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MONITORING RESULTS ON INDUSTRIAL WASTEWATER POLLUTANTS IN STEEL INDUSTRY

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ABSTRACT: *In the steel manufacturing process where the molten steel is cast, high volumes of water are used to quench and cool the steel. This contact or direct cooling water becomes contaminated with high levels of suspended solids and mill scale along with oil and grease. Being familiar with the sources of pollution, their monitoring and control represent a first step towards reducing the quantity and the toxicity of all emissions, focusing on applying a "cleaner" production in the industry of elaborating and processing metallic materials, too. Monitoring water quality has now become an indispensable tool for assessing trends in pollutant concentration and loads. Taking into consideration the effect of exceeded allowed values of various pollutants in discharged waste water upon the environment and human health, this paper presents their monitoring in a case study from a steel unit.*
KEYWORDS: *monitoring, pollutant, quality, environment, waste water*

INTRODUCTION

The steel industry is classified among the largest users, particularly due to high temperature within manufacturing processes. Starting with cooking and sintering processes, continuing with furnaces and steel plants to steel mills all these departments use large quantities of water [1].

Waste water discharged from a steel unit is the result of summation of many waste water treatment processes for a refinement [2].

Wastewater treatment systems typically include operations: sedimentation to remove suspended solids, physical or chemical treatment. Advanced technologies include microfiltration, nanofiltration, ultrafiltration, reverse osmosis and advanced oxidation [2-6]. Monitoring and control of water is also factor that influences the performance of the water treatment system [3].

All these categories of contaminated water from steel industry need to be treated impurities must be eliminated or reduced to certain values before their discharge into emissary in order for these not to harm the recipient they are discharged into and not endanger its water reuse [4].

These industrial discharge or wastes include pesticides, polychlorinated biphenyls (PCBs), dioxins, poly-aromatic hydrocarbons (PAHs), petrochemicals, phenolic compounds, microorganisms and the various heavy metals, which are a real threat to the environment and public health, because their toxicity and persistence in the environment [5]. The removal of toxic metals such as chromium, cadmium, copper, lead, nickel, mercury and zinc from waste waters became a necessity due to their toxicity and carcinogenicity [6-7].

Industrial effluents are a main source of direct and often continuous input of pollutants into aquatic ecosystems with long-term implications on ecosystem functioning including changes in food availability and an extreme threat to the self-regulating capacity of the biosphere [8-9].

Considerable quantities of suspended and colloidal matter in the discharge reduce the penetration of sunlight. In the water bodies, resulting in reduction of Photosynthetic activity, an essential feature of self purification of polluted water bodies [10]. Suspended and colloidal matter can also smother bottom dwelling aquatic organisms affecting the life of water bodies/streams and may lead to heavy siltation which affects the flow [10-11].

MATERIALS AND METHODS

Research has been directed to understanding the current situation of the amount of pollutants in the industrial water analyzed, based on pH measurements, chemical content of oxygen (CCO), suspension and heavy metals concentration, and using experimental data.

For experimental research it was chosen as research material the wastewater coming from continuous casting process of semi-finished products, and flowing into emissary.

The samples were collected using 500 ml polythene bottles. The bottles were thoroughly cleaned in soap solution first, soaked in 10 % hydrochloric acid (HCl) for 24hrs, and then rinsed with deionised water. All samples were tightly sealed and kept cool using ordinary dry ice in the field and while on transit to the laboratory.

Methods of analysis to determine concentration for each physical and chemical indicator have been applied according to current standards and for each method of determination the value is calculated separately.

PHYSICO-CHEMICAL VARIABLES

Water quality parameters provide important information about the health of a water body. These parameters are used to find out if the quality of water is good enough for drinking water, recreation, *irrigation, and aquatic life. Physico-chemical variables were examined from January to December 2011.*