents the variations of temperature w.r.t time

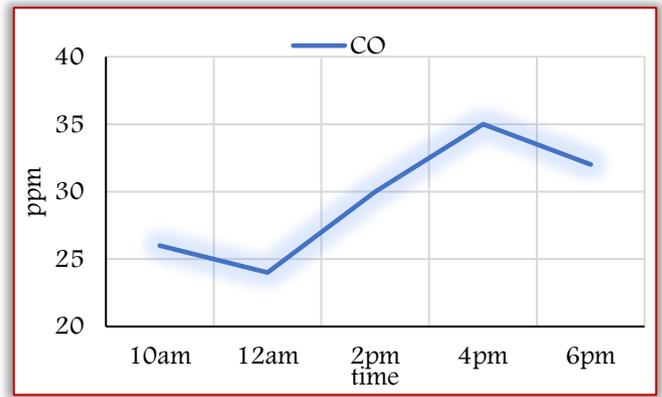


Figure 3- Above figure represents the variations of carbon monoxide w.r.t time.

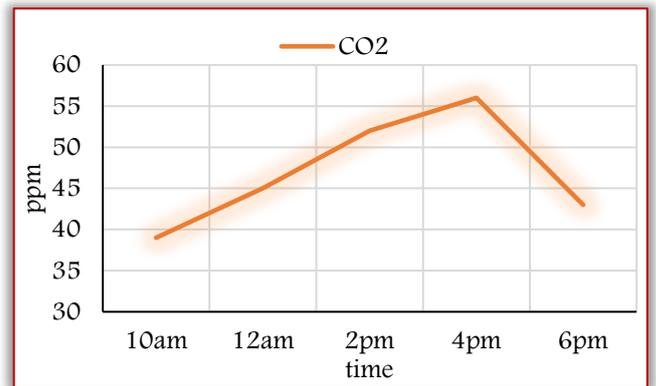


Figure 4- Above figure represents the variations of carbon dioxide w.r.t time.

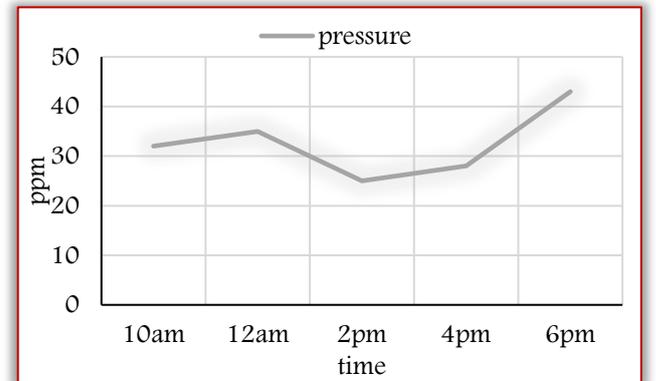


Figure 5- Above figure represents the variations of pressure w.r.t time

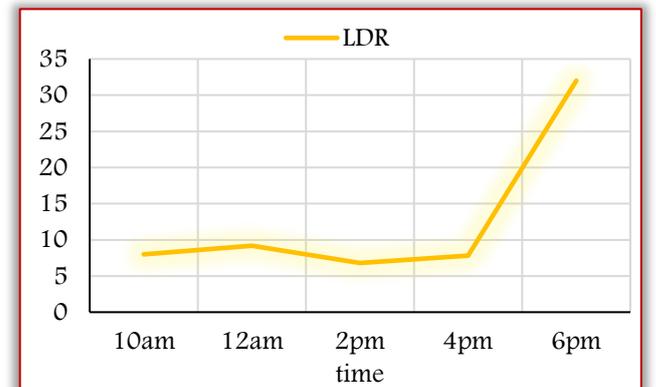


Figure 6- Above figure represents the variations of LDR w.r.t time

— GRAPH PLOT AT SHANIWARPETH

Explanation-The graph has been plotted at Shaniwarpeth. The above graph shows the variation between the parameters such as temperature, CO, CO₂, Pressure, LDR.

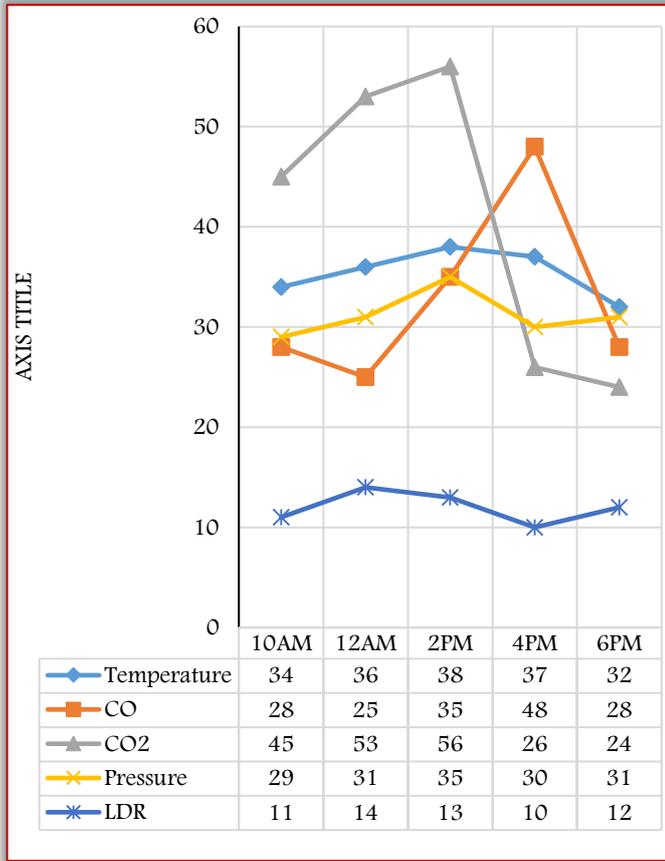


Figure 7 - Above figure represents the variations of the different parameters with respect to Time. The graph has been plotted at Shaniwarpeth.(Location 2)

There is sudden rise in temperature from 6C at 10am to 38C at 12am. Also there is drop in CO from 52 at 4pm to 28 at 6pm. Also there is drop in CO₂ from 56 at 2pm to 26 at 4pm. and also there is rise in pressure from 29 at 8pm to 43 at 10pm.

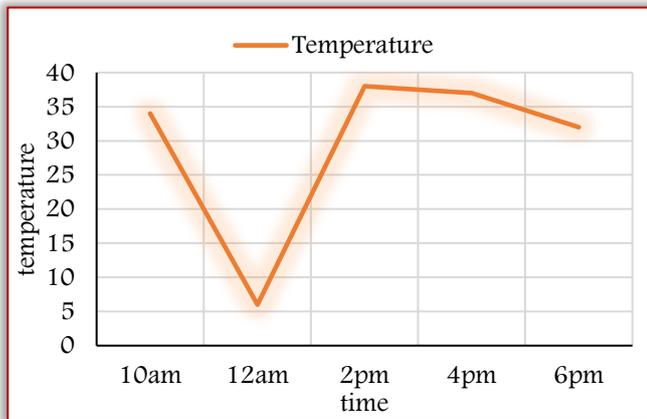


Figure 8- Above figure represents the variations of LDR w.r.t time

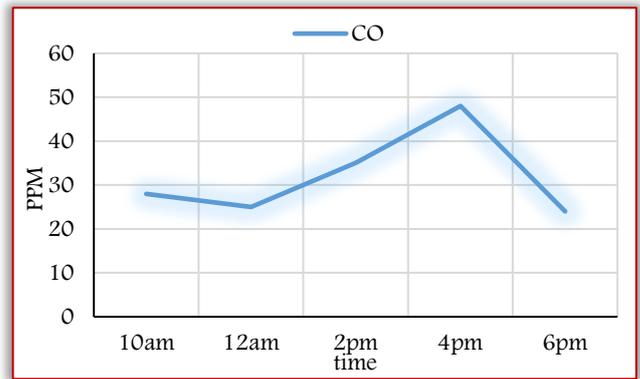


Figure 9- Above figure represents the variations of CO w.r.t time

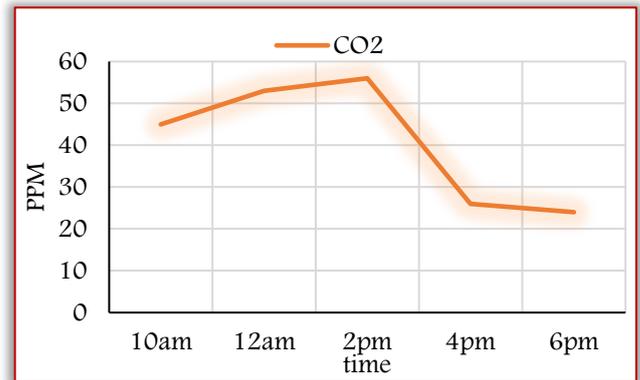


Figure 10- Above figure represents the variations of CO₂ w.r.t time

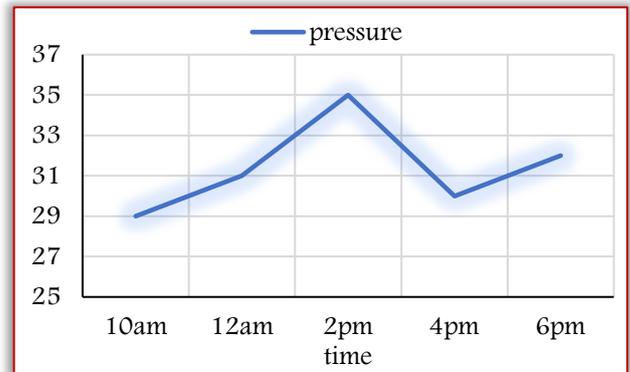


Figure 11- Above figure represents the variations of Pressure w.r.t time

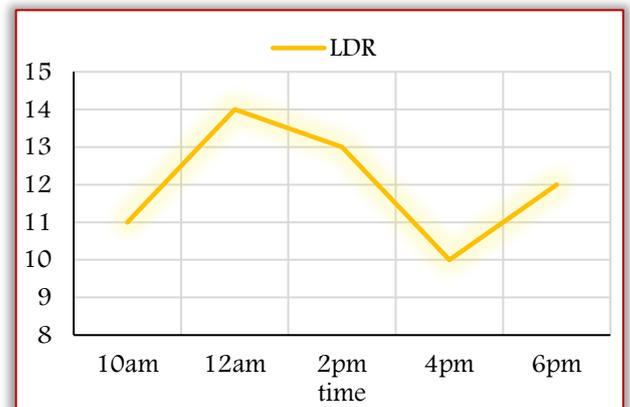


Figure 12- Above figure represents the variations of LDR w.r.t time

— GRAPH PLOT AT KARVE NAGAR.

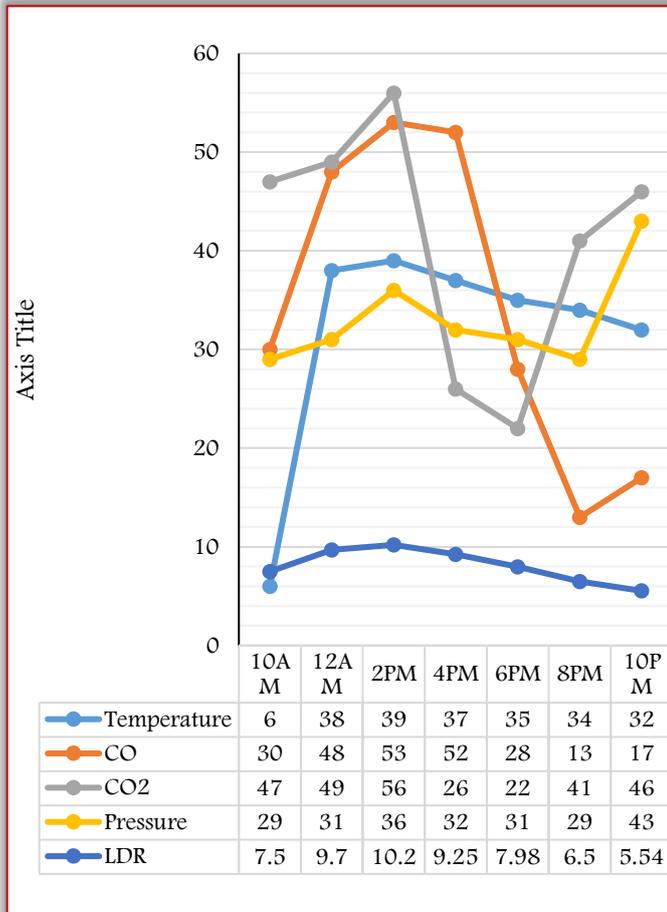


Figure 13 - Above figure represents the variations of the different parameters with respect to Time. The graph has been plotted at Karve Nagar.(location 3)

Explanation-The graph has been plotted at Karve Nagar. The above graph shows the variation between the parameters such as temperature, CO, CO₂, Pressure, LDR. There is sudden rise in temperature from 6C at 10am to 38C at 12am. Also there is drop in CO from 52 at 4pm to 28 at 6pm. Also there is drop in CO₂ from 56 at 2pm to 26 at 4pm. and also there is rise in pressure from 29 at 8pm to 43 at 10pm.

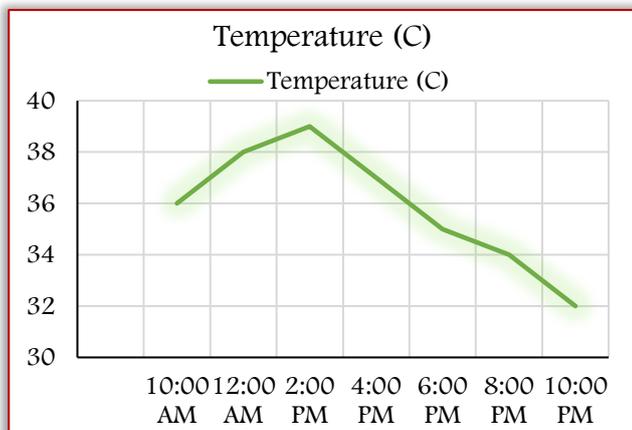


Figure 14- Above figure represents the variations of temperature w.r.t time

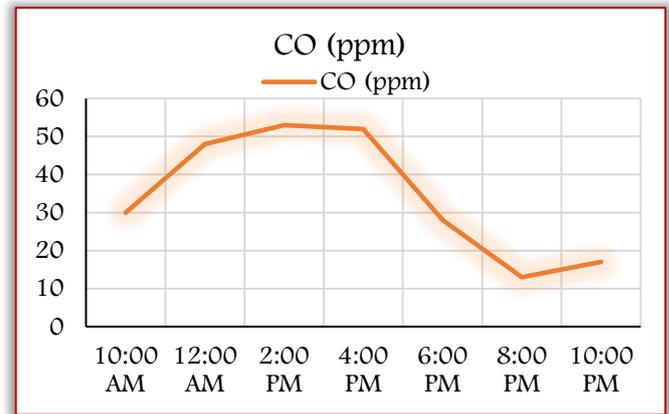


Figure 15- Above figure represents the variations of CO w.r.t time

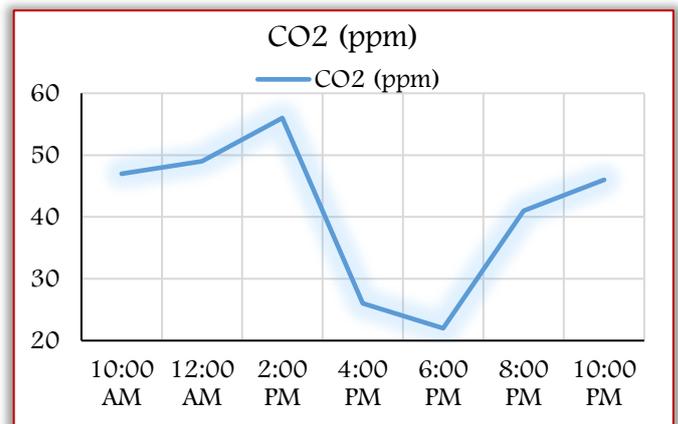


Figure 16- Above figure represents the variations of CO₂ w.r.t time

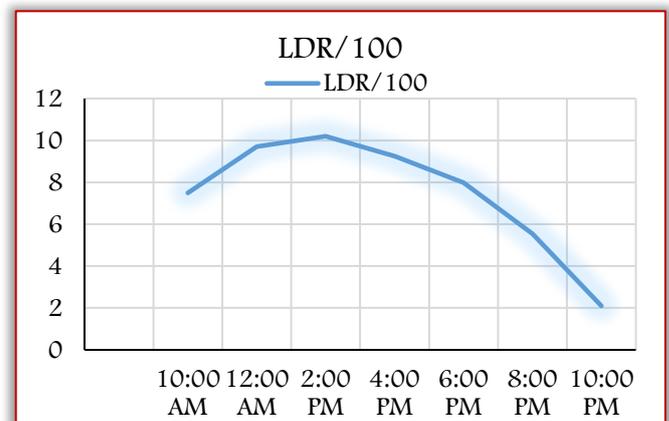


Figure 17- Above figure represents the variations of LDR w.r.t time

CONCLUSION

By keeping the embedded devices in the environment for monitoring enables self-protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e. it can interact with other objects through the network.

The results obtained from the measurement have shown that the system performance is quite reliable

and accurate. The important parameters of the environment such as temperature, CO₂ and light intensity are checked by the respective sensors. The measured parameters are stored into database and shown on web based GUI.

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THE RELATIONSHIP BETWEEN THE CROP, YIELD COMPONENTS, NUTRITION PARAMETERS OF MAIZE AND THE VARIOUS FOLIAR FERTILISERS ANALISED BY ONE-WAY ANOVA

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Abstract: Many agro-technical factors are of great importance concerning the amount of crop in corn production. One of these factors is nutrient supply, when plants are supplied with macro, meso and microelements. Nowadays cultivated plants cannot always obtain enough microelements from the soil, therefore the importance of foliar fertilization increased. Applied at the right time, foliar fertilization might increase the resistance of corn against biotic and abiotic factors as well. Both the amount and the quality of crop can be improved with foliar fertilisation. In our experiment we examined the effect of various foliar fertilizer products (Algafix, Amalgerol, Fitohorm Turbo Zn, and their combinations) on the important elements of the yield components of maize, the size and quality of the grain and economic calculations were carried out. The results were evaluated by single-factor analysis of variance (one-way ANOVA). Our aim was to determine for yield components and quality parameters, whether there is significant difference between the means of each treatment-group, i.e. whether the treatment had a significant influence on the mean value of the given parameter. This way, we can get an answer if it is worth dealing with certain treatments for the given yield components and quality parameters.

Keywords: maize, yield components, nutrition parameters, foliar fertiliser, nutrition supply, significance, one-way ANOVA, Tukey-test

INTRODUCTION

In practice, foliar fertilisers can meet only a few percent of the main macro-element demand of plants. Foliar fertilisation cannot replace nutrient uptake through the soil, just supplement it. The foliar fertiliser can get directly to the place of use, the leaf cells and it can act immediately without the mediation of the soil. Nutrient uptake can be sustained even in drought, with little water. Under ideal conditions, the nutrient utilisation might reach 100%, [1, 2]. Foliar fertilisation can only be effective if the missing nutrient elements are replaced indeed in the right way and at the right time. Foliar fertilisation tests and experiments must be conducted to check the effect of the fertiliser substances, [3].

Today, our cultivated plants cannot always get enough microelements from the soil to achieve high yields, therefore the significance of foliar fertilization increases. Timing is vital, as crop losses or loss of quality can be avoided by rapid and effective intervention, however, with the use of foliar fertilisers, and under favourable conditions, yield increase and quality improvement can be reached as well. With foliar fertilisation carried out at the right time the resistance to environmental stress factors, pathogens and pests can be increased. On large areas of plough land there is not enough zinc for the maize and the plant is sensitive to zinc deficiency. In the absence of zinc, the growth of the maize is restrained,

the generative organs are damaged, the flower-forming is delayed, or perhaps it will not happen at all. In the past few years the soil examination results showed that due to the intensive production the zinc supply fell back sharply on the good-endowed maize-growing districts of Hungary. Relative zinc deficiency can occur even when there is a good supply of zinc in the soil, which can be caused by the antagonism of phosphorus and zinc uptake in the areas where there are good or very good (sometimes too much) phosphorus supply. A similar phenomenon - the zinc binding - can be observed on alkaline (calcareous) soils. To avoid zinc and other microelement deficiencies, leaf fertilisation is recommended in the 6-8-leave stage of the plant, linking the application with a late post-emergence herbicide treatment. If we apply a foliar fertiliser in a separate run, we should choose the latest possible date for a conventional field sprayer, when we can do the treatment without damaging the plant, when there is enough foliage to the effective uptake of the foliar fertiliser, [4].

The low yield averages in maize production can be due to the fall-back of chemical fertilisation; therefore, the use of fertilisers must be increased in order to reach higher and more consistent amounts of maize, [5, 6, 7, 8, 9, 10, 11].

Nutrients for supplementing basic requirements, mostly the microelements, are taken up by the plant through the leaf. This process is carried out using leaf

fertilization or spraying in plant production, [12]. Jakab [13, 14] investigated the effect of foliar fertilisation on the yield of maize. The yield of the control plots ranged from 9.9 to 11.8 t/ha, while that of the treated parcels were between 10.3 and 11.47 t/ha. There was no statistically justifiable difference between the yield of the control and the yields of the foliar- fertilised parcels. Foliar fertilisation resulted in a decrease in crop-changes.

Foliar fertiliser products might be suitable to improve the maize-forming elements and the amount of the yield. When applying these fertilisers, yield stability can be increased, and they might affect the nutrient parameters as well, [15, 16, 17, 18].

MATERIALS AND METHODS

Our experiment was carried out in Hungary, in a settlement called Hódmezővásárhely, on the territory of the University of Szeged Pilot Farm Ltd. The experiment was carried out on chernozem soil, which was good in nitrogen, and very good in phosphorus and potassium. The zinc content of the soil, which is the most important micro element for maize, was low (Table 1).

Table 1. Soil test results of the experiment area

pH (KCL)	CaCO ₃ (%)	P ₂ O ₅ (mg/kg)	K ₂ O (mg/kg)	Zn (mg/kg)	Humus m/m %	K _A
7.17	3.33	336	620	1.76	3.39	48

Considering the whole vegetative period, the rainfall deficit was 83.6 mm, which is a considerable value. The average temperature exceeded the 50-year average in each month of the vegetation period of maize. The positive deviation of average temperature together with rainfall deficit had a negative effect on the development of maize, which resulted in low yields.

Various foliar fertilisers were applied during the research. The experiment was set in three repeats in random blocks. The size of the parcels was 7.6 m² each (10 m x 0.76 m). The fore-crop was maize and after the harvest the tillage involved deep ploughing at 30 cm depth in autumn. After the spring soil works and the seedbed preparation, sowing took place. The plant number was 72.000/ha.

The hybrid in the experiment was DKC 4025 (FAO 340). This hybrid is typically smaller, its stem is thicker, and its roots are strong. It has excellent yield-stability with good plant-number compensation features and very good stress tolerance. There was a post-emergent weed-control in May. Foliar fertilisation was applied twice (in May and June) with a dose suggested by manufacturers. The fertilisers were put out with backpack-sprayers. The applied products were the following:

—Algafix (AL) (microbiological bio-stimulator, the only product containing live algae from Lake Balaton),

- Amalgerol (AM) (a product containing plant oils, herb extracts, trace elements and essence), and
- Fitohorm Turbo Zn solution (FZn) (containing Zn microelement that improves the rooting and cob-differentiating of maize).
- Treatments combining the above-mentioned products.

Altogether, there were six treatments in the research and the control (untreated) parcel.

In the experiment the single-factor analysis of variance (one-way ANOVA) and Tukey test were used.

The one-way variance analysis (ANOVA) was used to find out whether the mean values of the various treatment groups differed significantly. For example, significant differences between the mean values of the various treatments as groups may reveal the effect of each treatment on the parameter under consideration, [19].

F-test was performed to check whether the difference between the mean values of each group was significant. If this difference is significant, the null hypothesis is rejected based on the test used. At this point, Tukey's test is performed to determine specifically which groups are significantly different, based on the mean values of the given treatment groups, [20].

This test works well with both the accumulation of the type 1 errors and the strength of the test. (If the null hypothesis is stated when using ANOVA, then there is no point in making the Tukey test.) When performing post hoc Tukey test, we first get the differences between the mean values of all possible group-pairs. We compare these differences with a critical value to determine whether they are significant. If the deviation of the averages exceeds this value, the actual difference is significant.

When the Tukey test compares the averages of the treatment groups in pairs it also examines the common impact in addition to the unique effect.

During the test, we first determined the deviation of the averages of all possible group pairs, then compared these differences with the following statistics:

$$HSD = q \sqrt{\frac{MS_w}{n}}, \quad (1)$$

where q is the studentized value set statistics with the appropriate degree of freedom. Its value can be found in a table. The value of MS_w is the average square deviation within the group, known from the ANOVA procedure, while n is the number of sample elements within the group, [20, 21, 22].

RESULTS AND DISCUSSION

In the framework of the study, experiments were carried out concerning the yield of maize and various

parameters of maize, i.e. different treatments and their effect on the subject of the experiment. The treatments affected the following parameters of maize: grain yield ($t \cdot ha^{-1}$), grain moisture (%), thousand grain weight (g), shelling rate (%), crude protein ($g \cdot kg^{-1}$), crude fat ($g \cdot kg^{-1}$), starch ($g \cdot kg^{-1}$), and crude fibre ($g \cdot kg^{-1}$).

We used one-way ANOVA to find out that the average values of crude protein ($g \cdot kg^{-1}$), crude fat ($g \cdot kg^{-1}$), starch ($g \cdot kg^{-1}$) and crude fibre ($g \cdot kg^{-1}$) content of maize differ significantly in the various treatment groups. Tukey-test was applied to find out exactly in which treatment groups the average values differ significantly.

The crude protein content of maize in the control parcel was 55.87 g/kg. This value was somewhat exceeded by the 56.59 g/kg result of the treatment with Fitohorm Turbo Zn solution as well as that of the Algafix treatment (57.10 g/kg). The foliar fertiliser presenting the best result was Amalgerol, providing a 5 g/kg crude protein plus. The combinations of the various products showed lower values than that of the control, therefore it can be stated that the foliar fertilisers in the research improved the crude protein content of the maize when applied solo, however, when they were combined they decreased it, compared to the control.

Accordingly, treatments No. 3 and 5, as well as No. 3 and 7, showed significantly different results in case of crude protein (g/kg) (Figure 1).

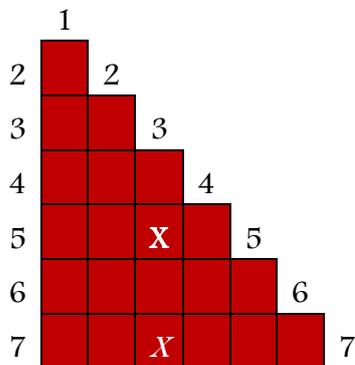


Figure 1. Significant differences in the mean values of crude protein (g/kg) of the treatment groups based on the Tukey-test

(X: significant at $p < 0.05\%$ probability level;
X: significant at $p < 0.01\%$ probability level)

In the examined foliar fertilisation treatments, the crude fat content of maize mostly decreased; it was only the treatment with Fitohorm Turbo Zn solution (32.97 g/kg) that could exceed the results of the control parcel 29.87 g/kg. The value of this treatment was proved to be statistically higher than that of the control.

The values of the other treatments did not reach that of the control. The lowest values were measured in

treatments Amalgerol (23.69 g/kg), and Algafix + Fitohorm Turbo Zn (24.5 g/kg).

In 11 cases out of the 21 possible ones, the mean values of crude fat (g/kg) could be clearly distinguished (Figure 2).

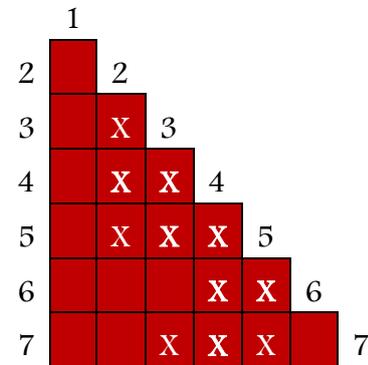


Figure 2. Significant differences in the mean values of crude fat (g/kg) of the treatment groups based on the Tukey-test

(X: significant at $p < 0.05\%$ probability level;
X: significant at $p < 0.01\%$ probability level)

In the grain of the maize it is the starch that accounts for the highest amount. During our research the highest starch amount was obtained in the Algafix treatment (709.47 g/kg). The second largest value was in the control treatment (702.21 g/kg). In the treatments with the other products we measured lower starch values than that of the control. The starch contents measured in the treatments Fitohorm Turbo Zn, Algafix + Amalgerol, Algafix + Fitohorm Turbo Zn and Amalgerol + Fitohorm Turbo Zn were significantly lower than the values of the control treatment.

In 9 cases out of the 21 possible treatment-pairs, the mean values of starch (g/kg) were visibly outstanding (Figure 3).

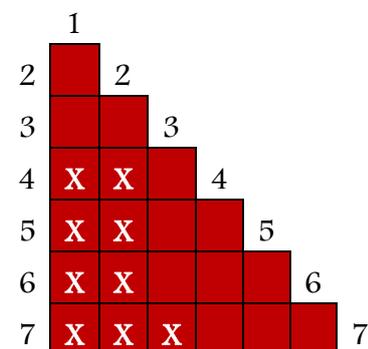


Figure 3. Significant differences in the mean values of starch (g/kg) of the treatment groups based on the Tukey-test

(X: significant at $p < 0.05\%$ probability level;
X: significant at $p < 0.01\%$ probability level)

Maize presented the highest crude fibre content in the treatment with Algafix (44.75 g/kg). Then the values

of the control (43.95 g/kg), and the Amalgerol treatment (43.28 g/kg) followed. Algafix + Amalgerol and Amalgerol + Fitohorm Turbo Zn treatment pairs showed approximately the same values (40.45 g/kg; 40.48 g/kg, respectively). The two lowest values were obtained with foliar fertiliser treatments with Fitohorm Turbo Zn (39.72 g/kg), and Algafix + Fitohorm Turbo Zn (39.10 g/kg).

In certain cases, we obtained significant differences between the values of the treatments here. The values of Fitohorm Turbo Zn (39.72 g/kg), and Algafix + Fitohorm Turbo Zn (39.10 g/kg) treatments were significantly lower than that of the control (43.95 g/kg), Amalgerol (43.28 g/kg) and Algafix treatments (44.75 g/kg).

In case of crude fibre (g/kg) as well, there are several treatment groups where the mean values are significantly different (Figure 4).

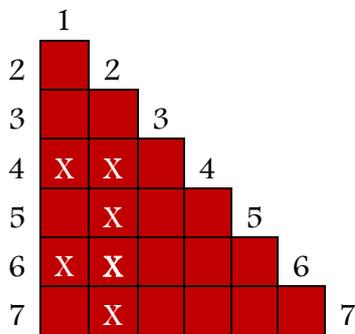


Figure 4. Significant differences in the mean values of crude fibre (g/kg) of the treatment groups based on the Tukey-test

(X: significant at $p < 0.05\%$ probability level;
X: significant at $p < 0.01\%$ probability level)

As for the examined yield component elements, there were no significant differences.

In case of thousand grain weight it was the Algafix product that resulted in the best value (312.33 g), which exceeded that of the control by 24 g. Similarly, good result was achieved by the Fitohorm Turbo Zn solution (302.17 g) as well. Amalgerol (299.33 g) and Amalgerol + Fitohorm Turbo Zn mix (295.50 g) were similar, and Algafix + Amalgerol combination was not much backward either with a result of 290.17 g. The lowest value was produced by the Algafix + Fitohorm Turbo Zn combination (286.67 g), which was even below the value of the control (288.17 g).

Shelling rate is a very important property value of the hybrids indicating the ratio of the grain compared to the whole cob. One important objective of maize breeding to increase shelling rate. Considering the hybrids of today this value is approximately 90%. There were no great differences between the values of the treatment groups in the experiment.

The value of the control parcel was 89% vol, just like the results of the Amalgerolos, Algafix + Fitohorm Turbo Zn mix, and Amalgerol + Fitohorm Turbo Zn

treatments. All these were somewhat exceeded by the results Algafix foliar fertiliser, and the Algafix + Amalgerol mix, with a result of 89.7% each. The best shelling rate (90%) was obtained with the application of Algafix foliar fertiliser by itself.

Grain moisture content at harvest is a very important parameter because the lower its value, the lower the cost of drying is. The literature describes cereal grain moisture below 14 % at which drying is not necessary and maize can be stored for longer periods. The droughts of the given year contributed greatly to the rapid drying of maize, which can be seen from the results.

The lowest grain moisture value was measured in the control treatment (12.85%). Similarly, favorable values were obtained when using the Fitohorm Turbo Zn solution (13.40%) and Amalgerol + Fitohorm Turbo Zn mix (13.36%). The other treatment values were slightly higher. The highest values were measured in Algafix treatment (14.39%).

As for grain yield, the values of all treatments were higher than the control value of 6.39 t/ha. The best results were achieved with Amalgerol + Fitohorm Turbo Zn treatment, which showed an increase of 1.11 t/ha compared to the control. This result was approached by the Fitohorm Turbo Zn solution alone (7.35 t/ha), and the Algafix + Fitohorm Turbo Zn treatment did not lag either (6.94 t/ha). In Amalgerol treatment 6.83 t/ha, while in Algafix + Amalgerol treatment 6.68 t/ha was measured.

The lowest result was achieved with Algafix (6.51 t/ha) for grain yield.

Compared with the control, we examined whether the yield surpluses in each treatment cover the costs of applying the fertilisers (product price + application cost). As for the prices, we considered the price list of a company selling agricultural input materials. The cost of the application is 5.000 HUF/ha (here we calculated with two applications) and the selling price of the maize was 44.000 HUF/t.

The study found that we received positive income for only two treatments. Algafix achieved a minimum turnover of HUF 470 HUF/ha, while in case of Fitohorm Turbo Zn treatment, a profit of 24.455 HUF/ha was achieved, compared to the control. Due to the high cost of the Amalgerol product, this treatment was not profitable. Regarding the combinations of the products, the total prices of the compositions did not cover the investment.

CONCLUSIONS

In the experiment, the effect of three foliar fertilizer products and their combinations were examined for the yield, yield component elements and some nutritional parameters of maize.

Based on the examinations carried out, it can be concluded that, due to the unfavorable dry weather conditions for maize, relatively low yields were

obtained in each treatment (6.39-7.5 t/ha). Amalgerol + Fitohorm Turbo Zn (7.5 t/ha), Fitohorm Turbo Zn (7.35 t/ha), and Algafix + Fitohorm Turbo Zn (6.94 t/ha) treatments were the most influential on the amount of the yield.

The amount of the crop was the most affected by Zn-containing treatments, indicating that the low Zn-content in the soil of this area could hinder higher yields. The uptake of Zn is also hampered by the very good phosphorus content of the soil due to the antagonism between the two elements. Therefore, we recommend replacing Zn as a leaf fertilizer to reduce the P-Zn antagonism.

In case of yield components, Algafix and Fitohorm Turbo Zn treatments produced the best results. Algafix, Amalgerol, and Fitohorm Turbo Zn treatments had beneficial effects on the examined nutritional parameters of maize. Based on the economic evaluation, it was found that during the experiment, we were able to achieve the highest income (24.455 HUF/ha) using the Fitohorm Turbo Zn treatment. In addition, Algafix treatment was also profitable (470 HUF/ha).

The results show that, for the application of certain products, it is necessary to know the nutrient content of the soil.

Therefore, we must strive to replace nutrients present with lower amount in the soil, which is the best way to increase the efficiency of maize production.

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STUDY OF EPOXY~GRANITE PROPERTIES USING INDIAN ORIGIN GRANITE

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Abstract: Granite is the material used for metrological and precision machine manufacturing applications; Granite is also used in some of the high accuracy machine tool manufacturing. Considering the good properties of granite and limitation of granite new emerging material Epoxy Granite is evolved. In this paper, Epoxy Granite properties using Indian Black granite are studied. In this paper, maximum load-bearing and density of epoxy granite have been focussed. Also, the combination which is best suited for the applications can be easily dragged out. Density is compared with maximum load-bearing and their relation is also put forward in this paper to simplify the selection process of epoxy granite.

Keywords: Epoxy Granite, Mechanical properties, Density, Maximum bearing load, Flexural Modulus

INTRODUCTION

Designing of machine component passes through a number of stages, it starts from defining functionality and performance requirement, to the testing of individual component and complete machine. Design consideration also includes the time required and cost involved in covert concept design to the functional machine. Design methodology influences the optimization of material selection which results in an optimized combination of cost, time and functionality. Machine component and performance, in relation to material used to manufacture them, needs focus on reducing the cost by using alternative material.

Fabricated steel structure, Cast iron are some of the conventional materials that are being used for the machine structural part (1) (2) (3). For precision machines granite is used as the main structural part of the machine-like base or bed. Granite is also majorly used in metrological machine manufacturing (4) (5) (6). Good compressive strength, high thermal capacity, high hardness, Machinability and possibility to lap the surface gives precision guide way manufacturability. High damping capacity is an added benefit of this material, which damps the external as well machine generated vibrations, which in-turn, helps greatly to achieve positional accuracy and repeatability, that results in the least tolerance parts and accurate measurements. Brittleness and material handling, availability of the material in a single piece as well as in the desired shape, the skill required for processing of the material are some of the limitations. Considering the good and limiting properties of granite, new material named epoxy granite is investigated (5) (3) (7).

Epoxy Granite is a composite material composed of aggregate crushed granite particles mixed with formulated epoxy resin. Once mixed, the mixture is cast in a mold and cured at room temperature. Epoxy

granite is a low-density material, owing very good dynamic properties due to which it's preferred more willingly in the machine tool industry. The density of granite varies from $2.5 \times 10^3 \text{ kg/m}^3$ to $3 \times 10^3 \text{ kg/m}^3$ whereas the density of epoxy granite varies from $2.45 \times 10^3 \text{ kg/m}^3$ to $2.8 \times 10^3 \text{ kg/m}^3$. Here the variation in the density is caused due to aggregate sizes, shapes and compaction.

A recent study on epoxy granite is about finding the different material properties required i.e. compressive strength, flexural strength, modulus of elasticity, coefficient of thermal expansion, damping capacity, etc. (8) (9) (10). Density is a property which decides the total weight of the system, and important from dynamic forces, transport, cost, deformation and self-weight point of views. Generally, lower density with higher stiffness is preferred for designing the structural part of the machine. Young's modulus plays a significant role against the deformation, higher the modulus of elasticity, better is the stiffness. When the loads are in a tensile manner, tensile strength is considered. The structural component of a machine-like base, sustains complete machine loads, here, we use Compressive strength for this calculation, whereas, Flexural strength is considered in the case of bending loads. Rotatory motion, linear motion and uneven loads generate vibrations in the machine but the damping properties of machine components can damp these vibrations. In porous materials, such as granite, water absorption affects the material properties. Surface Finish, which is the deviation of the surface against the true plane can be achieved in epoxy-granite composites. And, as a part of the thermal properties, coefficient of thermal expansion is studied.

In the world market, there are nearly 300 varieties of granite, out of which India supplies about 200 varieties (11). Out of these, prime varieties represent

a wide spectrum of colour, texture, and structure. The major production of granite in raw, as well as processed form, is generally from the southern region of India. Indian black granite, black galaxy, is one of the granites, being used in Metrology Industry. This granite holds certain mechanical, physical and chemical properties suitable for machines (1) (12). Study and analysis of epoxy granite properties using these materials are needed.

In the following paper, the study of Epoxy Granite properties using Indian black granite is carried out. Waste granite material from one of the metrological industries is used to prepare Epoxy-Granite specimens. Here, the attempt is to find out the maximum density of the dry mixture of different granular sizes of granite in different weight combinations. It also aims to simplify the selection of granite granular weight combinations to maximize the density and subsequent material properties. In the studies, density, compressive strength, flexural strength, damping factor, these properties were considered.

EXPERIMENTATION

— Specimen preparation

Indian Black Granite with compressive strength of 2700 kg/cm² to 3000 kg/cm² is selected to prepare granular. Granular particles are segregated into 4 different aggregate sizes of granite i.e., 0.1-0.3 mm, 1-3 mm, 4-8 mm, 8-11mm. A theoretical study has been conducted using 3D cad modeling with spherical shapes to decide the different size and weight percentage in combination as 40-30-20-10%, 30-25-25-20%, 20-20-30-30%, 10-15-35-40% respectively. Four different epoxy percentages by weight = 8%, 12%, 16%, 20% and two different vibrating frequencies = 45 Hz and 60 Hz are taken. Hence, variables under consideration are different aggregate sizes of granular granite and their percent aggregate combination by weight, different epoxy percentages by weight and different vibrating frequencies. Total 32 specimens were prepared by considering different combinations, 12 of which are shown in fig. 2.

According to ASTM – C35, a test specimen size of 300x50x50 mm is decided. The vibration table [fig. 1] is specially manufactured to conduct the compaction test of granular weight percentage vs density and to obtain the epoxy granite specimens [fig. 2] by providing different vibration frequency.

Initially, several iterative attempts were made to gain the maximum density and selective combinations were taken. As the outcome of compaction test, it was observed that maximum density is not achieved with individual granule, even though the granular size is 0.1 to 0.3 mm, granular combination of 0.1-0.2+12-14 mm grain size gives maximum density, and combination of 12-14 mm, 8-11 mm, 4-8 mm and

0.1-0.3 mm gives a secondary maximum weight of mixture. Compaction test outcomes were used to decide weight percentage as:

40-30-20-10%, 30-25-25-20%, 20-20-30-30%,
10-15-35-40% respectively.

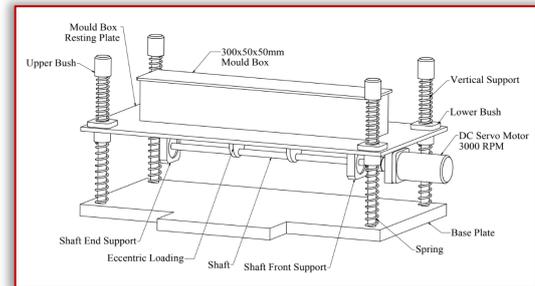


Figure 1: Mould box with vibration table

— Epoxy-granite specimen moulding/casting

Granular granite, resin and hardener were taken by weight percentage and mixed thoroughly for 10-12 minutes, on the other side, mould box was clamped on a vibration table and separating agent () was applied on inside walls of mould box for easy removal of cast afterwards. The mixture of epoxy and granular granite is poured in a mould box, and is kept under constant vibrations for about 10-15 minutes at a pre-decided vibration frequency. Mould box with mould is kept at normal room temp for 24 hrs and after 24 hrs the mould box was disassembled and the specimen was taken out for further inspection.



Figure 2: Specimens prepared by different combinations of epoxy and granite

INSPECTION AND TESTING

Dimensional measurement and weight of all 32 specimens were inspected and density of each specimen was calculated. A further study was conducted to find out the relation of a different combination of granular granite and its density.

$$\text{Density} = \frac{W}{V} \text{ gm/cm}^3$$

w= weight of the specimen, gm

v= volume of the specimen, cm³

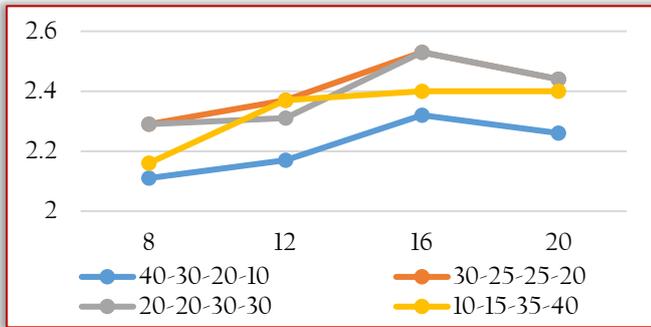
Flexural testing, using the 3-point method is used for measuring maximum load-bearing and flexural modulus. ASTM C580-02, a widely used UTM was chosen to conduct different tests.

ASTM C580-02, covered the determination of flexural strength and modulus of elasticity in flexure of cured chemical-resistant materials in the form of moulded rectangular beams. These materials include mortars, brick and tile grouts, structural grouts,

machinery grouts, and polymer concretes. These materials shall be based on resin, silicate, silica, or sulphur binders. This test is generally applicable to rigid and semi-rigid materials; therefore, this is used as a guide during experimentation.

RESULTS

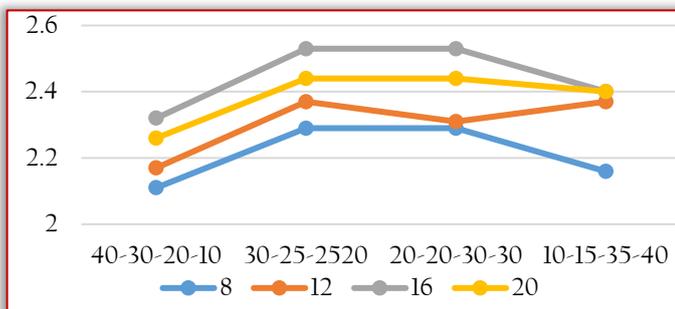
The results obtained are put into a graphical form and compared with their respective variables to find out the best combination for getting the desired property.



Graph I

A graph for density vs. epoxy percentage [Graph I] is plotted and 4 lines of different colours represent aggregate size combination, the graph clearly indicates that for all the combinations, at 16% epoxy concentration, specimens show greater density. So, it can be concluded that 16% epoxy gives greater density than any other epoxy percentage in the mentioned combinations. Thus, graph I is clearly indicating that density is directly proportional to the Max load.

Graph for density vs aggregate size combination [Graph II] is plotted and 4 lines represent epoxy percentages, graph is showing that 30-25-25-20 and 20-20-30-30 combinations are giving more denser specimen but particularly in case of 12 % epoxy at 20-20-30-30 combination, it is going downward which makes 30-25-25-20 combination superior. So, we can conclude that to get the denser specimen we can select 30-25-25-20 combination.



Graph II

Altogether, a specimen of 16% epoxy with 30-25-25-10 combination gives the best density among all the specimens.

From the application point of view, if density is playing a vital role and is responsible for many other parameters, this reference or experimentation is

enough, as well as, provides a guideline on how to find the best epoxy granite for loading applications particularly.

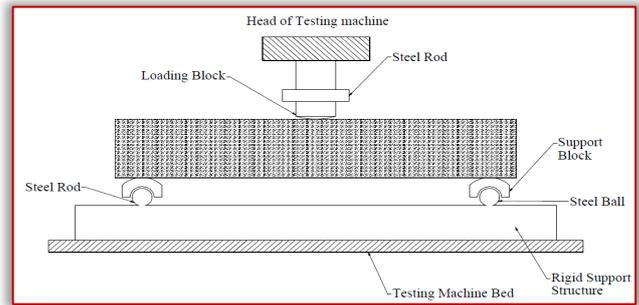


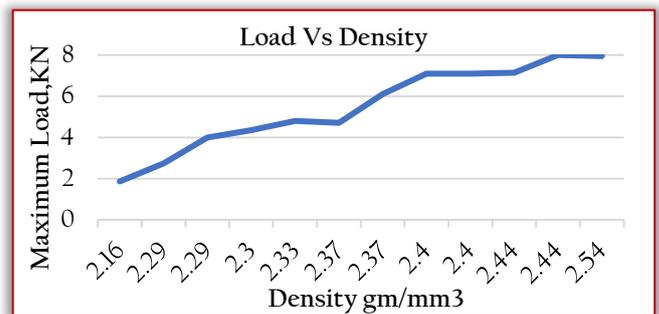
Figure 3: Flexural testing set up

Flexural Strength checking, in total 12 specimens were selected for this experimentation covering all the ranges of granite-epoxy combinations available.

Table 1: Density and max load of selected epoxy granites specimen

Specimen No.	Density (gm/cm ³)	Max load (kN)
1	2.33	4.8
2	2.29	2.73
3	2.37	6.1
4	2.54	7.95
5	2.44	8
6	2.29	3.99
7	2.3	4.35
8	2.44	7.14
9	2.16	1.86
10	2.37	4.7
11	2.4	7.1
12	2.4	7.1

By plotting the results into a graphical form, Maximum load vs density, we can observe that, for density value 2.54 gm/mm³, which is maximum among all and shows the maximum load capacity of 7.95 kN.

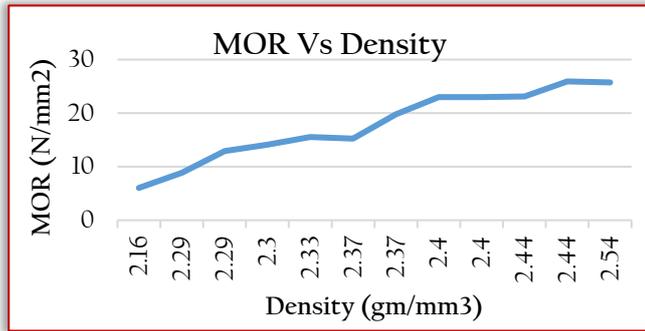


Graph III

Hence, sample no. 4 (Aggregate combination = 30,25,25,20; Epoxy percentage = 16%; Vibrating frequency = 60Hz; Epoxy type = E1) is taking maximum load. Least density which is 2.16 gm/mm³ of sample no. 9 (Aggregate combination = 10,15,35,40; Epoxy percentage = 8; Vibrating frequency=60; Epoxy type=E1) has least max load of 1.86 kN.

Hence, from the results and graph, it is reflecting that density has a direct relation with maximum load and density is directly proportional to the maximum load.

Also, modulus of rupture is directly proportional to maximum load. Hence, density is directly proportional to the modulus of rupture, and is shown below:



Graph IV

$$MOR = \frac{3 * F * L}{2 * b * d^2}$$

where: MOR= modulus of rupture, N/mm²; F = load at a given point on the load deflection curve, N; L = Support span, mm; b = Width of test beam, mm; d= Depth or thickness of tested beam, mm

CONCLUSIONS

1. Compaction technique can be used to maximize the density of Epoxy-Granite.
2. Maximum Density results into maximum flexural strength and max load carrying capacity.

Competitive Epoxy Granite Properties can be achieved by using Indian Black Granite.

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COLLECTING ELV RECYCLING CENTERS FOR CIRCULAR ECONOMY REQUIREMENTS

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Abstract: The circular economy is extremely important for achieving sustainable development, to which the international community has agreed and committed itself. In EU countries and other developed countries, the struggle for the reuse of resources is taking a long time since the need to change the concept of a global economy has become a necessity. This paper aims to analyze and briefly describe the functioning and organization of recycling centers in some EU countries that represent examples of good practice in the field of waste recycling, with the aim to illustrate the positive practices of the countries of the European Union that are one of the leaders in this field, the basis for the development of a more efficient and sustainable recycling system in the Republic of Serbia.

Keywords: recycling centers, recycling, circular economy, waste management, End of Life Vehicles (ELVs)

INTRODUCTION

The principle of circulation of matter in nature has long been known, and today it has become necessary to introduce the principle of circulation and production in order to minimize the production of waste, and the previously obtained products have a new purpose after rebuilding or a completely new form and purpose after recycling.

In contrast to linear, the tendency is towards a sustainable development in the form of a circular economy that represents a closed system in which it is reused and recycled. The circular economy provides a reduction in the use of raw materials to optimize the use of by-products, waste and recycling of rejected products as the primary source of materials for the production and reduction of pollution at all stages of the cycle (Figure 1). [1]

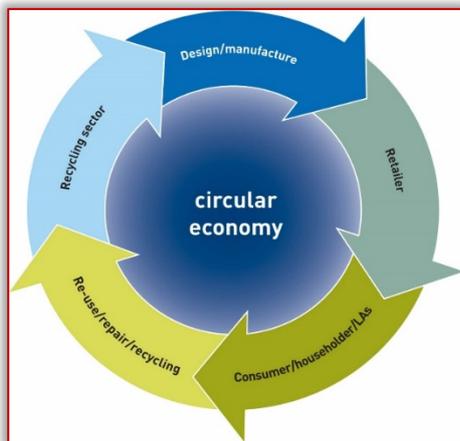


Figure 1. Circular Economy Model [2]

Recycling and treatment of waste represents the first major step in changing the way of thinking of businessmen and the overall cultural orientation of the society. Linear economy received it opposing the

concept that, instead of the movement of matter and energy in one direction is represented by the rotation of the energy and materials - a concept known as the circular economy. [3]

CIRCULAR ECONOMY - INSTRUMENT FOR SUSTAINING SUSTAINABLE DEVELOPMENT

The term "sustainable development" entered the general term in the 80s of the 20th century with the aim of indicating the connection between environmental protection and development.

The circular economy represents a new, more sustainable economic approach that should replace the widely represented and worn-out linear model. Traditionally, the current concept of life has been based on the policy of taking, exploitation and rejection, while the circular model advocates return to nature and the reuse of already used products. Drawing attention to energy efficiency and ecological sustainability is the basis of this way of thinking and can be applied to all aspects of life. According to the World Economic Forum, Switzerland is the country with the best attitude towards the natural environment and the significant extent of the use of renewable energy sources. [3]

The circular economy is extremely important for achieving sustainable development, to which the international community has agreed and committed itself. In EU countries and other developed countries, the struggle for re-use of resources is taking a long time since the need to change the concept of a global economy has become a necessity. [4,5]

Recycling is at the base of the changes that are needed in the fight against climate change. It leads to reduction of carbon dioxide emissions, reduces the exploitation of natural resources, is a valuable source of secondary raw materials for the industry, but it also has great economic potential. The EU counts that if the

goal of recycling 70% of waste is achieved, about half a million new jobs could be created [6].

THE SITUATION IN SERBIA AND POTENTIAL OPPORTUNITIES FOR THE DEVELOPMENT OF THE CIRCULAR ECONOMY

— EU Action Plan for the circular economy

Circular economic package gives a clear signal to EU businessmen using all the tools that are available to transform their economies, opening the way for new business opportunities and increasing competitiveness.

Broader measures to change the entire life cycle of the product beyond a narrow focus on the completion stage of life and emphasize the clear ambition of the Commission to transform the EU economy and bring adequate results. Innovative and more efficient ways of production and consumption should be increasingly occurring as a result of incentives being put in place. Application of the principle of circular economy has the potential to establish a significant number of new jobs in Europe, while preserving valuable and dwindling natural resources, reducing the impact of resource use on the environment and add value, notably economic, social and social, waste materials. Were determined and sectoral measures, as well as key activities include:

- ≡ Funding in the amount of over 650 million euros under the program Horizon 2020 and the 5.5 billion under the Structural Funds;
- ≡ Development of quality standards of secondary raw materials to increase the confidence of operators in the single market;
- ≡ Measures in the Work Plan of the Eco-design promote increased possibilities of repair of waste products, increasing their endurance and the possibility of a greater level of recycling, increasing the energy efficiency of these products;
- ≡ The revised Regulation on fertilizers, in order to facilitate the identification of organic fertilizers and fertilizers based on waste in the single EU market and support the role of biological nutrients;
- ≡ The strategy of plastics in a circular economy, which addresses the issues recyclability, biodegradability, presence of hazardous materials in plastic in order to achieve the goals of sustainable development with a significant reduction in the amount of waste ending up in the seas;
- ≡ Several other activities in the re-use of water, including the legislative proposal on the minimum requirements for the reuse of wastewater. [7]

— Waste recycling

Waste is any material or object which is formed in the course of their production, service or other activities, the objects taken out of operation, as well as waste materials generated in the consumer and which, from

the producer, or the consumer are not for further use and must be discarded.

Inadequate waste management is one of the biggest problems in terms of environmental protection of the Republic of Serbia and exclusively the result of inadequate attitude of the society towards waste. It was first reported in the period of rapid industrialization of the country, which followed the real danger of depletion of some strategic resources in a very short period and the progressive increase in the total amount of all types of solid waste. These developments were not accompanied by appropriate environmental policies. [7]

— National Waste Management Strategy

National Waste Management Strategy is a basic document which provides conditions for the rational and sustainable waste management at the national level (in Serbia).

In order to overcome these problems in the National Strategy shows the solution involving the formation of a network of five types of infrastructure in Serbia in the function of efficient waste management, which are shown in the table 1.

Table 1. Network of five types of infrastructure in Serbia [7]

Type of Property	Objects
Regional landfill	29
Transfer stations	44
Recycling centers*	17
Centers for composting	7
Municipal solid waste incinerators	4

* Recycling centers - The place of recycling of the waste materials in the production process for the original purpose, organic or recycling purposes other than for energy

The development of recycling of waste is one of the key preconditions for successful coping with the challenges of today's environmental protection. The socio-economic benefits that are reflected in the development of the recycling industry and the creation of new jobs have contributed to the strengthening of the competitiveness of cities and local communities. [7]

— Waste recycling in EU countries

Slovenia, as one of the smallest countries in the European Union (about 2 million inhabitants) managed to quickly adopt European standards in the field of waste management and to approach the European level.

When we look at other countries in the region, Slovenia is a good example of positive practice when it comes to waste recycling and generally waste management. Ljubljana is one of the first European cities to adopt the "Zero Waste Europe" model (the EU program dealing with the design and management of production processes to reduce the amount and

toxicity of waste, while promoting recycling to save resources). [8]

Germany is one of the world's leaders in the field of waste management. The waste management system is regulated by numerous laws, regulations and regulations that are in line with European directives in this field. The efficiency of the waste management system in Germany is not the result of the adoption of laws and their application, but also a high level of public awareness of the importance of environmental protection. The promotion of recycling has led to the fact that the citizens of Germany actively participate in the recycling process not only in habits, but also in need. Waste is considered as raw material and the inhabitants of Germany are aware that inadequate waste disposal is a waste of money. The increase in standards has led to an increase in waste quantities and citizens have been faced with the great problem of its accumulation, and then as an effective solution, recycling, which in this country reaches an extremely high level, is imposing. [8]

The biggest problem of every country is waste. There are many landfills to which no one pays attention, but everyone wants to remove and clean them as soon as possible. In highly developed countries, such as Sweden and Norway, recycling is at an enviable level. More than 50% of waste is recycled in the European Union. France, Germany, Austria and Switzerland are unrivaled leaders in the recycling of packaging waste. Although only 15% of waste is recycled in Serbia, this industrial branch goes upward. There are over 2000 companies dealing with the collection of secondary raw materials and recycling of waste.

RECYCLING CENTERS

An important part of the recycling system of waste is recycling centers. Recycling center is a functional environment, that is, an object / space equipped with appropriate equipment and machines, and as such is a place intended for separation and temporary storage of recyclable and bulky waste. These facilities play a very important role in the waste collection system, connecting citizens, collectors and operators, and in providing enough quantities of recyclable raw materials for the development of the recycling industry. The operation and functioning of recycling centers proved to be very cost-effective in European countries such as: Austria, Germany and Belgium where recycling rates exceed 50%, followed by Great Britain, Finland, Slovenia at the very top. Among the latter in this area are less developed countries such as Latvia, Lithuania, Slovakia and others. [8]

The Ministry of Environmental Protection plans to open several recycling centers for plastics and other waste in Serbia recently, which would create not only a good waste recycling system, but also through which employment will find more unemployed persons across Serbia.

From the above text it can be concluded that private sector participation, which is largely represented in EU countries, can additionally contribute to better organization, functioning and efficiency of recycling of waste within the framework of recycling centers, i.e. the experience of public-private partnerships has shown good results. The recycling industry in the Republic of Serbia is at the very beginning, the challenges we are facing in the field of waste management are big, but not insurmountable. The next period will show whether we are ready to properly use the proven European experiences.

END OF LIFE VEHICLES (ELVs) ASPECT IN SERBIA

At the beginning of mass car production and creating a car waste that have completed their life cycle, the idea emerged that certain parts of such cars can be reused (e.g. as spare parts). The car is a complex product and its life cycle should be in accordance with the cycle of circulation of raw materials. It should be recyclable as much as possible, and thus becomes an environmentally friendly product. [9, 10, 11].

Examining the legislation, primarily by considering the current general situation in the field of ELV (End of Life Vehicles) recycling in our country, the following can be concluded: ELV generally cannot act in a manner that ensures the environmental protection; ELV recycling system is not established because there is no globally organized management of such waste.

The overall aim of the Waste Management Plan is to establish an effective system for the management of waste vehicles in Serbia, including Legal, Institutional and Technical aspects. To achieve this goal, it was assessed the current situation regarding ELVs and it were identified deficiencies in the legal framework and implementation in practice. The main objective of EU Directive about ELV is synchronization of different national measures about ELV in order to minimize the ELV impact on the environment thereby contributing to the protection, conservation and improvement of environmental quality and conservation of energy. [12]

ELV dismantling centers are becoming a very topical issue in Serbia since efforts are being made to bring closer the standards in the EU countries. Like all other organizations, ELV dismantling centers face various risks and uncertainties in business. Bearing in mind that the network of ELV dismantling centers in Serbia is developing, it can be clearly seen that their business should be thoroughly studied as well as the interactions of the environment and the environment. Given the need to invest a lot in the development of the network of centers, the assessment of all the risks in their business becomes inevitable, and the definition of recovery capacity metrics becomes imperative. [13]

Vehicle manufacturers across Europe have their own concept of recycling ELV and a developed network of recycling centers. The goal of the manufacturer is to minimize unwanted environmental impacts throughout the vehicle's life cycle. For this reason, even at the design stage of the vehicle, the requirements for recycling are considered - the time required for the dismantling of the ELV, the selection of recyclable materials, the calculation of the time that will be foreseen for exploitation.

Based on the presented state, it can be concluded that the recycling centers are very necessary for Serbia and that their construction and sustainable development will significantly improve the domestic industry. In order to ensure their smooth operation and existence in stable but also crisis situations, it is necessary to provide guidelines on assessing their recovery capacity in case of any performance decline during work. [13]

CONCLUSION

Natural raw materials are limited and their availability and benefits in creating a new value can be extended using a circular economy. The concept of transition implies processes through which we strive to achieve economic growth and development.

The transition in terms of the improvement process represents the need to abandon the existing linear economy and find a better concept. For the abandonment of the concept of linear economy and the transition to the concept of a circular economy, changes in the system of values are necessary: education; defining and publishing new policy changes; changing consumer preferences and habits and developing new forms of behavior; organization of society; innovation in technology and other activities: new product design and business processes; designing, implementing and developing new business and market models; creating an appropriate institutional framework; creating appropriate material infrastructure; development of new methods for managing integrated systems; development of new financial products that support the concept of circular economy; development of a waste management system.

The car industry has greatly progressed in reducing the amount of ELV waste going to landfill and significantly increased the level of recycling and recovery. In this paper, we reviewed the current situation in Serbia and some EU countries. The main recommendations are to develop a shared vision and increase collaboration between stakeholders.

Recycling centers in EU countries are examples of good practice, models that should be used as a starting point in the field of recycling of waste in the Republic of Serbia. Recycling, recycling centers and transfer stations in our country are defined by legal and planning documents based on European experience.

But this alone is not enough to achieve the high standards that these Member States have set before us. The construction of recycling centers will make sense only with the education of the public and the promotion of recycling as a socially responsible behavior.

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CHARACTERISTICS OF BUSINESS INCUBATORS

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Abstract: The paper presents general characteristics of entrepreneurial infrastructure - business incubators. One of the modern ways of support to small newly established enterprises and entrepreneurs, which are in a development life phase, is the system of technological infrastructure: entrepreneurial incubators, technology centres, science parks and business zones. Those are different organizations which help entrepreneurs to develop their business ideas and to overcome more easily the initial problems in business, for which, in a wider context, the term business incubators is used, and also the clusters related to entrepreneurs who are in an advanced phase of entrepreneurship. An incubator is extremely suitable for newly founded small enterprises, which do not have their own business premises, sufficient funds and experience, on one hand, but, on the other hand, they have entrepreneurial ideas, goals and determination to do business. The opportunity to give local and regional support to newly founded and small enterprises by means of business incubators in Bosnia and Herzegovina is significant because it delivers the key elements for the development of incubators, such as unused spaces in all municipalities, that can be easily transformed into a workspace and adapt to the needs of new entrepreneurs.

Keywords: SMEs, Entrepreneurial infrastructure, Business Incubators, Entrepreneurship

INTRODUCTION

The support to the development of small and medium-sized enterprises in the Republic of Srpska had gained in importance in 2002, with the adoption of the Program of Small Business Development, and after that the Law on Stimulating the Development of Small and Medium-sized Companies was adopted. The adopting of the Law has created the basis for legislative, institutional and financial help to this area. On the basis of the Law, during 2004, there were formed: Department for SMEs and Production Craftsmanship at the Ministry of Economy, Energy and Development of the Republic of Srpska and the Republic Agency for the Development of Small and Medium-sized Enterprises. At the same time, on a local level, local agencies for the development of SMEs were being established. The support to the development of SMEs at a local level is also given by municipal development departments which, together with the above mentioned institutions, make support network for the development of SMEs.

Infrastructure is important for entrepreneurial activities [6] and may have different forms and functions. As first, the development of trade and industrial growth require physical infrastructure, road and railway traffic and transportation etc.

In all developed Western countries and in many developing countries, entrepreneurship and small enterprises as a whole are supported by the state, state institutions and nongovernmental organizations in many ways [7]. Such an orientation of a market-developed countries has deep roots, regarding the fact that the capitalism has tried many development models as opposed to one-dimensional models of economic flows control which have been practiced

more-less for decades in the countries of socialist and similar socio-economic systems.

Similarly to the leading countries of the West, many small countries which started with the implementation of market-capitalistic principles in the development of economy three to five decades ago, have reached an enviable level of development today[7] exactly due to the development of small enterprises.

The determinations of Bosnia and Herzegovina [2] related to the SMEs development sector rely on the recommendations of the European Charter and the Act on Small Business. The Law on Ministries and Other Control Bodies of Bosnia and Herzegovina has also defined the institutional framework in the field of issues in the sector of SMEs whose difficulties reflect, above all, in: approaches in defining policies, development strategies and goals in the sector of SMEs, competences, way of work a harmonized monitoring of the results in this area, mutual cooperation and profitability and excessive administration.

At the level of the Republic of Srpska, within the Ministry of Economy, Energy and Development, there is a department for small and medium-sized enterprises, the head of which is an assistant minister with the responsibilities in the work fields: development of entrepreneurship and craftsmanship, making of medium-term and long-term development plans and making of the development strategies of SMEs and entrepreneurial activity.

Pursuant to the (Law on Enterprises of the RS 2006), an enterprise is a legal person which performs the activity to gain profit, and an entrepreneur is a physical person who performs the activity to get profit and the activity of free profession, while an individual

agriculturist is not an entrepreneur. The Law does not know the notion of small and medium-sized enterprise, and because of that the same provisions apply to them as to the other enterprises.

The new (Law on Business Companies 2008) is a modern regulation, greatly harmonizes with the directives of the European Union company law and as such should contribute to the creation of a legal framework complementary the internal market of the EU.

The Law on Business Companies of the Republic of Srpska is based on the best solutions of modern national law of the surrounding countries, and also of some countries from Europe and the USA (Illinois), the Statute of the European Company from 2001, OECD Principles of Corporate Governance from 1998 etc. Entrepreneurship, in the sense of the (Law on Development of SMEs of the RS, 2013), is an innovative process of creation and development of business ventures or activities and of creation of business success at market. Entrepreneurial infrastructure presents spatial-technical forms for toe support of entrepreneurship development, with a special emphasis on establishing and development of SMEs.

In recent time [5], there is a greater emphasis in the commercialization of university research, especially through the creation of spin-off enterprises. They emphasize inhomogeneity of the concept of university spin-off enterprises and point out their heterogeneous properties.

The suggestions of [5] for the classification of university spin-off enterprises are: independent spin-off enterprises, connected spin-off enterprises, with joint investment and as organizational units of universities. Three key approaches are used for differentiating the types of university spin-off enterprises: researchers as entrepreneurs of spin-off enterprises, by the nature of knowledge transfer and the participation of external partners in a new company. These different criteria make the phenomena contained by the concept of university spin-off enterprises.

CHARACTERISTICS OF BUSINESS INCUBATORS

In the practice of small business development, the incubator model deserves special attention. It seems to be a practical approach in the countries of traditional support for the development of small business, and it seems that its perspectives also exist in the transition countries. Business incubators present, as stated by [1], a contemporary tool for entrepreneurship development in Europe and the USA, and they appear as a response to the recession era and the failure of industrial systems.

Most business incubators [1] use the existing abandoned infrastructure and brown-field investments for their development. Actually,

wherever the surpluses in capacity (empty halls, warehouses, agricultural objects etc.) occur, due to privatization or other reasons, it is possible to use them to develop incubator types of small business. It is, basically, a flexible method for new business development and support for economic development on a confined, local space. Incubators enable many small enterprises to start their work under the same roof with a favorable lease of a functionally prepared space, joint use of infrastructure, services, and specialized types of equipment. Also, they offer equal opportunities for using certain financial, technical and marketing programs. Incubators, located under one roof, enable multiple combinations of business cooperation among the owners of small enterprises, and, on the basis of that, an efficient use of their available resources in a narrow space.

A business incubator (The Law on Development of SMEs 2013) is a form of entrepreneurial infrastructure whose basic activity is to offer services by putting at the disposal, with or without charge, a business premise, consulting, administrative, technical and other services to newly founded businesses, not older than 5 years. Among the participants in the creation of incubators [4] may be: social communities; sponsors (associates); donors (contributors); firms as members or subtenants of incubators; and a service organization to perform common tasks for incubator participants. The social community (state, municipality) assists in creating the basic infrastructural conditions, especially regarding the provision of a location and respective capacity for incubators, but also in the creation of a local economic basis for the development of entrepreneurship under the roof of incubators. They also create some wider opportunities for gathering modest private capital to their partnership association for the purpose of establishing enterprises.

Starting from this, a very significant question arises: what types of enterprises can or should be potential members or subtenants of incubators? That, above all, depends on a determination of what an incubator should contain, for example, only production activity, crafts-service activity, trading activity or, maybe, the competitive freedom among some of them. What should be especially be taken into account is of how and where to find the locations and buildings for such ventures [4]. With that aim, abandoned smaller factories or particular production facilities should be discussed, as well as abandoned or unused schools, warehouses, storehouses, business premises, communal houses, buildings which were once used by the military etc. The locations of such buildings can be acceptable if they are near established business centers, in the suburbs of big cities, in small cities, bigger industrial and village settlements, tourist locations etc. As appropriate locations and buildings

which can be used and revitalized, the ones that are damaged or destroyed to a certain degree can be used as well, if not too large are the financial resources necessary for their revitalization.

In the end, there is no unified concept [7] for, model of or means to develop incubators. There are broad possibilities to establish the contents of work, to design innovative solutions for or opportunities related to urban, suburban or rural position of incubators and the like, and, due to that, the opportunities for specific and untypical types of the business complex. In smaller places, incubators can even be the centers of integrated development of business and employment, and, because of that, every particular case can have individual specifics.

The development of incubators as the instruments of economic policy [2] is especially supported by developed countries, while this cannot be said for countries in transition. The contribution of incubators is reflected by the fact that, when their work well, they significantly decrease the number of enterprise collapses, and they enables enterprises to create new job positions and diversification of production, so that they significantly contribute to the development of the small-business milieu and to local and regional development.

The conveniences and advantages of enterprises that operate in incubators are: use of knowledge and experience of expert and management team of the incubator, as well as the access to knowledge by means of linking into networks on a wider territory; mutual connection of entrepreneurs and opportunities for experience exchange; possibility of additional training and enabling through various programs organized by the incubator; possibility of easier access to financial and investment types of assistance; technical services of incubators; and positive climate and working environment that contribute to inventiveness and innovation of entrepreneurs [2]. Incubator managers and management [4] are among the most important factors for the future success of an incubator because success depends on their ability to manage to connect on the basis of shared interests with the parties seeking work and the success of the incubator (local government, business associations, enterprises), and, through that, contribute to the position and status of the incubator, realizing a quick development of their members, i.e. the enterprises.

Business incubators usually consist of a great number of small business units (usually 10–50 enterprises) [7]. There are usually enterprises with these traits: located in one place, mostly within one building; physically separated by room dividers (it is desirable that there is a possibility of moving the dividers if the enterprises have need to take more space); the building in which the enterprises are located should

have, at least, common rooms for the incubator manager, business-consulting services, joint meetings, a refreshment room where the participants can spend time together informally. Also, the facility must be equipped with adequate infrastructure: electricity, water, loading and unloading platforms, a sufficient number of telephone lines, parking space etc. The spaces are offered to entrepreneurs under flexible conditions, with low rents, and simple and favorable lease agreements. The incubator is equipped with integral services for offering business-support services to entrepreneurs on the spot, at low prices or for free. The mentioned services are specially related to training programs through which entrepreneurs can improve their knowledge and skills in specific business areas. There are also the services of business consultants, in the form of advice, business connecting and also the connecting of entrepreneurs with organizations that can provide the capital for the start-up and development of a business.

For the essential nature of the operation and significance of an incubator, the most appropriate definition[2] states that an incubator is an enterprise that operates for various purposes, in various ways, and it helps through various different forms the founding of new enterprises and their development into profitable independent enterprises.

One of the approaches for classification of incubators incorporates the criteria and aims of their founders (i.e. owners), with possible cases [2]:

- incubator is founded as an enterprise that leases the business premises and makes profit, which is the criterion of the ownership approach,
- incubator is founded as an enterprise which, besides inexpensive business premises, supplies professional advice and helps the development of entrepreneurship, thus manifesting the social goal of supporting the development of small and medium-sized enterprises. This type of incubator must also be financially supported, usually during the first 5 years of its existence.

The actual practice [2] shows a larger number of entrepreneurial incubators, such as:

- Traditional or classical business incubators that offer their clients an arranged workspace and expert business advice on the spot.
- Administered organized premises are “naked” business incubators that offer to small enterprises, their tenants, only organized workspaces at affordable prices, not giving business advice. It is assumed that the enterprises have already survived the initial period and that they have already developed. This type of incubator enables renting, but

pursuant to market prices, both of bigger premises and of consulting and technical services. Such an approach characterizes the US conception of an entrepreneurial incubator.

- Incubators without walls are organizations that do not offer business premises, but only the organized business-support services.
- Incubators of the new economy are highly specialized in the fields of quick-growing sectors, such as high technology and the Internet. The advantage to the founders is the expected benefit from the quick growth of the value of enterprises in which the owners have their share.

Between the traditional business incubators and the business incubators of the new economy, a great number of different organizations can be placed, dealing more or less with providing support for the development of innovations and entrepreneurship, such as: business and innovation centres (BIC), technology centres, knowledge centres, technology-transfer centres, technology parks, science-technology parks etc.

A traditional or classical business incubator provides the business premises under favourable conditions (with accompanying office, secretary and similar technical services) and also provides business services (training and business advice), which comprises the framework of the concept of so-called traditional or classical business incubators. This type of incubator, usually, usually functions to enhance regional and local economic development (through the development of entrepreneurship and creation of new enterprises) and in the creation of new jobs.

The most important characteristic of the concept and success of this type of incubator is the fact that they offer quality services and business advice individually to every small enterprise. Without this, such business premises would be administered organized workspaces—only similar to incubators. Their emphasis on socioeconomic functions conditions their character, being non-profit almost as a rule, and it means that national and local authorities and the public sector must have a significant role in their founding and operations. Classical business incubators sometimes more emphasise social components, because it is not rare that they are used as the supporting instrument for the development of entrepreneurship of certain social groups, such as women, returnee immigrants, refugees or national minorities.

The Business Innovation Centre (BIC) is the dominant model of business incubator in the European Union. BICs differ from the US incubator model [7] primarily because of the fact that they give greater significance to consulting and developing entrepreneurs'

professional skills, being less targeted at providing premises at lower rents. They are, actually, an improved model of the US business incubator. Thanks to BICs in certain areas, from different sources, by means of various projects and advice to entrepreneurs, local growth and development of services necessary for a success of small and medium-sized enterprises is realised and supported. The concept of business incubators in Europe started to be built in the 1980 s on the basis of the US model, with the aim of alleviating the consequences of breakdown of the large business systems and overcoming the problem of unemployment. It can be said that it demonstrated its justifiability. In the territory of Europe [2], the most famous institution for help and promotion of BICs operates successfully—namely, the EBN (European Business and Innovation Centre Network) which gathers more than 180 BICs. In the realization of its mission, the EBN supports local sources and the development of abilities, securing the unified activity of target groups in the territories similar to regions so that BICs, in their operations, work pursuant to certain standards of the EU. The incubator personnel, both permanently employed and temporarily engaged (Talent Pool), basically provide their clients with twelve main services shown in the following overview[2]: selection of entrepreneurial ideas; selection of entrepreneurial projects; evaluation of entrepreneurial ideas; evaluation of entrepreneurial projects; training and preparation of entrepreneurs; technical services; marketing consulting; preparation of business plans; rental of space; acquisition of space; rental of services; and entrepreneurial advice.

Technological centres offer a highly suitable form of entrepreneurial infrastructure, in which technologically demanding programs are realized on the basis of consulting and a mediatory role. The centres have incubator-like characteristics because they enable the numerous services and cooperative relationships for enterprises. In a technology centre, there are opportunities for: association of entrepreneurs on the basis of interest in various projects and groups; business of a larger number of enterprises in one place with business infrastructure provided; connections to other consulting institutions and networks; access to the bases of patents; and assistance to entrepreneurs on the formalities for obtaining credit or risk capital. Technological centres usually have their own laboratories and special measurement, testing and control equipment. When they reach a certain mass and level of their own equipment, they can easily transform into a technology park.

A knowledge centre is an organization established with the aim of enhancing research in a certain area. The knowledge centres are usually established by

public research organizations, faculty institutes and business organizations. They are usually organized as organizational units. A technology-transfer centre is a research-development unit organised as a business association. A technology park unifies, in its structure, the work of technology centres and affirmed medium-sized and big enterprises. There is an emphasis on technology transfer and the cooperation of scientific and research institutions with enterprises.

Technology parks enable the renting of larger areas at market prices for prototype production, and it does not impose time limits on enterprises regarding the use of the space. A technology park (The Law on Development of SMEs 2013) is a form of entrepreneurial infrastructure that, within a defined space and with adequate equipment, performs the connection of scientific and research institutions with business subjects for the purpose of technology transfer, application of innovations and development of the economic area in which it is placed.

In the countries in transition[2], due to underdevelopment and the small number of incubators, technology parks work partially as incubators, because the state supervises the space and services, so that the length of stay in a park are limited and only a few enterprises can be accommodated. Technology parks have a significant role in the development of the region because, pursuant to the EU criteria, they are placed in an area where about 300,000 people live, having one or two universities and a few supranational associations [2].

Technology parks are, through joint investments, founded by a country, regions, cities, major enterprises, faculties, banks etc., investing non-refundable assets in the form of land, buildings and money. The members of the management board of a technology park are the most prominent businessmen, representatives of local institutions and representatives of founders and are the basis of further connecting interested parties and securing assistance for the incubator. A technology-park manager is a key person for success, since he/she must be an expert in many business fields and capable of leading a team.

A science park is an institution in which scientifically-oriented people, e.g. researchers, professors, financial experts, consultants and businessmen, are concentrated. At the same time, it is the place that connects science and economy. The basis of the activity of science parks is the application of achievements and innovations in the field of engineering and technology on a commercial basis, and support for the founding and development of enterprises based on knowledge. The most common location of a science park is close to a university, and the founders can vary from a country, municipal and local institutions to banks and chambers of commerce.

As stated by [8], universities are the motors of an economy based on knowledge and also the places where knowledge is produced and exploited. They further address the improvement of the concept of entrepreneurial infrastructure as the analytical framework for understanding the organization dynamics of a modern university and insurance of entrepreneurial evolution within higher education. Some research [9] gives useful insights into the planning and performance of technology-transfer activities.

Research shows that the degree of industrial R&D, the quality of faculty and venture capital are significant indicators of the technology-transfer effect. They put the accent on universities as motors of economic development and on increasing their engagement in technology transfer in the field of entrepreneurship. Some research [3] has paid special attention to the characteristics of academic “spin-off policies”, where technology transfer and entrepreneurial infrastructure were weak outside high-tech clusters, indicating a significant influence of academic institutions on the potential growth of spin-off policies.

CONCLUSION

Every local community or a set of local communities which are connected geographically, to attract a larger number of enterprises to their territory, the territory of the Region, takes various activities to improve the conditions of work of SMEs. Local community plays a very significant role, while the task of the country, or the government, is to activate the inner resources, as additional development impulses. A prudent activity of local communities with the aim of developing own infrastructure and entrepreneurial potential and attracting of investments can be a concept of regional development.

Local community must develop an attractive environment for capital and enterprises. The establishment of business incubators accelerates and simplifies the placement of spatial resources in the function of economic development, investments, growth and employment. Everywhere in the world, business zones present a significant instrument for the stimulation and development of entrepreneurship and general economic growth of a certain area. They are established on the basis of a clearly expressed interest between the businessman and bodies of local and regional government, with the support of higher levels of government and research-educational organizations, universities and institutes.

Note:

This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty “Mihajlo Pupin” Zrenjanin, University

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POSSIBILITIES OF APPLICATION OF INDUSTRY 4.0 AND CURRENT SITUATION OF FUNCTIONING OF PRODUCTION SYSTEMS IN LARGE ENTERPRISES

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Abstract: Modern enterprise in new conditions, conditions of globalization, turbulence, the global market, numerous rapid and increasingly frequent changes, has been forced to adapt and change, in order to achieve competitiveness and survive in modern business. From theoretical point of view, authors of this paper analyzed the importance of the application of modern industrial production lines in serial production in the case of large enterprises. Through the work, several aspects that affect the quality, such as productivity, efficiency, effectiveness and other parameters that directly or indirectly affect the quality of finished products are considered.

Keywords: Industrial lines, production, large enterprises, quality, productivity, efficiency, effectiveness

INTRODUCTION

Modern enterprise in new conditions, conditions of globalization, turbulence, the global market, numerous rapid and increasingly frequent changes, has been forced to adapt and change, in order to achieve competitiveness and survive in modern business. Companies that want to be successful and to advance in the marketplace must be innovative, flexible, and ready to adopt and apply new knowledge, strategies and technologies. The strategy of constant innovation and the dynamics of change is the response to demands posed by market struggle.

Over the past twenty years, many companies have realized that the demands of the global market, including increasingly demanding and more sensitive customers, set new standards for production flexibility. Additionally, nowadays in very difficult times of the recession and financial crisis, enterprises of all sizes and shapes, from industrial giants, through middle and small, to micro enterprises, face numerous challenges of their own survival. Gradually, mass production, which was inherent in a large number of companies, opened up space for the introduction of a new system whose focus is exclusively on the buyers. In one word, the need to shift from the economies of scale strategy to the strategy of the width of an enterprise's activity is imposed.

According to the [1], system that revolves around the customer is created with the idea that through the process optimization, it enables a cheap product, on time and with the best possible quality. Such a system is just a lean production. By introducing a lean production system, a continuous process of continuous systematic identification and removal of redundant phenomena in the company's operations is established by eliminating everything that represents

no value from the buyer's perspective. Thus, in the conditions of crisis, the costs are significantly reduced which enables the achievement of small, but long-term financial benefits, which is the key to achieving a long-term and sustainable competitive advantage. On the other hand, if we neglect the current crisis for a moment in a modern business environment where the life cycle of products drastically reduces, lean production, also known as the world class production, enables companies to respond in an adequate manner, quickly and successfully to various and numerous requirements and users, both in terms of low cost / cost, as well as in terms of quality, time and innovation.

INDUSTRY 4.0 AND THE POSSIBILITY OF ITS THEORETICAL AND PRACTICAL APPLICATIONS

The goal of this philosophy is to enable a company to achieve satisfactory, if not leading, market position in the conditions of growing competition, falling customers' loyalty, constant technological innovations, drastic shortening of the life of products. It is known for its direction to reduce 7 types of losses (7 wastes), and its intention is to increase value in relation to the customer or each of the next in the value chain. For many, this is just a set of tools that help us identify and continually eliminate losses, and consequently improve product quality, reduce production time and reduce costs. There is also an alternative approach to lean production that is changing, Toyota, where it intends to establish a "flow" and a continuous flow of work through the organization of work, which is not based on the elimination of losses. The difference in both approaches is not in the goals, but in the way how to reach them. The advantage of this second approach is that it requires a complete (systemic) approach, while

in the first approach we focus only on one narrow part of the problem in the production process [2]. There have been only a few aims to actually calculate readiness factor. Mostly it has been based on the level in the industrial revolutions, but that can really be adequate to decide is the certain company ready or not for the new concept. Figure 1 shows four industrial revolutions.

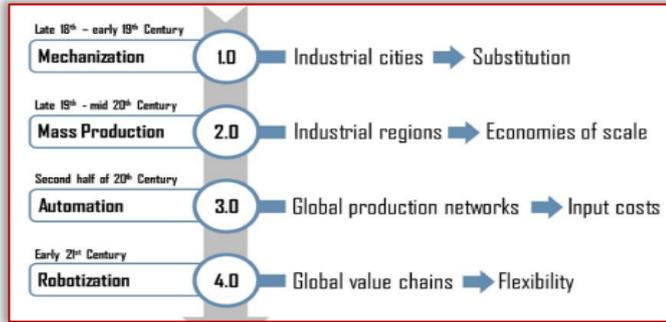


Figure 1. Four industrial revolutions [3]

Through surveys that have been carried out [4], optimization of production and business processes has become the target point for all of the enterprises to strive. Traditional analytical tools used to increase process efficiency and reduce costs have been mostly focused on physical processes that participate in all production stages, while alternative methods of increasing efficiency consider the process as a whole and optimize the integration of each stage of production. The integration of all processes in an enterprise, in itself, has the primary goal of providing such a system that will provide the right information at the right time and in the right place. Today, lean actually represents every effort to achieve greater effects with less investment, exploring value from the customer's perspective, and on the basis of the obtained knowledge, processes are redesigned to increase the value. The socio-technical effects of global competition compel companies to develop and implement new product development strategies, in order to provide the customer with a high-quality product in the short term, with less cost and faster response to customer demand [5].

Observing the differences, traditional or mass production is considered as an outdated paradigm, precisely because there is no direct link between production and demand. On the other hand, lean represents a new paradigm, since the production of different models in small series directly meets the needs of customers, and allows the company to adapt to market changes more easily and quickly. According to [6], the smaller the series, the overall business process is easier and better run. Lean production takes place continuously, from a single-phase flow, emphasizing the optimization and integration of machines, materials, people and objects, which can be defined as a whole. The emergence of a lean

production system is not related to the attempt to fully exploit traditional ways of production, but rather to answer the company's ability to survive in a highly demanding, rapidly changing and completely unstable modern market.

Table 1: Basic management principles [7]

	Traditional production	Lean production
Production planning	Forecasting (push)	Buyer order (pull)
Production	Supplies	Buyer order
Time	Long	Short
Size of series	Big	Small (continuous the flow)
Control	Based on samples (inspection)	All effects (on itself source, by workers)
Layout	Functional	In line with the movement product
Training workers	Low	High
Inventory turnover	Low (<7 crafts)	High (> 10 crafts)
Flexibility	Low	High
Purchase value sold goods	High (with tendency growth)	Low (with tendency decay)

If we look at the previous table and take into account all the comparisons between the traditional production systems and the lean system, it can be concluded that the introduction of the Lean concept increases the degree of automation, which in the traditional system is at a very low level, the functions of the system are turning to customers. Observing the presented differences, traditional, or mass-production is considered an outdated paradigm, precisely because there is no direct link between the pace of production and the pace of demand. On the other hand, lean introduces a new paradigm, since the production of different models in small series directly meets the needs of customers and allows the company to adapt more easily and quickly to market changes. Lean production takes place continuously, from single-phase flow, emphasizing the optimization and integration of machines, materials, people and objects [6].

MODERN PRODUCTION SYSTEMS AND THEIR FUNCTIONING IN THE REAL ENVIRONMENT ON THE EXAMPLE OF LARGE ENTERPRISES

Modern companies in the world that deal with large-scale and mass production mainly use line-production systems. The foremost question with such systems is whether the proper quality that is required on the market will be achieved and if it does not achieve what is needed to be improved in order to meet the relevant standards.

The world market dictates the conditions that need to be met so the product and the relevant system together

with the product can to penetrate the market. New Age demands both time and quality, the ratio of short time and high quality. According to this way of functioning of the market, most of the large companies that contain production are using linear-serial production.

From the aspect of linear-serial production, the theoretical claims about the quality for a little time are incomplete, and in this paper the research on the real case of linear series production was carried out. The serial, linear organization of the production process includes drives with specialized plants and devices in which a certain technological process exists in the form of a production process.

In this organization, production scheduling is conditioned by the existing technology, and the equipment in the process is arranged in the line order given in technological processes for the production of products. The linear-serial form of organization of production is characteristic of the activities such as food industry, dairy, pharmaceutical, textile, leather, automotive, and metallurgy [8].

According to the research carried out at the Novares Serbia factory, which belongs to the companies that produce plastic parts for car bodybuilders in large series, the following results on the quality, productivity and efficiency of line-production have been achieved.

Figure 2 shows the percentage of examined workers in order to create an image of the eloquence of the response.

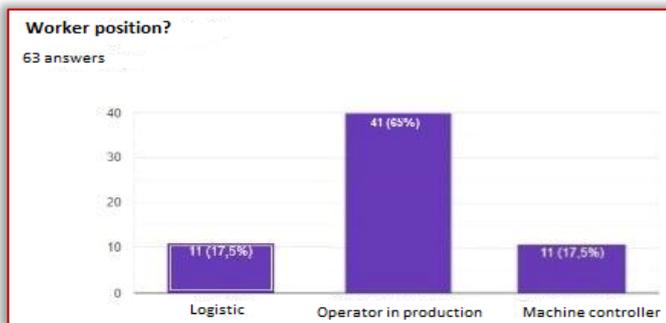


Figure 2. Percentage of examined workers

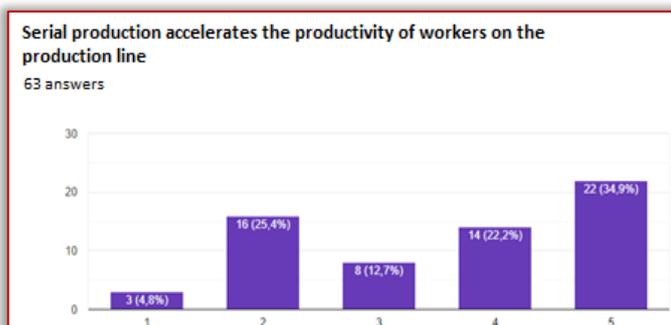


Figure 3. Display of worker productivity on the production line

Figure 3 gives a graphic representation of the productivity of workers on the production line.

It can be seen from the graph in Figure 3 that the worker productivity on the production line is mostly produced by serial production, since 63 respondents 23 answered with a score of 5 (34.9%), while 14 responded with 4 (22.2%), which sums up the majority of opinions on the side of the positive impact of serial production.

In Figure 4 the answer to the question about the relationship of efficiency and effectiveness in this type of production lines is presented.

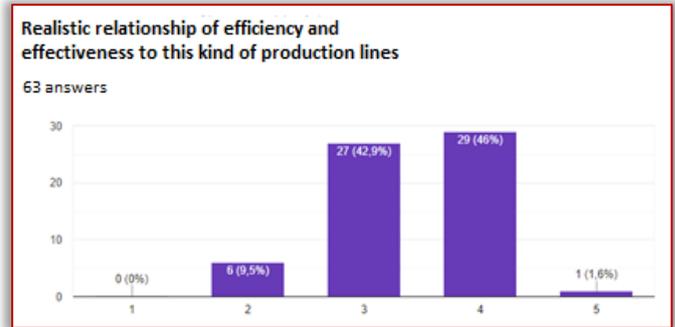


Figure 4. Efficiency and efficiency ratio on line serial production lines

According to Figure 4 and the graphic representation, it can be concluded that the ratio of efficiency and effectiveness to a satisfactory level using this type of production, as 29 respondents gave a high grade of 4 (46%), while a good majority of the majority gave a mean score of 3 (42,9%).

The graphic representations in the previous figures can be used to answer the fact that linear production by production increases the efficiency of production, where it can be freely stated that according to the given answers this hypothesis can be confirmed, and it is concluded that there is enough space for the ratio of efficiency and effectiveness in this type linear serial production can increase.

Figure 5 gives a graphic representation of the effect of a routine action that requires linear serial production to the very quality of the product that comes out of such production.

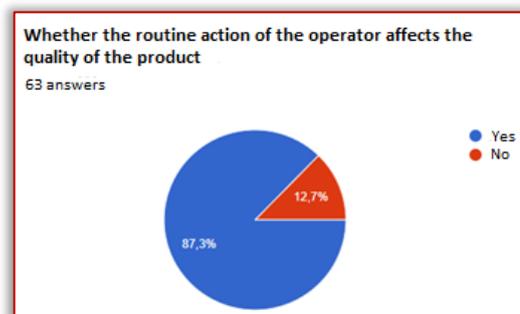


Figure 5. Pie display of the impact of routine on quality

CONCLUSIONS

Basic knowledge of modern production management, basic theoretical knowledge about Lean concept of production and its influence on production parameters are set out through the work.

The Lean concept is a wide system totally implemented in production systems. It takes time, resources, personnel to establish a stable system that is capable of implementing the Lean concept and ultimately applying it to production systems. Until such a type of production is applied in detail, production losses will continue to occur, as in most large production companies we have the presence of line-production, which, as a final result, besides the standardization, has large losses, which are reflected in the decline in quality due to the achievement of the appropriate time frames in which it is necessary to dispose of the product on the market.

The stack of combined production systems cannot combine productivity and effectiveness, in order to improve this relationship as already mentioned, it is necessary to first analyze all aspects of the nature of production, and then thoroughly approach the introduction of new methods of production management, modern concepts that strive for the Japanese zero-error philosophy.

With a large number of existing, already established production systems, a very small percentage of the overall time spent and dedication in the business process of waste to activities that really add value to the end consumer (Figure 6).

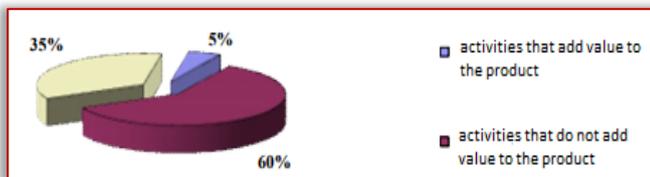


Figure 6. Framework structure of traditional activities of production system [7]

The basic advantage, that is, the basic novelty of the business system, in relation to all other business systems, is the insistence on eliminating all defects and all empty movements, without exception, in the entire business process. It is considered that the tolerance of any kind of disadvantage distorts the overall idea of a successful market operation, because one deficiency leads to the other and as a tower of cards, in a very short time, the market position of the company will be shaken, if not permanently disturbed. This, so called domino effect, in line with the lean concept of business, can be noticed by observing four categories of waste:

- primary category, excessive, unnecessary amount of production resources (labor, equipment, facilities), leads to the creation;
- secondary categories (in the opinion of many authors of the worst categories of waste), hyper production, which, then, leads to the emergence;
- tertiary categories, excessive stocks (additional workplaces obscure the problem of hyper

production and increase the losses included in the opportunity costs), leads to the creation;

- quaternary categories, unnecessary capital investment.

Note: This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty “Mihajlo Pupin” Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 03–04 October, 2019.

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ECOLOGICAL MONITORING OF MICROBIOLOGICAL, BIOCHEMICAL CHARACTERIZATION AND GROWTH OF *SECALE CEREALE* L. PLANT IN SOILS AMENDED WITH SEWAGE SLUDGE

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Abstract: The objectives of the model pot experiment were to determine the effects of sewage sludge application on biological (Different microbial and activities of enzymatic properties, carbon dioxide production) and physicochemical (pH, soil moisture) properties as well as rye plant productivity for 9 weeks were studied. Two soil types [kovárvány brown forest soil (Nyíregyháza), and meadow chernozem soil (Szeged)] were used and treated with various rates of sewage sludge [Control soil (0), 20, 40, 60, 100 (sludge) %] originated from Nyíregyháza sewage water purification.. Results indicated that the soil retained its moisture content for a longer period than the free wastewater sludge control soil. Also, soil pH was maintained to be favourable for plant growth more than the control soil. In addition to exhibiting healthy growth and development, the plants also produced the greatest dry matter mass on soils with the largest proportion of sewage sludge (60–100%). Also, enzyme activities in the soil samples treated with sewage sludge were increased in soil with higher sludge doses. There was an increase in the density of the microbial population in the rye rhizosphere as the sludge dose increased. Results demonstrated that Gram negative bacteria were dominant in the rye plant rhizosphere and the ratio between Gram-negative and Gram-positive bacteria in the Kovárvány brown forest soil and meadow chernozem soil treated with Nyíregyháza sludges were 2.367 and 2.35, respectively. Finally, soil treatment with the sludge stimulated rye plant growth, the biochemical and microbial properties of the rye plant rhizosphere. For maintaining the soil quality, the authors recommend to treat the acidic soil with a ratio of 40–60% of this sludge to improve the fertility of the soil.

Keywords: monitoring, rhizosphere properties, microbiological, biochemical, rye plant growth, sewage sludge

INTRODUCTION

Monitoring of soil properties, microbiological and biochemical parameters is one of the most essential characterizations to qualify soil health when amended with sewage sludge. The biological activities of the soils are determined by several microbiological and soil enzyme activities together. Demographic growth and western economic model seriously menace these vital resources: soil scarcity, soil losses through erosion, natural disasters and contamination; water scarcity and contamination; and limitation and exhaustion of mineral resources and fossil energies.

Today, one of the most pressing environmental and environmental problems of is the increasing volume of waste, including wastewater amendment, sewage sludge application, utilization and disposal.

Sewage sludge is used as possible way of organic fertilization and importance because it is not only nutrient input into the soil, but it improves soil structure and induces useful microbiological processes. Sewage sludge is environmentally polluting if the concentrations of heavy metals level is high. And, on the other hand, is suitable for farming as organic fertilizer. From an environmental and soil protection point of view, it is important that the sewage sludge used does not restrict the production of safe food raw materials.

The organic matter of sewage sludge is decomposed by heterotrophic nutrition prokaryotes and fungi. Biodegradation of organic matter in soil is basically

the result of microbial and biochemical processes, therefore all factors that have an effect on the structure, function and enzymatic activity of microorganisms impact the rate of degradation. In the case of agricultural and forestry utilization it contributes to increasing the content of organic matter of the soil and has a favorable influence on the physical and chemical properties of the soils. Sewage sludge increases the water absorbing ability of soils, promote aggregation of the medium on sandy soils and increase the cation exchange ability. As a result of sewage sludge application, the amount of microbotas in the soil usually increases. The nutrient flow for the soil is determined by the activity of enzymes, in addition to the physical, chemical parameters, plant cover and microbial activity.

Generally, most growth parameters, as well as the biomass of treated wheat, were significantly increased with the amendment of SS, up to the addition rate of 40 g kg⁻¹. The content of all heavy metals (except Cr in grains and Pb in spikes) significantly increased in different tissues of treated wheat with the increasing rate of SS application [1].

Reutilization of putrescible municipal solid wastes in agriculture can provide valuable plant nutrients. However, it may pose serious non-carcinogenic health risks for a human when contaminants, especially the heavy metals in MSW, end up in plants through the waste-soil-plant continuum [2]. Results indicated that for the most oxidative processes, the

released organic matter was probably mineralized by the hydroxyl radicals produced during the treatments. It is interesting to remark that even if the biochemical methane potential was barely enhanced by the different methods applied, all the methods demonstrated to enhance the overall kinetics of the biomethanation processes, increasing the rapidly biodegradable fraction of the sludge.

During the present work, author investigated the effects of sewage sludge on the some soil properties such as soil pH, moisture content, CO₂-production, FDA activity and the rye plant growth at different levels of sewage sludge treated in two soil types [3]. Results showed that MSWC doses over 10 t ha⁻¹ may create a heavy metal risk in long term for soils with pH ≥ 7. Therefore, in MSWC use over agricultural lands, heavy metal contents should always be taken into consideration and excessive uses should be avoided [4].

From the literature covered it can be concluded that sludge deposition induces two detrimental effects on the environment:

- 1) raising of the levels of persistent toxins in soil, vegetation and wild life and
- 2) slow and long-termed biodiversity-reduction through the fertilizing nutrient pollution operating on the vegetation.

Since recent studies show that eutrophication of the environment is a major threat to global biodiversity supplying additional nutrients through sludge-based fertilization seems imprudent. Toxins that accumulate in the vegetation are transferred to feeding herbivores and their predators, resulting in a reduced long-term survival chance of exposed species. We briefly review current legislation for sludge deposition and suggest alternative routes to handling this difficult class of waste [5]. Although guidelines limit the addition of toxic elements in sludges and soils, thus reducing the quantities of these elements accumulated by plants, total concentrations of toxic elements in soil provide no indication of their availability to plants.

The procedures applied to the determination of the forms of elements in sludges and soils and attempts to relate forms extractable in a variety of reagents to their availability to plants have been discussed. The factors which influence the forms of nutrient and toxic elements, their long term availability and hence their accumulation by crops are also reviewed [6]. It appeared that improving the structure to enhance the contact efficiency between the wastewater and the soil in soil mixture blocks was important for enhancing treatment performances.

The combined use of existing wastewater treatment systems with the MSL system was effective for preventing environmental pollution over a long period [7].

MATERIAL AND METHODS

The origin of soil samples were: Meadow chernozem soil (RCST) of the Szeged and Kovárvány brown forest soil (KBET) was from the Center for Agricultural and Technical Sciences at the Nyíregyháza Research Institute of the University of Debrecen.

Soil samples were collected from the upper layer of 0-25 cm. Some chemical properties of communal sewage sludge from the municipal wastewater treatment plants (Nyíregyháza) and soil samples are presented in Table 1.

The air dry soil was thoroughly mixed with sewage sludge so that the final mixture contained sewage sludge in the soil sample was as following percentages: 0% (sewage-free control soil), 20, 40, 60 and 100% (sewage sludge only, without soil). Rye (*Secale cereale* L.) seeds were sterilized [8] and planted in plastic containers of 3 kg of tested soil as prepared above. After ten days of germinating, young plants were reduced for 10 plant densities/pot.

Soils pH was measured by Pérez De Mora et al. [9] at various sewage sludge doses (after 63 days of incubation). The pH of the untreated and treated soil was tested in a 1: 2.5 (soil: 1 mole KCl) g ml⁻¹ ratio after shaking for 60 minutes. The moisture content of the treated and untreated soil samples was modified by the method of Brzezinska et al. [10] (measured at 48 hours at 28°C, incubation). Initial soil moisture was of the soil samples was 60%. The relative dry weight of the rye plants samples was determined after 9 weeks of cultivation (with a constant moisture content of about 60%) (at 75°C, drying cabinet, to constant weight).

Table 1. Properties of the soils and sludge used in the model experiment

Parameters	Soil types		Wastewater sludge: NySzv
	KBET	RCST	
pH _(KCl)	5.78	6.02	6.71
Dry matter content, %	na	na	53
Organic matter, %	na	na	21.7
Humus content, %	2.54	3.55	na
Total-N, mg·kg ⁻¹	na	na	7470
NO ₃ -N, mg·kg ⁻¹	23	39	na
NH ₄ -N, mg·kg ⁻¹	5.6	4.5	na
Mg, mg·kg ⁻¹	214	257	2507
Na, mg·kg ⁻¹	64	53	994
P ₂ O ₅ , mg·kg ⁻¹	318	378	28720
K ₂ O, mg·kg ⁻¹	412	428	3171
Zn, mg·kg ⁻¹	1.7	1.1	537
Cu, mg·kg ⁻¹	1.4	2.4	110.4
Mn, mg·kg ⁻¹	55	61	421
Fe, mg·kg ⁻¹	945	1094	11308
Cd, mg·kg ⁻¹	1.7	1.02	2.3
Pb, mg·kg ⁻¹	1.3	0.96	66.9

na: no data available

Determination of CO₂ production: For the measurement of CO₂ emissions, 0.5 kg of sewage

sludge treated soil was poured into 2 l glass containers and in the middle of the soil were placed a plastic tube containing 50 mL of 1.0 mol of NaOH solution to bind the developing CO₂, then the containers are tightly closed. The NaOH solution was titrated with 1 mol of HCl solution and calculated the volume of CO₂ released during the soil respiration [11, 12].

— **Characterization of soil microorganisms:**

The total plate count of aerobic bacteria, aerobic endospore-forming bacteria, filamentous fungi, yeasts, cellulose decomposers and phosphate-solubilizers in the rye rhizosphere was determined by means of a soil suspension. The roots separated from the plants were washed in sterile tap water to remove sticky soil particles followed by washing with a sterile 0.85% NaCl solution again. 10 g of the washed roots were cut and placed in 90 ml of sterile saline. A suspension of sterile tap water was prepared from the suspension. The total numbers of colony forming units (CFU) of culturable microorganisms were determined by serial dilution and plating on selective media. Plate counts of culturally viable bacteria and endospore-forming bacteria were made on Tryptone Soya Agar (TSA; Oxoid, Basingstone, Hampshire, England) amended with 0.1 g/l cyclohexamide. For fungi the Martin's medium for fungi [13] was Rose Bengal Agar (RB; Oxoid) amended with 30 mg/l streptomycin sulphate. Yeasts were cultivated on Malt Extract Agar, actinobacteria were counted on Glycerol Casein Agar [14, 15] amended with 0.05 g/l cyclohexamide. Examination of phosphate solubilisation was done in the medium described by Goldstein [16] for the selection of phosphate solvents. Dicalcium phosphate agar plates were inoculated, so that pure ring-producing strains around their cells are phosphate-free. Cellulose agar plates were seeded using two types of media (PDA: fungi and Nutrient agar: bacteria), which included the carboxymethylcellulose Congo red (CMC-Congo red) substrate as determined by Hendricks et al. [17].

All plates were inoculated with 0.1 ml of soil suspension and cultured at 25°C for 4 to 7 days for fungi, 30°C for 2 days for heterotrophic and endospore-forming bacteria and for 10 days for actinobacteria. Isolation and classification of microorganisms were done according to their morphological characteristics (colour, shape, appearance, cell size). Cultivable aerobic heterotrophic bacterial isolates belonging to different genes were studied by colony and cell morphology, Gram staining, spore staining, oxidase and catalase reactions, oxidation and fermentation of glucose, and motion and pigmentation.

— **Enzymatic Activity**

Dehydrogenase activity ($\mu\text{g INTF/g}^{-1}$ dry soil) was measured according to García et al. [18]. The catalase

activity ($\mu\text{mol O}_2/\text{min}^{-1}/\text{g}^{-1}$ dry soil) was measured by potassium permanganate O₂ consumption following the addition of H₂O₂ [19]. Urease and protease activity ($\mu\text{mol NH}_4^+-\text{N/g}^{-1}$ dry soil/h⁻¹) according to Nannipieri et al. [20]; phosphatase activity ($\mu\text{mol p-nitrophenol (PNP)/g}^{-1}$ dry soil/h⁻¹) regard to the method of Tabatabai and Bremner [21]; β -glucosidase activity ($\mu\text{mol p-nitrophenol/g}^{-1}$ dry soil/h⁻¹) was determined by the method described by Masciandaro et al. [22]. Invertase activity was measured by Siegenthaler [23] using p-nitrophenyl α -D-glucopyranoside (Fluka, Buchs, Switzerland). After adding a solution containing p-nitrophenol, tris buffer (pH 9.5), it is converted to nitrophenolate anion which can be measured by a spectrophotometer due to the pH effect. The extinction value at 400 nm is multiplied by 21.64 in an invertase number. The aryl sulfatase activity ($\mu\text{mol nitrophenol g}^{-1}$ dry soil/h⁻¹) was determined according to Tabatabai and Bremner [21] (absorption of p-phenol at 400 nm after incubation with PNP sulphate).

RESULTS AND DISCUSSION

The results of the present studies showed an increase in the observed parameters (pH and moisture content) after treatment of soil samples with sewage sludge. For acid soils, the pH value (Figure 1) was increased in sewage treated samples and the moisture content remained longer than in the control (Figure 2).

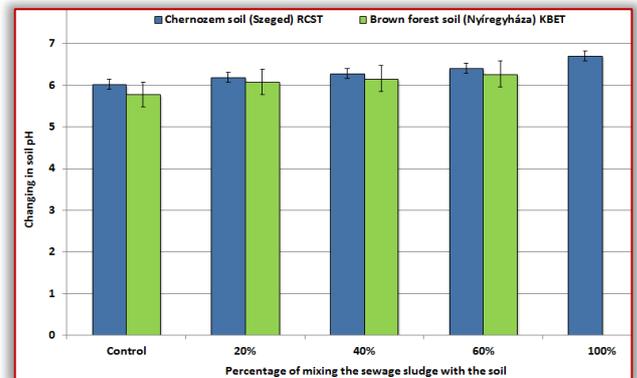


Figure 1. Impacts of sewage sludge on pH of the two soil samples

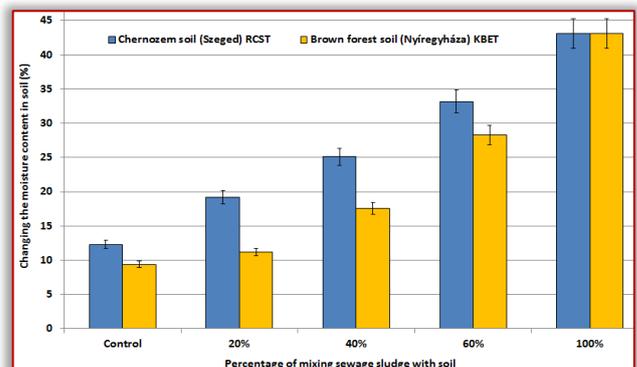


Figure 2. Impacts of sewage sludge on moisture content of the two soil samples

The addition of sewage sludge to soil significantly increased rye plant dry matter content (Figure 3) for each soil sample. Growth and development of plants were faster and healthier, in particular the clay abrasion of 60% sewage sludge in the case of brown forest soil and chernozem soil treated with sewage sludge from Nyíregyháza.

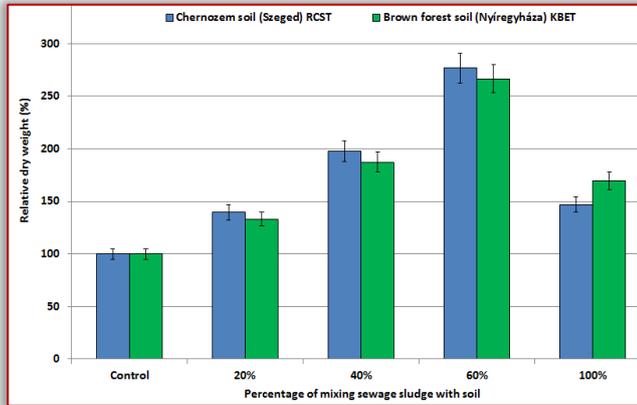


Figure 3. Effect of sewage sludge on rye plant dry weight in two soil samples

The total biomass mass of the plants increased proportionally with the increase in the amount of sewage sludge added to soil. Growth and nutritional needs were uniform on the basis of morphological characteristics during the vegetation period. Adverse symptoms were not observed on either control plants or plants derived from sewage sludge treated soil. The morphological characters of all plants (leaves, shape, colour and size) were normal and healthy. The maximum rye plants dry matter mass was observed with a mixture of sewage sludge 60: 40%. No significant statistical difference was observed in the relative dry weight of the rye in the brown forest soil treated with the sewage sludge from Nyíregyháza. According to the results, alkaline pH sewage sludge increases the pH of acidic soils, which favours the growth of rye plants and reduces or inhibits the harmful effects of heavy metals.

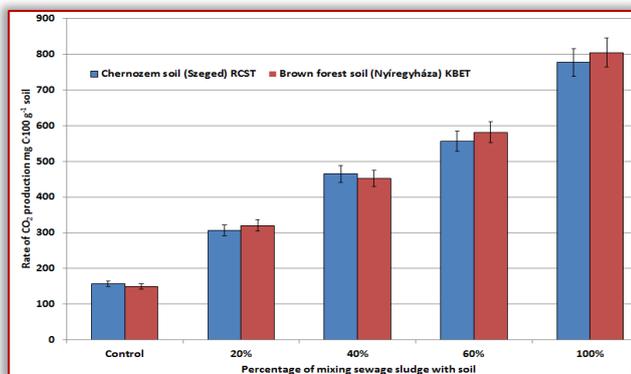


Figure 4. Effect of sewage sludge on the amount of CO₂ released in soil samples

The degree of microbial activity can be determined by the amount of CO₂ released from the two soil samples. In this study, the value of soil respiration compared

with the control increased significantly by increasing the sewage sludge dose. Figure 4 shows that the amount of CO₂ released from the metabolism of microorganisms, root respiration in the soil of the meadow chernozem and in the brown forest soil from Nyíregyháza.

Such rate of respiration can provide valuable information on the increased metabolism activity of the soil microorganisms. The highest CO₂ emissions were observed in the soil of the brown forest soil from Nyíregyháza.

— Enzymatic activities

The results of measuring dehydrogenase activity also confirm the microbial population. In our experiments, the enzymatic activity measured in sewage sludge treated soils exceeded double the values of the control samples. The enzyme activity of FDA hydrolysis was determined by spectrophotometric measurement, and the results of which are shown in Figure 5. The largest FDA activity was registered in RCST soil. In samples of sewage sludge: soil mixture 60: 40% to 100: 0% FDA activities showed positive significance for each treatment. The results show that the amount of fluorescein produced by FDA hydrolysis (spectrophotometric measurement) is in direct proportion with microbial growth, and the hydrolytic activity of FDA shows a close correlation with soil respiration.

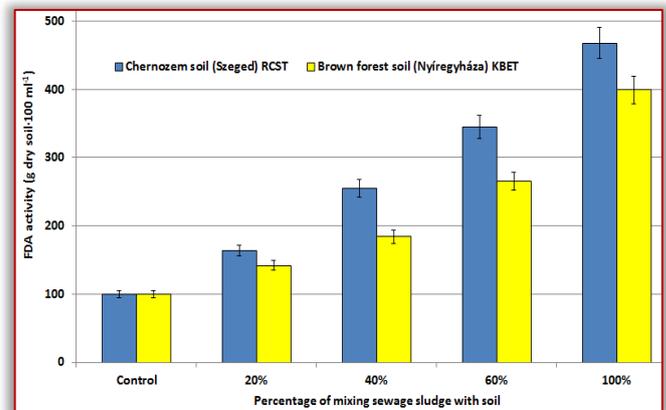


Figure 5. Effect of sewage sludge application on the activity of FDA enzyme in two soil samples

Accordingly, the organic material turnover of the examined model experiment is influenced and determined by the overall microbial activity. There was also a growing tendency for FDA activity after increasing the amount of sewage sludge mixed with soil. The equilibrium effects of sewage sludge did not only significantly increase the soil microbial population, but also the activity of the soil enzymes investigated, soil respiration and FDA activity.

Soil dehydrogenase activity refers to the total oxidative activity of the soil microbial and can therefore be a good indicator of the degree of microbial activity. Sewage sludge addition increased

dehydrogenase activity and catalase activity for each treatment (Figures 6 and 8).

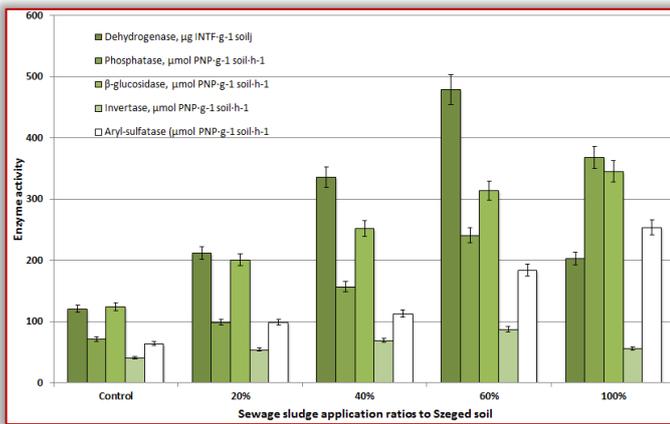


Figure 6. Effect of sewage sludge on the activities of some enzymes in soil of Szeged

The highest enzyme activities of urease, protease (Figures 7 and 9), phosphatase, β-glucosidase and aryl sulfatase (Figures 6 and 8) were found in the presence of sewage sludge only. The higher enzyme activity can be explained by the increased microbial activity that is caused by the high nutrient and organic content of sewage sludge. Protease activity increased significantly after 9 weeks of growth time. The more organic matter the sewage sludge in question is, the more enzyme activity is due to its complexity with the resistance to organic matter. The enzyme activity was also higher in the rhizosphere of brown forest soil mixed with the sewage sludge in Nyíregyháza.

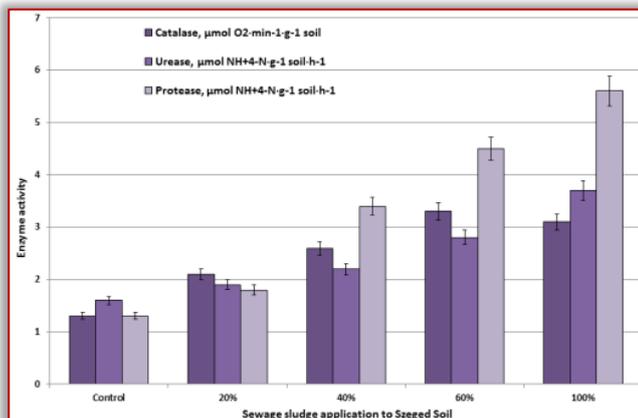


Figure 7. Effect of sewage sludge application on the activities of catalase, urease and protease enzymes in soil of Szeged

During the experiment, the plant grown on sewage sludge treated soil had a positive effect on the synthesis of the β-glucosidase enzyme. The highest values were measured in soil treated with sewage sludge, apparently due to the degradation of organic matter. The values of aryl sulfatase activity in the rhizosphere of rye treated in different soil types are similar to that of protease and urease activity.

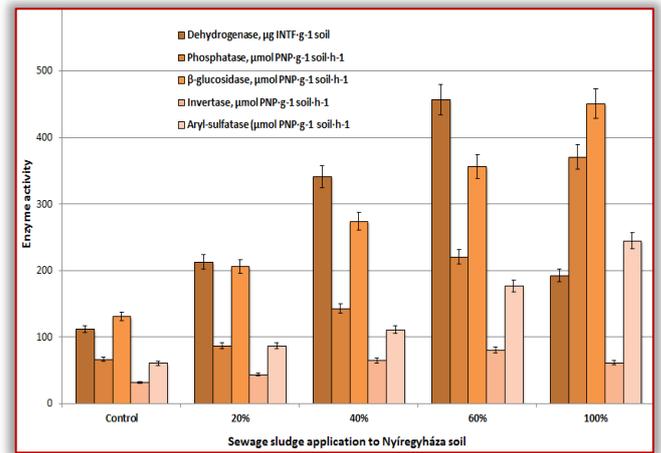


Figure 8. Effect of sewage sludge on the activities of some enzymes in soil of Nyiregyhaza

— Composition of microbe population

The number of aerobic heterotrophic bacteria, aerobic spore-forming bacteria, actinobacteria and fungi was determined after 9 weeks of plant growth in the two soils mixed with different doses of sewage sludge are presented in the Figures 10 to 12.

It was found that population of the different microbial groups significantly increased with the addition of 20% sludge to soil. This suggests that the increased microbial populations are able to utilize large quantities of organic matter and use sewage sludge as energy sources. Consequently, sewage sludge has a beneficial effect on the general microbial activity of the soil and on some specific microbial portions.

A 1254 bacterial strain was isolated from the rye-soil sewage sludge model experiment. It can be concluded that the bacterial populations increased significantly with sewage sludge treated soils by increasing the amount of sewage sludge used (Figures 10 and 12). The bacterial number of bacteria was 4 to 14 times greater than the control depending on the sewage sludge-soil-plant system. The largest bacterial number was found in brown forest soil mixed with the sewage sludge in Nyiregyhaza.

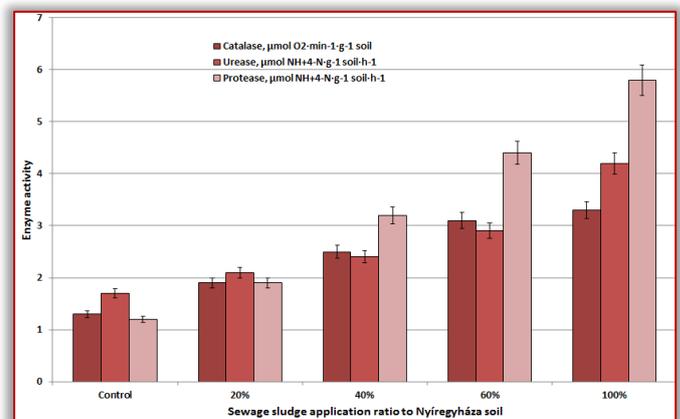


Figure 9. Effect of sewage sludge on the activities of catalase, urease and protease enzymes in soil of Nyiregyhaza

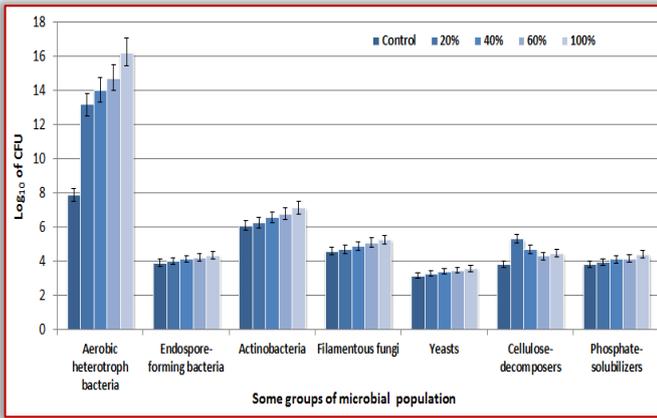


Figure 10. Effect of sewage sludge application on microbial structure in soil of Nyíregyháza

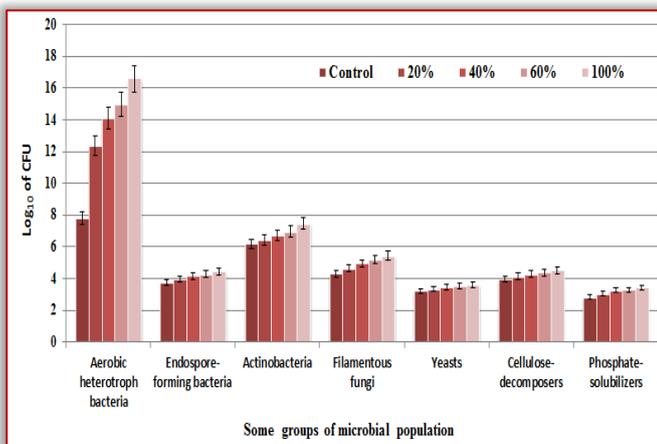


Figure 11. Effect of sewage sludge application on microbial structure in soil of Szeged

The most common isolates were the following genera: *Achromobacter*, *Acinetobacter*, *Aeromonas*, *Alcaligenes*, *Arthrobacter*, *Azotobacter*, *Bacillus*, *Brevundimonas*, *Burkholderia*, *Cellulomonas*, *Chromobacterium*, *Chryseobacterium*, *Corynebacterium*, *Enterobacter*, *Escherichia*, *Flavobacterium*, *Klebsiella*, *Microbacterium*, *Micrococcus*, *Pseudomonas*, *Rhodococcus*, *Serratia*, *Stenotrophomonas*, *Staphylococcus*, *Streptococcus*, *Streptomyces* and *Zooglea*. We have not found representatives of *Aeromonas*, *Citrobacter*, *Listeria*, *Salmonella*, *Shigella*, *Vibrio* and *Yersinia*. The bacterial number of aerobic spore-forming bacteria in sewage sludge-soil-plant model experiment was 3 to 7 times greater than control. Sewage sludge treatments increased the population of actinobacteria compared to untreated soils. The number of actinobacteria in the sewage sludge-soil-plant model experiment was 2-22 times higher than the control. The highest number of actinobacteria was observed in brown forest soil of Nyíregyháza. Domestic isolates in different sewage sludge/soil mixtures belonged to the *Streptomyces* genus. The fungal populations in each sewage sludge/soil mixture were largely different from the control. The number of filamentous fungi

according to the sludge-soil-soil ecosystem was 2-13 times greater than that of the control. In a model experiment composed of various sewage sludge/soil mixtures, more than 350 representative fungal strains were isolated. These isolates belong to the following genera: *Alternaria*, *Aspergillus*, *Cephalosporium*, *Cladosporium*, *Fusarium*, *Geotrichum*, *Mucor*, *Penicillium*, *Rhizopus* and *Trichoderma*. In addition, there are many strains belonging to the *Saccharomyces* genus, which were only isolated from soil of Nyíregyháza. Most of the filamentous fungi were found in brown forest soil, especially when the soil was treated with the sewage sludge in Nyíregyháza (Figures 10 and 11).

—Bacterial communities

In our experiments gram negative bacteria dominated the rhizosphere of the rye. The proportion of gram-negative and gram-positive bacteria (Figure 12) is proportional to the brown forest soil and the Chernozem soil in the meadow mixed with Nyíregyháza sewage sludge 2,367; and 3.24 respectively. These data suggest that there is no statistical difference between the bacterial communities of rye rhizosphere in the brown forest soil treated with the sewage sludge in Nyíregyháza, while in the other soil there was a significant difference. The soil treated with the sewage sludge in Nyíregyháza was higher in gram-negative bacteria than in soil from Szeged.

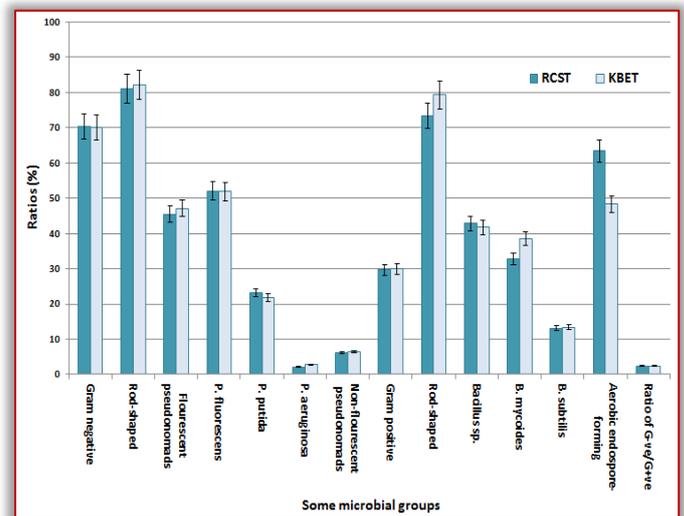


Figure 12. Effect of sewage sludge application on microbial communities in soil samples of Nyíregyháza and Szeged

Sustainable agriculture will pay attention primarily to water and soil protection and conservation, avoiding soil erosion and degradation, and also care for the use of resources (water, energy, machinery, fertilizers and amendments and soil labours) in a frame of environmental respect. Sludge and sustainability, when proper sludge products quality attained and recycling is feasible many objectives connected with sustainability are accomplished: Soil economy and

recovery eliminating landfill disposal and contributing to rangelands restoration; The use of resources through promotion of soft technologies; Mineral nutrients savings through recycling and mineral fertilizers replacement; Fossil fuel energy savings through mineral fertilizers replacement; Nature's protection through reduction of fertilizers production; and Erosion control and increase of soil fertility and productivity.

Investigation of the data showed that there is more evidence that such parameters are sensitive indicators of the composition and function of the stressed soil caused by the use of sewage sludge because microbiological activity directly affects the stability of agro-ecological systems and fertility. There is a growing interest in the use of soil enzymes as indicators of soil fertility, because the activity of soil enzymes is sensitive to many factors. Since the enzyme activity is substrate-specific, it is difficult to predict the nutrient supply of the soil from the activity of an enzyme, and the parallel measurement of several properties can better describe the microbiological activity of the soil.

The number of heterotrophic microorganisms in the soil usually increases following the addition of sewage sludge. In fact, microorganisms capable of utilizing the organic material of sludge are rapidly propagating.

In the pot experiment of two soil samples and one sample of sewage sludge to form plant-soil systems, whose application possibilities can favourably contribute to plant nutrition. We found that besides rye growth, the plant health was better than control. So the plant utilized the micro and macro nutrients necessary and easy to apply from the immediate environment.

According to Stadelmann and Furrer [20], the number of aerobic bacteria and beetles increased due to sewage sludge addition.

In summary, the treatment of soil samples with sewage sludge stimulates the plants development, improves the physical, biochemical and microbial properties of the rhizosphere, helps to maintain soil moisture and increases soil pH, which is also favourable for plant growth. To improve soil fertility, the authors propose an alkaline sewage sludge treatment for acidic soils.

The sewage sludge application causes an increase in the microbial populations. Environmental factors also affect microbial activity and mineralization of sewage sludge. Sewage sludge and its management affect the quality of the organic material, its degradation speed, the time required for it, and the amount of nutrient released. Our results confirm the statement by Garcia et al. [18] that microbial and dehydrogenase activity is directly related to each other and depends on the metabolic state of microbial populations in soil.

Crecchio et al. [25] observed that with increasing use of communal waste compost the organic C, N, dehydrogenase, β -glucosidase, urease, nitrate reductase and phosphatase activity of the soil increased with the composition of the bacterial communities living in soil did not change significantly. However, in our case, the activity of soil enzymes and the density of microbial populations increased with the addition of sewage sludge.

Sewage sludges, as products obtained by wastewater treatment, contain organic matter, micro and macronutrients and are potentially useful for any agriculture use. They may contain undesirable harmful materials. For these reasons, the use of sewage sludges in agriculture, at European Union (EU) level, is regulated by the EU Sludge Directive 86/278/EEC. One of the current Council Directive of 12 June 1986 aims on the protection of soil environment, when sewage sludge is applied in agriculture is to avoid toxicity effects on soil, plants and man [26, 27]. Considerable improvement in dehydrogenase activity and aggregate associated organic matter was observed particularly when higher amount of sludge was applied our results are confirmed with the observation of Mondal et al. [28]. The greater soil urease and invertase activities in spring soil amended with sewage sludge provided evidence of increased soil microbial population [29]. Soil microorganisms excrete a variety of enzymes such as ureases, invertases, dehydrogenases, cellulases, amylases and phosphatases that have long been recognized as a primary means of degrading xenobiotics in soil and water ecosystems [29]. According to Pierzynski et al. [30], soil quality is determined mainly by physical (structure, water retaining capacity, etc.), chemical (organic and inorganic substances concentration) properties which can strongly affect fertility, biological activity, or other important soil factor. Our results are in agreement with the Pierzynski et al. [30] in regards to the issues of plant growth and soil quality. The degradation of the organic material of the sewage sludge can be monitored well in the soil based on the measured amounts of the releasing of CO₂. Previous studies [31] have shown that soil respiration has increased due to addition of sewage sludge.

CONCLUSION

The presence and activity of soil microorganisms is essential for the fertility of agricultural soils. The beneficial effect of fertilization on soils' productivity has long been known. The results of our experiments support the above mentioned works that the density of microbial populations is related to the amount of sewage sludge mixed with soil. Our results are in accordance with the above mentioned work, which increases the fertility rate and the density of microbial populations as well as soil enzyme activity by

increasing the proportion of sewage sludge mixed with soil. Sewage sludge extraction can be partially replaced by organic fertilization and fertilization, as well as the treatment of soil physico-chemical properties. At the same time, due to the aspects of food safety, the use of continuous state monitoring methods is recommended.

Note:

This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty “Mihajlo Pupin” Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 03–04 October, 2019.

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THE HYDRAULICALLY ASSISTED BATHYMETRY MODELING OF EFFECT OF WEATHER ON RESERVOIR WATER LEVEL

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Abstract: Life on Earth depends on water, yet water resources are severely stressed by the rapid growth of the human population and activities. The exploration and monitoring of water resources is a prerequisite for water accessibility and rational use and management. Surface water systems can be mapped using multispectral, digital image sensors and some other models. Therefore, this study analysed the effects of weather variations on the water level of Eleyele reservoir for a period of 32 years (1984, 2000, 2016 at 16 years interval) using the hydraulically assisted bathymetry model. Rainfall and temperature data were statistically analyzed using IDRISI Selva 17.0. The result of the weather variation shows 94% regression value between rainfall and temperature as they increased drastically in 2016. Hydraulically Assisted Bathymetry (HAB) model developed and used for estimating stream water depths showed open water area decreased from 122.73 ha to 101.55 ha and from 101.55 ha to 61.74 ha between years 1984 and 2000, and 2000 to 2016 respectively. In addition, the HAB model showed that between 1984 and 2016, the depth of the dam along the cross-section reduced by 0.2 m at the deepest part of the reservoir. This study established that reserved forest zone suffered degradation with a noticeable increase in encroachment on the dam level. This approach can be used to model the impact of weather variations on the water level of dam / reservoirs.

Keywords: weather; bathymetry modeling; reservoir; water level

INTRODUCTION

Water resource is a key factor in many economic activities ranging from agriculture to industrial production. Water is one of the most precious natural resources, which support human health, economic development and ecological diversity. It is the most valuable and vital resource for sustenance of life and for any developmental activity (Mishra, 2013). In Nigeria, as in any other African developing countries, population is heavily dependent on fresh water, forests, croplands and fisheries (Homer-Dixon and Blitt, 1998). Increased demand for fresh water resources associated with these trends is expected to be especially intense in rapidly urbanizing regions (Taylor *et al.*, 2004), and in the agricultural sector in order to boost food production (Carter *et al.*, 2009; MacDonald *et al.*, 2009).

The population growth has put pressure on the Africa's environment to sustainably provide goods and services to an increasing population with the current technologies, resulting in the loss of forests, animals, plant species, land degradation, increasing water shortages and declining water quality. At present, water resources are severely stressed and particularly scarce in most parts of the world (Sharma *et al.*, 1989). In many arid and semiarid regions for example, water shortage is a major obstacle to sustainable development and poverty alleviation and the cause of serious conflicts between some countries (Asadi *et al.*, 2012).

Water shortage can be further aggravated by the global climate change that is predicted to severely affect the regions of the world. Thus, exploration,

mapping, and monitoring of water resources are a prerequisite for the availability, accessibility, fair utilization, and rational management of water resources in our world today (Asadi *et al.*, 2012, Yan *et al.*, 2010).

Throughout the world, water consumption is increasing more rapidly than the human population and has raised the socioeconomic and strategic importance of water resources (Alaaddin *et al.*, 2008). With the surface water sources dwindling to meet the various demands, groundwater has become the only reliable source. The indiscriminate use of this vital natural resource is creating groundwater-mining problem, hence water resource need evaluation to meet the ever-growing needs (Mishra, 2013).

— Models and Selection Scenario

Six watershed models were used to simulate hydrology and water quality among these, SWAT and HSPF was the most common, both utilized by three studies. The array of models suggests that no singular watershed model is appropriate for assessing cumulative impacts, and other factors may drive model selection. Butcher *et al.*, (2010) utilized both SWAT and HSPF, and selected them based on the requirements that a model be process-based, dynamic with daily time steps, able to simulate water quality, widely used and accepted, in the public domain and with an existing GIS interface. Thus, their rationale was in part mechanistic and in part based on ease of access. Praskievicz and Chang (2011) chose WinHSPF because it is one of the most commonly used public domain modeling systems with a large user

community and abundant technical support, and because it is able to simulate water quality. The use of various watershed models allows researchers to examine their relative strengths and weaknesses. Butcher *et al.*, (2010) found that HSPF was better able to replicate observations during calibration and validation, but SWAT simulations of watershed response to changing conditions were more robust. All climate models were based on General Circulation Models (GCMs), although studies used varying GCMs from different sources. Nearly all studies relied on emissions scenarios developed in the United Nations Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (SRES) to drive the GCMs, but they differed in the number of emissions scenarios they used. Nelson *et al.*, (2009) tested the A2 and B2 scenarios, representing mid-high and mid-low emissions, respectively. Both Viger *et al.* (2011) and Tu (2009) tested three scenarios, B1, A1B and A2, representing increasing emissions levels with B1 as the “best case” and A2 as the “worst case” in their analyses.

Franczyk and Chang (2009) relied on the A1B scenario, and Wilson and Weng (2011) and Praskiewicz and Chang (2011) on the A1B and the B1 scenarios. Butcher *et al.*, (2010) relied only on the A2 scenario. Scenario selection reflects a choice by the researchers regarding the context of the results. Researchers using multiple scenarios sought to capture the variability implicit in the scenarios by including a range. Franczyk and Chang (2009) used the A1B scenario because it was the “middle of the road scenario”, while Butcher *et al.*, (2010) used the A2 scenario because it was the “pessimistic” scenario. Only Tong *et al.*, (2012) did not rely on a climate model or SRES scenarios, and instead developed four hypothetical scenarios.

The use of these hypothetical allowed the authors to examine a range of responses, but may have limited practical application as the results are not predicted changes and cannot capture seasonal variability. Models often used for land use include FORE-SCE (Viger *et al.*, 2011), IDRISI (Wilson and Weng, 2011; Tong *et al.*, 2012) and a linear regression extrapolating historical land use trends (Tu, 2009). GIS are capable of managing large amounts of spatially related information, providing the ability to integrate multiple layers of information and to derive additional information (Arshad, 2008).

Krishnamurthy (1996) and Ramaraju (2006) used Remote Sensing and GIS techniques for water exploration and identification of artificial recharge zones. The study modeled the Effect of weather on Eleyele reservoir (Dam) water level by analysing the rainfall and temperature pattern within the study area for 32 years and using hydraulically assisted bathymetry model to determine the water level.

MATERIALS AND METHODS

—The Study Area

Eleyele Dam covers the water storage area itself plus a strip of dry land surrounding the reservoir and varying in width from 30.48 m – 365.76m. It is located in Ibadan North West Local Government Area of Oyo State and lies within latitude $7^{\circ}30' - 7^{\circ}45' N$ and longitude $3^{\circ}55' - 3^{\circ}88' E$. The area elevation is relatively low ranging between 100-150m above sea level and surrounded by quartz-ridge hills toward the downstream section where the Eleyele dam barrage is located.

The reservoir was made by damming River Ona with a total area of 526.0921 hectares and situated within the lower boundary of Guinea Savanna vegetation belt having the combination of equatorial and tropical hinterland climate (Akingbogun *et al.*, 2012). Figure 1 shows the Map of Ibadan showing the location of Eleyele Reservoir.

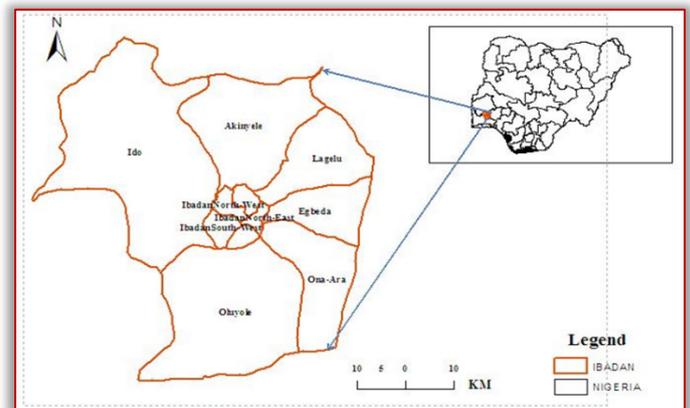


Figure: 1: Map of Ibadan showing the location of Eleyele Dam (Source: FRIN, 2016)

—Methods employed

This study employed GIS and Remote Sensing and the general procedure used in this study are described. Several data sets are prepared as inputs to the ArcGIS and IDRISI softwares.

—Data acquisition

Quick Bird/ Google Earth images for the delineation of the study area and Weather parameters.

—Data preparation

Eleyele basin images are covered by path 191 and rows 55. A supervised classifier (parallelepiped classification) was used to stratify the images.

—Cross-Classification Analysis

Categories of image 2000 were compared with those of 2016 and tabulation of the number of cells in each combination was produced. Cross classification was performed using CROSSTAB module in IDRISI. It performs an analysis that compares images containing categorical variables of two types which are hard classification in which all pixels in the maps have complete membership to exactly one category. CROSSTAB outputs a cross-classification image and

table. The cross-tabulation output is a tabular matrix that shows the number of pixels that correspond to each combination of categories in the two images being compared. CROSSTAB expresses the tabular matrix in terms of the proportion of the total number of pixels. CROSSTAB gives summary statistics, such as the Cramer's V and Kappa (IDRISI manual, 2012).

The first of these measures is CRAMER'S V, a correlation co-efficient between the images that ranges from 0.0 indicating no correlation to 1.0 indicating perfect correlation. A chi-square statistics is output along with the appropriate degree of freedom (df 6) and the significance of the Cramer's V was tested. If the chi-square is significant, so it is Cramer's V. Since the 2 images have exactly the same number of categories, another measure of association called Kappa was produced, which is an Index of Agreement for each category.

—**The hydraulically assisted bathymetry model**

For this study, a remote sensing model named the model hydraulically assisted bathymetry (HAB) model (Mark *et al*, 2005) was used for estimating stream water depths without the use of ground crews was adopted. The models is based on simple concepts of open-channel flow and require only slope data for the stream bed and discharge data from a nearby gaging station at the time of image collection. HAB model does not require ground data on depths or water optics thus removing logistical obstacles associated with field surveys and radiometric calibration and enable depth estimates using historical and modern photos and digital data. This model utilized Beer-Lambert law, which describes the exponential absorption of light in water columns where scattering is minimal:

$$I = I_0e^{-\beta D} \quad (1)$$

where: e is the base of natural logs,
I is the intensity of light at some depth,
I₀ is the intensity of light immediately prior to entering the water column, is a constant indicating the strength of absorption per unit depth, and D is the distance that the light passes through water (Denny, 2003).

In most images, intensity (I) is unknown for each pixel, so that the digital numbervalue (DN) is substituted into Eq. (2), and the distance of light passage is identified as the depth of water:

$$DN = DN_0e^{-\beta \cdot D} \quad (2)$$

To solve for depth, rearrange Equation 2:

$$DN = \ln(DN/DN_0) / -\beta \quad (3)$$

The value DN₀ must be equal to the DN of the riverbed when any significant water depth does not cover it (Mark *et al.*, 2005). To estimate DN₀, the DN value of the dry shore material adjacent to the river was used, since the same material that makes up the majority of the wetted riverbed pixels as in the absence of field measurements, is initially unknown. Using the same

cross-section, we then reiterated Eq. (3) with different values until estimated discharge equaled the known stream discharge of 3.4m³/s for the HAB derivation, which occurred at =0.652 m. A final value was determined and substituted into Eq. (3) to determine the depth of the Dam, The resulting HAB equation for predicting depth was:

$$D = \frac{\ln\left(\frac{DN}{51}\right)}{0.652} \quad (4)$$

Change in water level map was carried out in order to determine the status of the dam. The thematic map of the study years was extracted by Boolean operation. The outputs were transformed into vector layers for overlay operation in order to display changes and locations over the years.

RESULTS AND DISCUSSION

—**Temperature and Rainfall Pattern in the Study Area**

The temperature and rainfall distribution pattern of the study area over the study period were presented in Figures 1, 2 and 3 depicting the high temperature in the study area leading to reduction in the water volume in the reservoir. Also, Figure 4 indicates a strong relationship between rainfall and temperature with a regression value of 94%. Both rainfall and temperature graphs show that rainfall and temperature increased drastically in 2016. This resulting to vegetation loss and may contribute to evaporation of the dam and transpiration the surrounding ecological features.

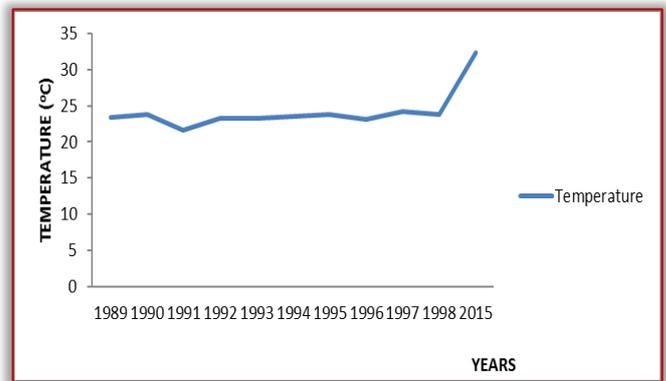


Figure 1: Temperature Pattern for Eleyele Water Dam

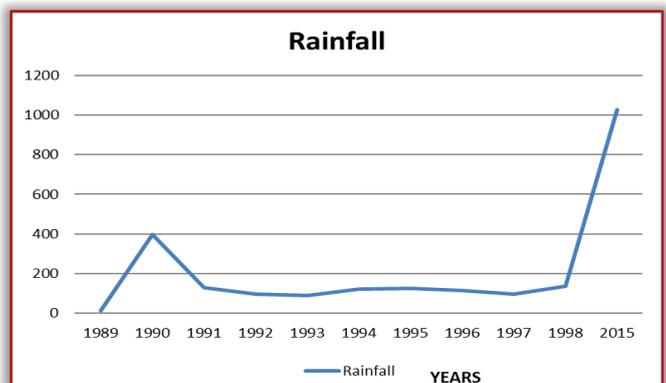


Figure 2: Rainfall Pattern for Eleyele Water Dam

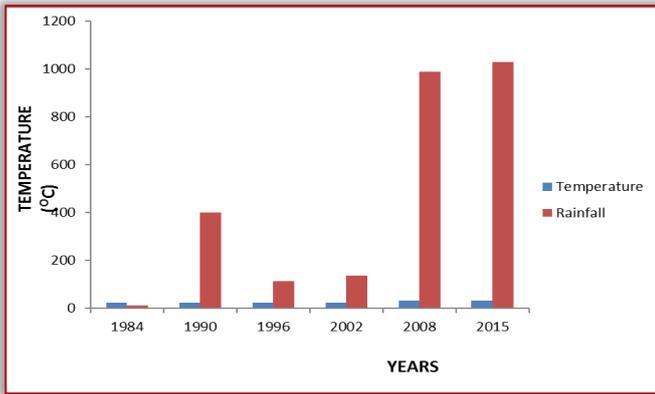


Figure 3: Rainfall and Temperature pattern for Eleyele Water Dam

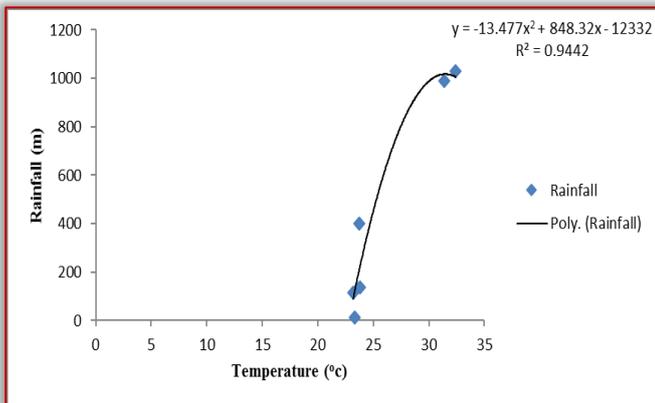


Figure 4: The relationship between rainfall and temperature

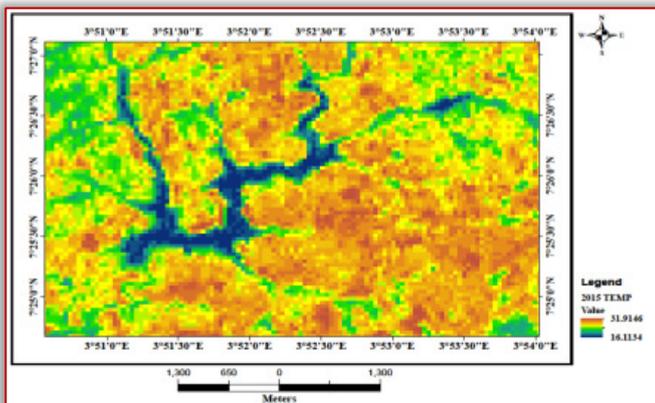


Figure 5: Surface temperature image

Figure 5 shows temperature distribution of the study area as at 2016 in pixels (30m x 30 m). The surface temperature map revealed that built up land has the highest temperature while the water body has the lowest temperature.

Table 1: Water area distribution pattern between 1984 and 2016

Category	1984		2000		2016	
	Hectares	%	Hectares	%	Hectares	%
Open Water	122.74	3.14	101.55	2.59	61.74	1.58
					54.54	1.39

Table 2: Markov: 2000/2016 Transition Probability of Water areachanges

LULC	Built Up	Open Water	Vegetation Cover
Open Water	0.5794	0.0472	0.3734

Water area distribution pattern between 1984 and 2016 in the dam is shown in Table 1, while Table 2 shows the 2000/2016 Markov Transition Probability of Water area changes. From Table 2, it is clear that the water body is endangered as a result of negative influence human activities depicting serious threat faced by Eleyele in future due to anthropogenic activities as indicated in decrease in open water rate from 2.59% to 1.58%.

— Cross Tabulation Operation

The results of cross tabulation are in Table 3 listing the total as well as several measures of association between the images. The cramer's value of 46% indicates an extremely good relationship indicating that the two variables are measuring the same concept.

Table 3: Cross-tabulation of 2000 (columns) against 2015 (rows)

Categories	1	2	3	Total
0	176	0	785	961
1	10609	4	16019	26632
2	0	534	216	750
3	944	860	18873	20677
Total	11729	1398	35893	49020

Chi Square = 21190.02539, df = 6, P-Level = 0.0000, Cramer's V = 0.4649

Table 4: Proportional Cross tabulation

Categories	1	2	3	Total
0	0.0036	0.0000	0.0160	0.0196
1	0.2164	0.0001	0.3268	0.5433
2	0.0000	0.0109	0.0044	0.0153
3	0.0193	0.0175	0.3850	0.4218
Total	0.2393	0.0285	0.7322	1.0000

Overall Kappa = 0.3086

— Changes in water level of the DAM

Change in water level map was carried out in order to determine the status of the dam as extracted from the thematic maps of the study years using Boolean operation. The outputs were transformed into vector layers for overlay operation. The overlay vectors layer is shown in Figure 6 depicting the changes and change locations from 1984 to 2016 and readings summarized in Figure 7. The estimated discharge equaled the known stream discharge at = 0.652 m and the calculated depth along the examined cross section of the Eleyele Dam between 1984 and 2016 using equation 4 and result to 0.2 m.

The results showed that urban growth (anthropogenic factors) within the study area imposes a lot of pressure on the reservoir. Between 1984 and 2016, the depth of the reservoir reduced significantly. In addition, the reserved forest zone has suffered degradation seriously and if the trend continues, the

encroachment will further reduce the reservoir area and the surrounding reserved forest will disappear. By projection, the reservoir area will reduce by 1% (39.08 ha) of the total area considered for the study area by the year 2032. The combined influence of climate and human activities effect the land use, which also affect the water levels in the dam over 32 the years and this, confirms the findings of Viger *et al.*,(2011); Wilson and Weng (2011) and Tong *et al.*,(2012) on the use of regression models on the on land use trends impacts.

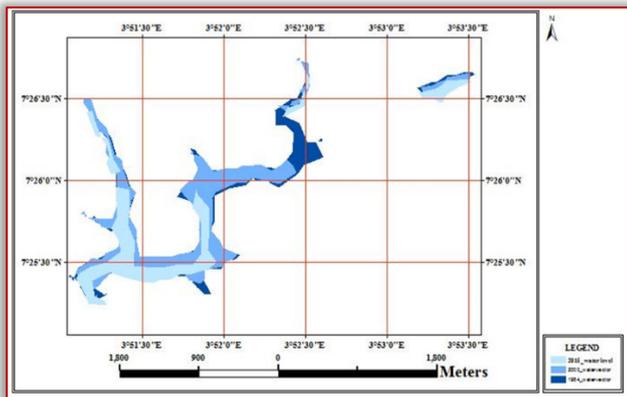


Figure 6: 1984/2000/2016 Water Level of Eleyele Dam

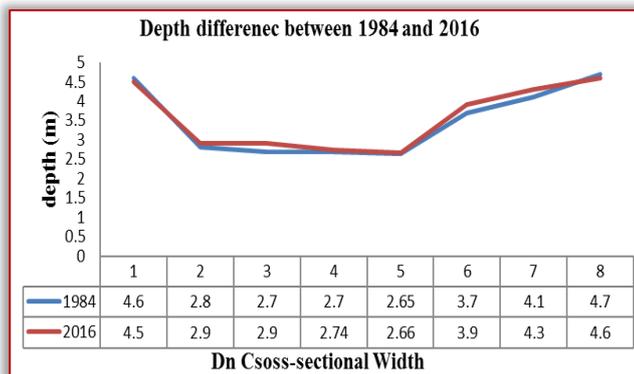


Figure 7: Dam water level

CONCLUSIONS

The effect of weather on Eleyele reservoir (Dam) water level was analysed using rainfall and temperature pattern within the study area and dam water levels determined within 32 years (1984-2016) with the aid of GIS analytical functions. The results showed that urban growth (anthropogenic factors) within the study area imposes a lot of pressure on the reservoir as there was reduction in the reservoir depth significantly between study periods. With the results of this study, image cross-sections can be used to better representatives of the stream or river. As a result of the long term effect on the water resources in the area, government should evacuate the inhabitants of Eleyele watershed, who had converted the watershed to commercial and residential zone in order to reduce the deforestation of the riparian vegetation observed to have suffered serious decay between 1984 and 2016 as

uncontrolled anthropogenic activities around the dam contributed to the water level / depth decrease of the dam. The dam profile also reveals that surface filling may be a factor for the rise of the surrounding continent.

The regression analysis showed strong relationship between temperature and rainfall. Checkmating the activities of man, which have been observed, in the course of the study, as the major cause of forest degradation around the dam would save the environment from effects of climate change. Such development could also facilitate immensely evapo-transpiration of the dam.

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MODEL OF AN ENVIRONMENT-FRIENDLY AND SUSTAINABLE POWER PLANT

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Abstract: Power plant is one of the major sources of Carbon dioxide gas emission. This gas is leaving an atrocious impact on the environment such as the Greenhouse Effect. This paper proposes a new model that ensures lower Carbon dioxide emission from the power plants. In this model, steps of chemical processes are used in a cycle. The basic principle of the model is represented through 5 chemical reactions. Exclusive reactions like Sabatier Reaction, Hydrogen Production, and Hydrogen Fuel, etc. are used in this cycle in a systematic way. It is observed that the Oxygen to Carbon dioxide ratio in the air can be increased with every completion of this cycle. Also, Methane is re-produced in one step of this cycle which ensures sustainability. It is observed that only 3% of energy is lost to run these extra processes. So, this model can prevent the Earth's environment pollution with a nominal energy loss.

Keywords: Environment, Power Plant, Sustainable Energy, Emission Control, Chemical Process

INTRODUCTION

The major source of air pollution is the emission from combustion that takes place in industries, power generation systems and electrical utilities. The environmental pollution from burning various fossil fuels in thermal power plants poses tremendous health hazard to modern civilization. In addition to causing annoyance to public, air pollution by thermal plants contributes to the cause of property damage, various respiratory diseases and lung cancer.

From burning of fuels (coal, oil and gas) the combustible elements are converted to gaseous products, and non-combustible elements to ash. As a result, thermal power plants continuously emit a massive amount of Carbon dioxide in air. These Carbon dioxide has a molecular structure that triggers the global climate issues by the following mechanism: The internal molecular vibration and rotation of Carbon dioxide causes its molecules to absorb infrared radiation.

When Carbon dioxide gas form part of the atmosphere, they absorb some of the heat that the earth normally radiates into space. So, heat is trapped that would otherwise be lost (Peirce, 1998). This is causing the temperature to increase every year. Hardley Centre for Climate Prediction and Research claims that, "An upward trend can be clearly seen in the annual mean global temperature that initiated from 1920 and continued for the rest of the century." It also shows in a chart that the average temperature increase from 1975 to 2000 was of about 0.5°C/0.7°F (Lawson, 2009). It has been projected that average temperature across the world would climb between 1.4°C and 5.8°C over the next century.

The second of IPCC's impact categories is ecosystem, where it states that, "Approximately 20-30% of plant and animal species assessed so far are at the risk of extinction if increase in global temperature exceed 1.5-2.5°C (Lawson, 2009)."

Scientists have proved that the root cause of global warming is the increase of man-made Carbon dioxide emissions in the free air. Under the light of these certain facts, it is customary that the emission process of Carbon dioxide needs to be modified. But due to economic facts, none of the industry leaders are executing such steps. On the other hand, energy demand is increasing day by day.

According to IEA- key world energy statistics 2015, world final energy consumption of 2014 (109,613 TWh) was more than double of the final energy consumption of 1973 (54,335 TWh) (International Energy Agency, 2015). It also projects 28% increase of energy demand by 2040. Scientists and engineers have demonstrated the necessity of introducing sustainable systems that can ensure fulfilment of the future energy demand.

So, to reduce the Carbon dioxide emissions and ensure future energy demand are the major concerns of the Century. This paper offers a power plant cycle that ensures lower Carbon dioxide emission and reproduction of hydrocarbon that yields sustainability for future use.

This paper proposes a new model where ideas of Artificial Photosynthesis, Hydrogen Fuel and Sabatier Reaction will be used to develop the energy production. Every completed cycle of the system gradually reduces Greenhouse Gas emission and ensures a good amount of Oxygen emission. Which

will increase the Oxygen to Carbon Dioxide ratio of the atmospheric air.

The basic principal of the model can be represented by 5 steps of chemical reactions. Various fuels (coal, fuel oil, shale oil, natural gas) are used in thermal power plants. Though the principle of the proposed model is applicable for all the other fuels, only methane (CH₄) is discussed in this paper due to being most widely used.

For better understanding of the new model, operation procedure of a general steam power plant that uses Methane as the fuel is briefly demonstrated below.

TYPICAL OPERATION PROCEDURE OF A STEAM POWER PLANT

Heat required for steam production in a steam power plant is achieved through the combustion of methane. In methane power plants, the following chemical steps take place:

Due to heat and attack by the active elements, methane reacts with methyl radical (CH₃), which then reacts with formaldehyde (HCHO). This formaldehyde reacts with a formal radical (HCO), this forms carbon monoxide (CO).

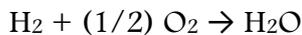
In these steps, the active elements are used and H₂ and H₂O are formed with the CO.

Principle reaction:

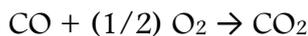


Here, methane gas is converted into two new fuels (CO and H₂) and into one product (H₂O). This process takes place very quickly, within a fraction of millisecond to a few milliseconds, this depends on some parameters such as: pressure, flame temperature, and fuel-air ratio. The process is called Oxidative Pyrolysis.

After oxidative pyrolysis, the H₂ oxidizes, which forms H₂O, which replenishes the active species, and releases heat. This step occurs quickly, usually in less than a millisecond.



In the final step, the CO is oxidized, forming CO₂ and releasing more heat. This step is slower than the other steps, and generally requires up to several milliseconds to occur.



The produced heat is used for steam production and the produced Carbon dioxide is released in free air.

PRINCIPLE OF THE PROPOSED MODEL

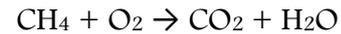
As mentioned earlier, the proposed model is divided into 5 chemical steps which will take place in different complex compartments (cells). These compartments make up a plant altogether.

Products from each compartments will be exchanged with the other. One run of the cycle is completed after each step-wise completion of the model. The steps of the model are as follows:

—Methane Combustion:

This is the first step of the model and is the general mechanism used in any thermal power plant. Here, methane is combusted with oxygen and heat is produced. Heat is then used to produce steam. Mechanism of this step is briefly discussed in the previous section of this paper.

Overall reaction:



The produced Carbon dioxide (CO₂) shall not be released to air, rather it will be captured and then sent to the next step which is “Artificial Photosynthesis” and the produced H₂O is sent to the third step which is “Hydrogen Production.”

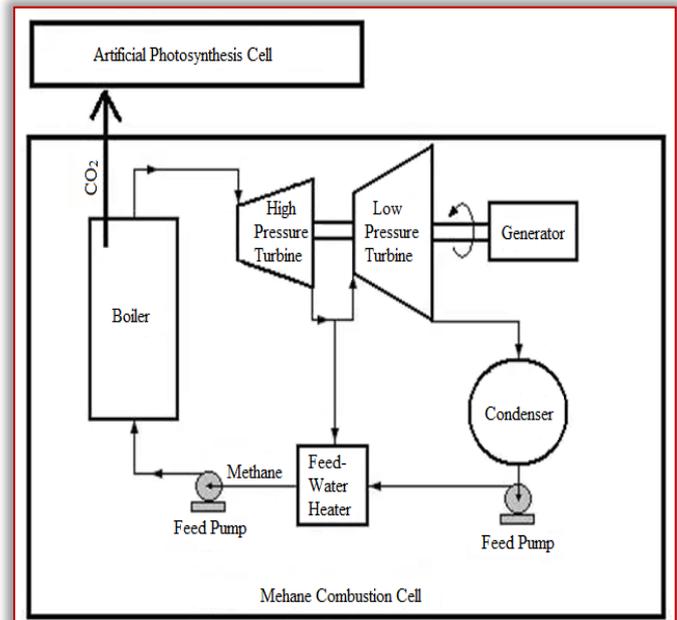


Figure 1: Capture of Carbon dioxide from a typical thermal power plant cycle.

—Artificial Photosynthesis:

In this step, the captured Carbon dioxide from Methane combustion is split into Carbon monoxide and Oxygen. Simple changes are needed to be made to capture this Carbon dioxide from the discharge manifold (Shimizu, 1999). The aim of this step is to produce Carbon monoxide that can be used in the following step which increases energy output. Also, a small amount of the produced Oxygen from this step is sent to the fuel cell and the rest is released in the air. So, this step shall help to increase the amount of oxygen ratio in air.

Artificial Photosynthesis can be done through various mechanisms. But, in this paper it is demonstrated through energy storage reaction (Chen, 2012).

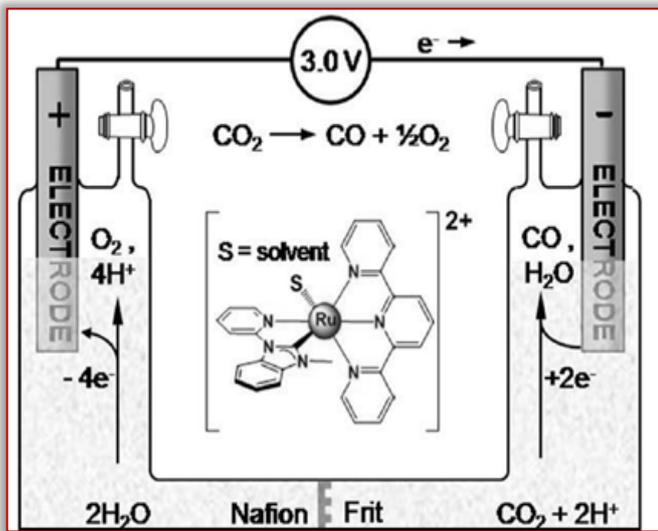
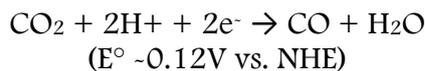
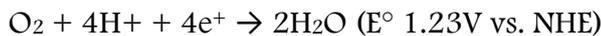


Figure 2: Two compartment cell for Artificial Photosynthesis

This energy storage reaction is split into the following half reactions:



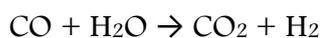
The final reaction stands,



The process is designed using a two compartment electrochemical cell which is reactive electro-catalyst for water oxidation to Oxygen and Carbon dioxide reduction to Carbon monoxide

— Hydrogen Production:

Hydrogen is required to run the fuel cell in step 4 and Sabatier reaction in step 5. Though Hydrogen can be extracted naturally, but it is not in large enough quantities to be produced economically. Therefore it needs to be separated from other elements. Methods of Hydrogen production includes electrolysis, thermolysis and steam refining from hydrocarbon. Due to the fact that natural gas is cheap and easily available, the steam refining from hydrocarbon method is most widely used. The chemical process for Hydrogen Production is an exothermic, lower-temperature, water gas shift reaction: (performed at about 360°C)



This is called the Water-Gas Shift Reaction which is the second step of steam refining from hydrocarbon method. Here, Hydrogen is produced and Carbon monoxide is eliminated by passing it through a catalytic reactor, called shift reactor. Where carbon monoxide reacts with steam and forms carbon dioxide and hydrogen. As this step is exothermic, according to

Le Chatelier's principle the reaction must be done at a low temperature. This reaction is conducted in both high temperature shift and then low temperature shift to get maximum output. The H₂O to CO₂ ratio should be as high as possible to avoid any side reaction (Braga, 2017).

— Fuel Cell:

A fuel cell is a device that generates electricity by a chemical reaction. This is an important step of the model. Because it supplies not only renewable source of electricity, but also heat energy that can be used in other purposes (Michael, 2008).

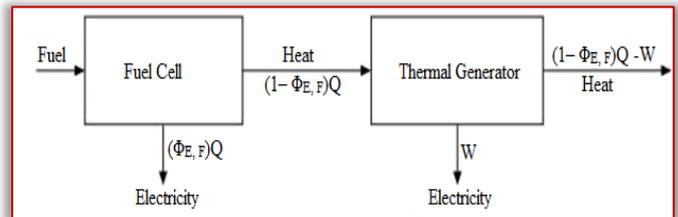


Figure 3: Energy production from a fuel cell

There are many types of fuel cells and any of them can be implemented in the model. Alkaline fuel cell is preferable for its high efficiency, fast start and simple design.

Here, hydrogen is sent to the anode where a catalyst splits hydrogen's negatively charged electrons from positively charged protons (H⁺). At the cathode, protons combine with oxygen resulting in water.

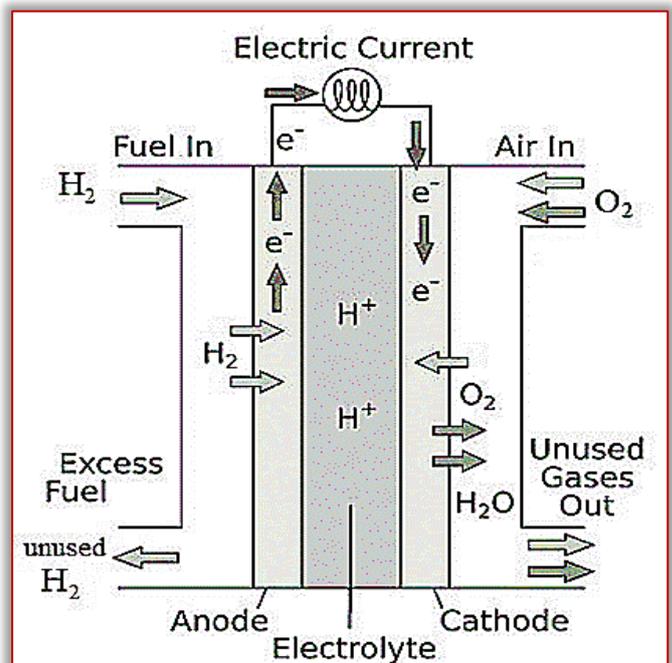
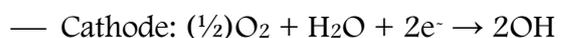


Figure 4: Principle of a Fuel Cell. (Source: Dept. of Energy)

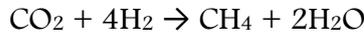
This chemical reactions occur in an alkaline fuel cell:



Hence, electricity is produced due to the flow of electrons.

— **Sabatier Reaction:**

It involves the reaction of hydrogen with carbon dioxide at elevated temperatures (optimally 300-400 °C) and pressures in the presence of a nickel catalyst to produce methane and water. It is described by the following exothermic reaction:



Optionally, ruthenium or alumina (aluminum oxide) makes a more efficient catalyst (Brooks, 2007).

To avoid the energy crisis in near future, we must employ sustainable systems. This step reproduces methane which can be re-used hence, it contributes to a more efficient usage of non-renewable energy.

SUMMARY OF THE MODEL

At first, the Carbon dioxide and steam produced from the combustion of methane will be captured. Then it will be sent to the Artificial Photosynthesis compartment and split into Carbon monoxide and Oxygen. This Carbon monoxide will be sent to Hydrogen Production compartment where reaction with steam (from Methane Combustion) will take place. Then the produced Hydrogen from Hydrogen Production compartment will be sent to both the Fuel Cell compartment and Sabatier Reaction compartment. In this case, only 25% of Hydrogen will be sent to Fuel Cell and the rest to Sabatier Reaction compartment. This will balance for maximum conversion of Carbon dioxide in Sabatier Reaction, energy production in Fuel Cell and release of oxygen from the system. Since Hydrogen is more efficient for producing energy compared to Methane, the distribution of Hydrogen must be optimal.

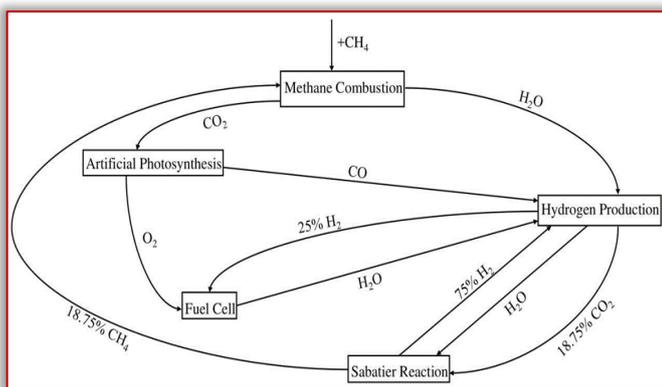
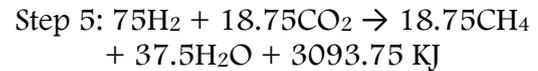
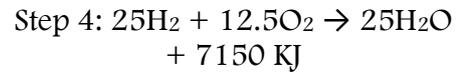
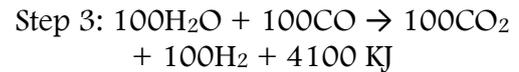
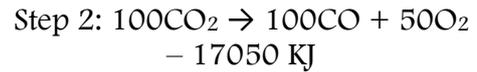
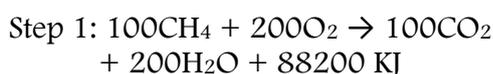


Fig. 5: Flow diagram of the proposed power plant model

The basic principle of the model can be represented by these 5 steps of chemical reactions: (100 moles of Methane is considered to demonstrate the product distributions.)



This model releases 75% of the produced oxygen to air and re-uses 18.75% carbon dioxide for the next cycle. So, every next cycle produces more energy, hence more Oxygen and less Carbon dioxide is released to the environment compared to the conventional power plants. Thus increases the oxygen to Carbon dioxide ratio of the environment and eradicates global warming.

VIABILITY & SIGNIFICANCE

Net energy production from this model was determined by adding the produced energy values of each step given in Process Summary.

So, the net energy of the model: 85493.75 KJ.

Which is 97% of the conventional process (Methane Combustion: 88200 KJ).

Hence, the energy loss of the model is only 3%.

A field assessment was conducted on Ashuganj Power Station Company Ltd. in Bangladesh. System losses were neglected for the ease of calculation.

For the maximum capacity of 146 MW of the Power plant, it was determined that 11.7 X 10⁹ liters of Carbon dioxide is released to the air per year. For 18.75% conversion of this Carbon dioxide by Sabatier reaction at step 5, this emission was reduced by 2.19 X 10⁹ Liters.

Which means emission reduction of 15000000 liters/MW in a year.

As suggested by Osama T Akoubeh in a model, methane could be simply re-produced using Sabatier reaction (Akoubeh, 2015). In that case, the Carbon dioxide collected from Methane combustion will be directly sent for Sabatier reaction. Which means, a model where only the step 1 and 5 is applied. But in that case, the system produces zero net energy. So, the model fails to provide any means of benefit. Additionally, this model is unique for the future energy demand, sustainability. Hence, reduction of carbon dioxide emission can be enacted through the model proposed in this paper with a minimal energy loss (3%).

CONCLUSIONS

The proposed model releases 18.75% less Carbon dioxide in air compared to the conventional power plant system. This is possible due to Sabatier Reaction (Step 5) where this Carbon dioxide is converted to

Methane (CH₄). In this model, 4 out of the 5 steps are exothermic. And renewable energy is used in Fuel Cell (step 4). Due to higher heating value (BTU/lb) hydrogen is more efficient fuel compared to methane. So, Fuel Cell provides efficient and clean energy. On the other hand, reproduced methane can be used that yields sustainability. So, this model can help to improve the future energy scenario.

Energy produced in the model, such as from Fuel Cell can be used to run the power plant itself. On the other hand, this model offers the most economical solution for environment pollution without any kind of extra processing, carbon sequestration storage (CSS), or transportation.

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ENVIRONMENTAL NOISE POLLUTION IN THE UNESCO CITY OF OHRID

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Abstract: In this paper a research is made by analyzing the noise level variations in the area of city Ohrid. City of Ohrid is one of the 28 sites that are part of UNESCO’s World Heritage of Cultural and Natural treasures and it is also the largest city on Lake Ohrid, making it a vast tourist attraction. One of the main complaints by the tourists during the tourist season is the level of noise that is produced by several sources. For better understanding and analyzing the noise pollution in the environment, two kinds of research are made. First research is made by public survey and the second one is made by measurement of the level of noise produced in specific locations that are most frequent with visitors. A set of measures are made for reducing the noise pollution, making better environment and improving locals and tourist accommodation.

Keywords: environment, noise pollution, Ohrid

INTRODUCTION

The Municipality of Ohrid is located in the southwestern part of the Republic of North Macedonia. Ohrid is also the name of the city where the municipal seat is found. Ohrid is a small resort city on the hilly shores of Ohrid Lake in the southwest of the Republic of Macedonia (Fig.1). In the city’s compact old town, medieval churches, monasteries and open-air ruins stand alongside traditional houses with red-tiled roofs. The massive walls of the centuries-old Samoil’s Fortress, at the top of the hill, dominate the city skyline (Fig.2).



Figure 1. Location of Ohrid in south-west region of Republic of North Macedonia

Ohrid region which includes Ohrid Lake and the mountain Galichica, allow Republic of North Macedonia to be among the few countries with rich diversity of habitats for wildlife. In 1958, due to the characteristic location, extremely rich flora and fauna and exceptional natural beauty and landscape values, Galichica Mountain was declared as a National park “Galichica” with 25,000ha protected area. On the other hand, in 1979 the Ohrid Lake was declared under UNESCO protection. With its unique flora and fauna, the lake is one of the largest biological reserves in Europe. The Ohrid Lake is one of the deepest and the oldest in Europe, preserving a unique aquatic ecosystem with more than 200 endemic species. The

lake fish fauna include 17 native species, of which 10 are endemic (two of which belongs to Salmonide family). Ten from the fish species have a commercial value. But also a lot of snails (85%), worms, and sponges are endemic species. Littoral zone is characterized by considerable communities of the plant and animal species. The red belts at this part of the lake have a big ecological importance as biotopes for a lot of other organisms, places for fish reproduction, and bird nesting place. Related to bird nesting over 60,000 birds have been observed in the Lake.

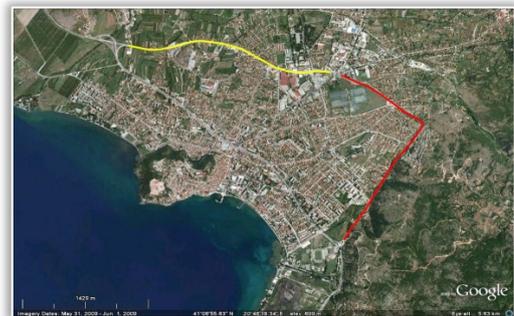


Figure 2. Map of Ohrid city

Environmental noise is a severe problem in urban cities similar as Ohrid. Noise pollution and its consequent influence over the environment and life quality of human beings may be considered a “hot topic” in scientific research. Many noise surveys treating the problem of noise pollution in many cities throughout the world have been conducted (Curitiba, Brazil [1], São Paulo [1], Rio de Janeiro [2], Belo Horizonte [3] and Porto Alegre [4,5]). Sounds are part of our everyday life and they are often unwanted or harmful in outdoors environment created by human activities. Environmental noise affects primarily the quality of life, disruption of the normal rhythm of work and rest. It causes both physical and psychological problems among population by disturbing the basic activities of man such as sleeping,

rest, study, communication, and it reflects especially on hearing impediment. Noise is constantly growing and it is especially difficult to control in densely populated agglomerations and residential areas near airports, railways and highways [4-8].

MATERIAL AND METHODS

— Research methodology

Some researches [6] use methods that develop SILENCE Work package H.2 for monitoring roadside noise and identifying noisy vehicles, and [8] take the measurements that are carried out according the ISO 1996-2 standards, other are made [7] by analyzing the sound level data collected from different points and vulnerable institutions, which were selected according to the importance and vulnerability.

For the purpose of defining the future policy for environmental noise as one of the main environmental problems in the Republic of North Macedonia, noise management is regulated in the provisions of the Law on Protection against Environmental Noise [11]. This Law has transposed the basic Directive on environmental noise - 2002/49/EC (12), by which the main recommendations of the European Union have been fulfilled and full management of environmental noise has been enabled. The Law provisions specify:

- Methods of assessment by noise indicators;
- Methods of assessment for harmful effects;
- Adoption and implementation of planning documents, as well as
- Undertaking of measures for protection against environmental noise.

Based on the Law on Protection against Environmental Noise, the Ministry of Environment and Physical Planning, in cooperation with the competent ministries has so far adopted several bylaws in order to enable full implementation of the Law on Protection against Environmental Noise. These bylaws regulate detail inspection supervision, environmental indicators and their application, noise monitoring, adoption and implementation of planning documents and conditions and technical measures for protection against environmental noise caused by specific sources.

The Law stipulates the main carriers of the obligation for environmental noise management, these being [27-30]:

- Bodies of the state administration;
- Municipalities (in our case study, Ohrid Municipality), City of Skopje and municipalities in the City of Skopje;
- Legal and natural persons.

Control and reduction of environmental noise has two main goals, first to protect us from noise that annoys us or disturbs everyday activities and second, to protect us in future from increased noise levels that

will further deteriorate the quality of the environment, like in [1-4,6-8].

Measurement and monitoring of noise in the Republic of Macedonia is not a continuous process. One of the basic measures for achievement of high level of noise control and reduction is to establish noise monitoring, which is systematized measurement, monitoring and control of the state of environmental noise. For the above reasons exactly, it is necessary to establish state and environmental local noise monitoring networks, especially for agglomerations, main roads, main railways and airports as specified in the Decree for agglomerations, main roads, main railways and airports for which strategic noise maps should be prepared. Collected, verified and processed data and information on the state of environmental noise make the official database of the state of noise in the environment, serving as basis for noise management and protection against noise.

For the purpose of avoiding, preventing or reducing harmful effects on human health and environment, limit values for noise levels are specified to limit the levels of all sources of noise, including time period, position of the source and types of areas where noise is generated.

According to the extent of protection, limit values for the basic noise indicators L_d and L_e range from 50 dB (A) for areas of first extent, to 70 dB (A) for areas of fourth extent, while for the basic indicator L_n they range from 40 dB (A) for areas of first extent, to 60 dB (A) for areas of fourth extent.

According to the type of premises when measured inside the premises, limit values for the basic noise indicators L_d , L_e and L_n range from 30 dB(A) to 55 dB(A). Limit values for noise levels in areas outside urbanized locations, depending on the area, for the basic noise indicators L_d , L_e and L_n range from 35 dB(A) to 70 dB(A).

RESULTS AND DISCUSSION

On (Fig.3) are presented the hot-spots in the central city area that is protected by the UNESCO as a cultural and natural treasure, where largest noise generators are located such as the crowded restaurants and bars with frequent tourist visitations.



Figure 3. Hot-spots for noise measurement in Ohrid City

Identified noise sources [6] in the municipality of Ohrid mainly originate from:

- local noise,
- traffic noise,
- noise from industrial plants and factories and est.

Local noise-originate from the restaurants, cafe bars, night bars, open party events.

The level of noise is highest in the old city core such as the area of the Old City, City Square, Ohrid Bazaar and Ohrid Lake Port and Lake Shore where the intensity of tourist is in a large number. This level of noise is also present on the beaches through the day.

Traffic noise- [6] Problems that originate from traffic occurs as a result of:

- Increase of vehicle frequency during the rush hours especially during tourist season
- Lack of parking places in private and municipality sector
- Power engines and sirens from vehicles and motor boats
- Airplanes noise from taking off and landing
- Loud music originating from powerful sound systems in cars and boats
- Lack of bicycle paths and standards for their usage as a transport method
- Lack of public transportation

Noise from industrial plants and factories-originate from everyday activities from the local industrial plants and the ones in the industrial area in Ohrid municipality.

For complete analyses of the noise distribution, several measurements are made in the locations presented on the map. Measurements are made in several time intervals during morning hours (lowest frequency of people movement), afternoon hours (high frequency of people movement) and in the night hours (highest frequency of people movement).

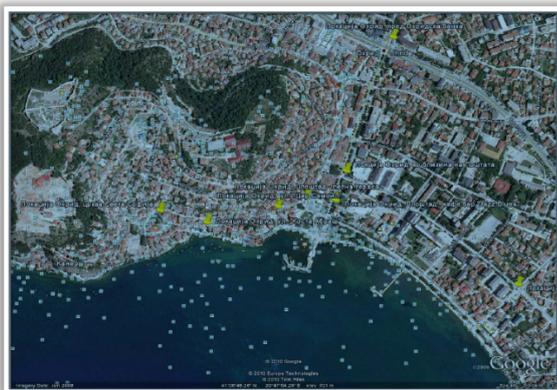


Figure 4. Points for noise measurement in Ohrid City

The first noise measurement was made in the period between 30-th of April and the 1-st of May 2010, a period in which the number of tourists was increased as a result of the holidays. Measurements were made

in the defined points (Fig.4) in different periods of the day.

Second noise measurement was made in the period between 22-nd and 24-th of July 2010 on the same defined points (Fig.4). This set of measurements was upgraded with additional points of noise measurements as a result of the alarming noise pollution that was registered at the measuring points. This period is also known as starting point of the tourist season.

From the obtained results from all of the measuring points the conclusion is that in all of the time intervals day or night, values are over the maximum limit of noise set by the Law on Protection against Environmental Noise.

The maximal values that are over the limits are measured during the night hours. The extreme values of noise are registered in the measure points set on the street Car Samoil, Kosta Abrash and the city square where values reach up to $Leq=81.9-89.9$ dB(A).

These streets are full of cafe bars, night bars equipped with powerful sound speakers producing loud music. In the night hours are registered noise from young people conversations, singing and laughter etc. All of these factors contribute to stepping over the appropriate limit of noise production.

In a comparison of the results with the one obtained from the period of 30-th of April – 1-st of May 2015 the same specified locations have values that are over the noise limits in the night hours that are up to $Leq=75$ dB(A) on street Car Samoil, $Leq=68.1$ dB(A) at measuring point Leskoec, $Leq=66.9$ dB(A) measuring point bul. Turisticka-Jane Sandanski, $Leq=68.1$ dB(A) measuring point near Ohridska Banka etc.

From the field inspection of the given locations the results are leading toward conclusion that the main reasons for noise pollution are:

- not abiding the laws and its requirements
- inappropriate working regulations
- lack of behavior from the locals and tourists
- distance and space planning in the Old City area
- inappropriate sound isolation in the local coffee bars and restaurants
- high vehicle frequency, lack of parking places
- driving with high speed etc.

CONCLUSION

The Seventh Environmental Action Programme (7EAP) “living well in the boundaries of our Planet”, has an objective to provide, by 2020, significantly reduced air pollution in EU and approach to the levels recommended by WHO. It also recommends that this will require implementation of updated policies for noise harmonization with the latest knowledge and measures for reduction of noise and its sources, including improvements in urban planning. In short-term, the European Commission will undertake

review of the Directive on environmental noise in the course of 2014, which might result in proposal to amend Directive and strengthen its implementation. In order to achieve the objective of the 7EAP and enable prevention and reduction of noise which causes harmful effects on human health and reduce the number of people exposed to harmful noise levels, the following recommendations should be followed:

- Adoption of all bylaws deriving from the provisions of the Law on Protection against Environmental Noise;
- Provision of maximum implementation of the provisions of the existing legislation in the area of environmental noise;
- The process of preparation of spatial and urban plans and acts for their implementation, in the frames of the content on protection, should include protection measures against noise as well;
- Planning documents for structures that are subject of building approval should fulfill specific conditions and measures concerning standards for protection against noise in buildings;
- Preservation of quiet zones in agglomerations as such;
- Provision of modernization of installations by remediation of existing and introduction of new solutions for noise reduction;
- It is recommended that the Ministry of Environment and Physical Planning and agglomerations obliged to prepare strategic maps to commence the process of preparation in the course of 2014;
- It is recommended that the Ministry of Environment and Physical Planning forms a working group composed of professional representatives of the relevant institutions to work on determination of national method for noise mapping;
- It is necessary to establish noise monitoring as systematized noise measurement, monitoring and control of the state of noise in environmental media and areas;
- It is recommended that the Ministry of Environment and Physical Planning in cooperation with the Ministry of Health, prepares the Annual programme for work of the state noise monitoring network and the Programme for public health in the segment of protection against noise;
- It is necessary to establish Information system of the state of environmental noise as part of the overall environmental information system in the Republic of North Macedonia to cover data obtained from noise monitoring, strategic maps and action plans for noise and other relevant data obtained by individual noise measurements; and

— Based on processed data on environmental noise in the three cities in the Republic of North Macedonia, undertake measures for reduction of environmental noise in them.

Note: This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty “Mihajlo Pupin” Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 03–04 October, 2019.

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THE ROLE OF REENGINEERING AND TQM IN IMPROVING THE QUALITY OF BUSINESS IN ORGANIZATIONS

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Abstract: This paper presents the role of the application of reengineering and TQM to improve the efficiency of the company's business. In a situation when we have more competition, where there are many organizations today it is needed request for constant development and innovation. One of the possibilities presented in the paper is used. Reengineering represents a complex operation in which everything, except the final objective, is changing. Total Quality Management (TQM) is presented as the continuous satisfaction of customer needs, wants and requirements. Quality was and still is the key aspect in the process of increasing value for the final user. It is believed that reengineering and TQM represent excellent operational and functional brilliance for companies. But with these two concepts there are certain differences.

Keywords: Reengineering, TQM, Business, Quality

INTRODUCTION

In today's conditions, when many companies are facing market loss, i.e. lack of customer confidence, there is a decline in company profits and job losses. In this case, some of the companies to implement reengineering must fundamentally implement a complete reorganization within their company in order to survive at the market. Applying the concept of reengineering is a very complex process where people need to have a good manager with authority and knowledge of the job he is doing. This concept requires great renunciation and great effort for the manager who puts it into action.

The reengineering concept is a radical approach to restructuring all business activities and processes within the company in order to innovate new business activities and increase profits by increasing competitiveness and constantly improving the quality of the company's business. Reengineering does not represent a modification of the current business but it starts from the beginning and searches for better ways of business performance, different from the previous one [19].

Total quality management (TQM) is a management approach through which a company can achieve long-term goals. These goals are customer satisfaction, and improved competitiveness on the market [8]. The seven dimensions of TQM are leadership management; employee relationships; reporting, and data quality; training, and skill development of employees; supplier quality management; product, and service design; and process management [16]. The base philosophy of this concept is the utilization in companies regardless of

their size, and industry. TQM tools and techniques can improve knowledge gathering from the internal and external environment of the organization [15]. Quality management in the organization plays an important role in the realization of the basic principles of long-term and sustainable development of society [17].

REENGINEERING

— The concept of reengineering

The concept of reengineering is one of the most radical processes of managing a company. There are many misconceptions about the essence of reengineering. Many times organizations carry out a major reorganization and call it reengineering. Some other organizations reduce staff, and they call it reengineering. And some others just run an efficiency program, different from the usual ones, and turn it into reengineering [6].

In modern business conditions, changes have become constant and faster organizations are forced to make much more effort to adequately follow them. Businesses need to accept the basic principles of entrepreneurial management based on the following factors: the acceptance of change, innovation and knowledge creation as the main economic resource [7]. The needs of the concept of reengineering today present us with new challenges, which require that the problem within the organization be solved in a new and more efficient way. That is why the need for reengineering just today and now.

The concept of reengineering is related to the name of Michael Hamer, who first used the term in the early 1990s. Reengineering was created in response to the Japanese concept of quality management and

represents a pragmatic approach to change in line with the American way of thinking. According to Hamer, reengineering is the fundamental design and radical redesign of business processes to achieve dramatic improvements in performance [1]. New times are challenging for us, seeking to address the problem of the organization in a new way. Hence the need for reengineering just today and now. There are numerous reasons for the need to implement business process reengineering [18].

Reengineering does not represent a modification of the current business but it starts from the beginning and searches for better ways of business performance, different from the previous one [19]. Business processes to date are largely outdated and ineligible because they cannot meet customer expectations as well as company requirements. The concept of reengineering represents a different and completely new form of business process, a new quality of business. In addition to productivity growth, it aims to include a healthy and new workplace, new knowledge and full collaboration of employees at all levels in the organization, problem identification, acceptance of any suggestions and criticisms, teamwork and work discipline of all employees of the company. Reengineering began with the idea that all changes in the environment should be overcome [4]. Changes are caused by the application of new science and technology, the rapid aging of organizations and their business processes [11].

Businesses can achieve radical performance improvements if they use business process reengineering, in other words, if they manage to break the old rules of business and organization [11]. The concept of reengineering is a very difficult and risky business process, but it is still accepted as the best option for companies wishing to take a new path of business, reengineering as such process brings with it new changes, attitudes, ideas, modern technology and new organization of work.

For US and European companies, applying the concept of reengineering is acceptable if the companies:

1. Have problems,
2. they still have no problems, but I can predict, and
3. they are doing well, but they want to move forward [5].

Determined that 50-70% of reengineering business processes did not give the expected results. In the same time, they found out that there was some progress in certain segments: 20% of cost reduction, 50% of time process reduction and 25% of quality rise [21], [19].

There are two types of approach in reengineering:

- Gradual – it is characterized by a small risk, easy management, less turbulence in short time intervals, and

- Radical – based on the idea that when permanent changes or individual corrections do not give results, the only way to change the status is to be exposed to radical changes and the implementation of fresh, new solutions [19].

Radical changes can be achieved by changing organizational performances, such as: price, production time, service, quality, application of different tools and techniques in the realization of certain business activities. Reengineering is a process that contributes to transformation in enterprise's business but the main reason for failure is caused by a tendency to change all processes at once and in the same time [19].

It is wrong to reengineering as a change that applies only to for-profit business. Reengineering does not focus solely on profit or loss in the balance sheets, commodity prices, or value adding in the processes of modern capitalism or globalization. He is engaged in work and is relevant for any organization in which to perform any job, big or small, manufacturing or service, profit or nonprofit, private or public sector [2].

Targeted business in modern business does not always produce the best results. Hammer believes that businesses need to organize their business around processes rather than functions, and that modern Western companies resemble silos - organized vertically, by functions that represent only parts of the process [1]. There are four key words in reengineering: Fundamental, Radical, Dramatic, and Process.

— Phases of business process reengineering

The three basic processes of reengineering are entities, objects and activities. Reengineering must be applied to all entities (interorganizational processes, interfunctional processes, and interpersonal processes), facilities (equipment, materials, information) and activities (executive, operational) in the business process [8].

Business process reengineering is a multisector business, which seeks an innovative approach to the problem in an organization. It is implemented through radical changes and through all the functions of the company and involves conceptualizing the project, creating a new business and integrating a new process in the organization. [8]

Generally speaking, the circle of business improvement should start from exploring customer needs and analyzing competition, and possibly the bottleneck of the business process. It is necessary to determine the goals and mission for the company and to begin modifying, or completely replacing the process, it must be constantly monitored and evaluated from the population of results, above all production characteristics. Reengineering finally completes the process by re-exploring the needs and

demands of the market. The reengineering process consists of six stages:

- Predicting change processes,
- Presentation of the reengineering project,
- Diagnosis
- Redesign,
- Reconstruction,
- Process evaluation [13].

The objective of reengineering is related to satisfying customers' needs and in this particular case the attention should be paid on the following:

- It is necessary to work fast. Reengineering will not be successful if the process is slow because it should be carried out until the resistance in the organization appears,
- Risk is unavoidable. There is no progress without risks. The unknown is always frustrating but the greatest risk comes from unchanged state,
- Imperfection must exist. Mistakes cannot be avoided whenever something new and unknown is done. Mistakes are necessary for learning, and
- Activities mustn't be stopped suddenly. A great number of enterprises stop reengineering process as soon as the results are visible. It is bad because the final objective is important and the process must not be stopped when the first problems appear [19].

The importance of reengineering lies in changing the rules of behavior in the organization so far, rather than on better or more consistent application of existing ones. Instead of custom procedures, reengineering seeks to design and incorporate completely new, inventive solutions that require a different approach and fully capture key processes within the enterprise [20].

TOTAL QUALITY MANAGEMENT

— Concept TQM

Modern society requires responsibility and contribution. According to Draker, a knowledge-based organization requires that I take responsibility for the organization's given accomplishments for its contribution and its behavior [8]. All employees belonging to the work organization must fully consider and reflect on the further goal of making and contributing. There are four factors that require public intervention and regulation [10]:

- Protecting the planet,
- Protecting the most vulnerable in the economy,
- Consumer protection,
- The (market economy) system itself has tendencies that destructively affect its functioning.

The essence of the concept of responsibility lies in the following [8]:

- Each individual must be held accountable for their actions,
- Every individual should become a “contributing individual”,
- Action is taken on the basis of an analysis of the factors that prevail in the case.

Total quality management is a concept that completely took shape in the 1980s. as such the concept represents the Japanese and American strategy for improving the quality of business. Basic development occurs in Japan after the Second World War, in the 1950s came from US experts who, in the form of technical assistance, educated Japanese experts, how to manage the company. A significant development of the concept of quality of the Japanese economy, in addition to Deming's teachings on the proper management of a company, on certain achievements of Schuhart, was to some extent the application of the Kaizen philosophical principle. It's about permanent, systematic and organized improvement of the company's products and services, that is, a continuous improvement of the quality of business [8].

One of the goals of modern business is to achieve business excellence and to achieve world-class products and services. It can be successful only on the basis of continuous continuous improvement of the quality of business organization, which refers to the constant growth of productivity of work and knowledge of each individual in the organization. The concept of TQM is specifically targeted at employees, ie man is the most significant resource of an organization's business. Every employee in the organization should become responsible for their contribution to improving the quality of business. Each employee can be evaluated on the basis of improving labor productivity and knowledge.

The Kyoto Declaration, adopted at the 4th International Productivity Symposium in 1990 in Japan, provides five suggestions for improving productivity [8]:

- Human resources care,
- Collaboration of management with employees,
- Mutual understanding,
- Global cooperation,
- Work for a better future.

The situation today in the field of quality in domestic conditions characterized by elaboration of a standard ISO 9000, and a dominant direction in the certification of a system of quality, whereby the quality of the system, i.e. TQM becomes the primary goal [6]. In the business world, the largest companies in the world insist on the use of a systematic approach in the implementation of the TQM concept, as the only

correct way of ensuring the quality of business. The application of the modern concept of quality, based on the principles and elements of TQM, is an effective and efficient means of achieving the general goals of the organization (economic efficiency, meeting the needs of the entities of the organization and competitiveness in the market), thus ensuring the survival and development of the organization [6]. The EFQM European Foundation for Quality Managements defines TQM in a company for business excellence, based on customer focus, supplier partnerships, and development and employee involvement [14].

Basic similarities between reengineering and TQM are reflected in the process orientation, the initiative for introduction in both cases is given by top management, and in both cases responsibilities and authorities are delegated, as well as the needs for education and training, as well as the application of quality methods and techniques (quality tools) [6]. TQM is based on product and service quality and excludes innovation and process replacement. Quality management is a monotonous cycle with continuous improvement of quality, while reengineering implies radical changes of process [1].

TQM is a solution focused on quality, not wide enough and does not take into account the speed and innovation of the product. Reengineering involves doing business in a rapid and drastic change, introducing new processes rather than upgrading existing ones [4]. Basic differences of TQM and Reengineering concepts follow in Table 1.

Table 1: Comparison of TQM and Reengineering features [8]

	TQM	Reengineering
Trait	Advancement	Innovation
Level changes	Gradual	Radical
Starting point	Starting point	Starting point
Frequency of change	Continuously	Periodically
It takes time	Long	Short
Participation	Bottom up	Top to top
Field of operation	Narrowly, within existing functions	Broadly, through functions
Risk	Moderate	High
Tool	Statistical control	Information Technology

These two concepts are thought to overlap with each other over time over the life cycle of a single process [12]. The best solution for the company is to use both of these concepts, where necessary to insist on the constant improvement of the quality of operations.

It can be concluded that reengineering improves organizational structure, enables rapid and drastic changes, increases quality and reduces costs, reduces process execution time, improves internal and

external relations, eliminates unnecessary activities. Makes for a comfortable work atmosphere and defines broad employee responsibility. Unfortunately, because of big costs at applying BPR and a high percentage of failure, it is recommended to enterprises which do not have great problems in their business to implement TQM system [19,22].

CONCLUSIONS

It can be said that TQM and reengineering are customer oriented. Both concepts seek to improve customer satisfaction, propose and put management in the role of the user, in order to properly understand the advantages, mistakes and disadvantages of what is offered to the user. TQM and BPR concepts are process oriented. Both concepts go towards improving and improving the process, not just the product. These two concepts can be said to have a similar team approach in business.

Companies that opt for one of these techniques will certainly not go wrong. Reengineering is certainly the most radical concept compared to the TQM concept. TQM approaches as a tactical concept, if a company wants slow but secure and stable growth and development, as well as constantly improving processes and products, TQM should be implemented into the company. If a company chooses to implement a reengineering concept, the top management of the company must spend some time thinking and defining processes and how to improve those processes before they undergo radical changes and reengineering business processes.

Lessons learned through the process of defining processes and eliminating redundant operations, then teamwork of employees from various functions, improving employee knowledge, applying the principles of "get it right" as well as many other activities are invaluable to the organization. If the job is not characterized by a permanent monitoring of the market and knowledge of appropriate response that will satisfy discerning customers and it is not possible to develop and improve the company [9].

Note:

This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty "Mihajlo Pupin" Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 03–04 October, 2019.

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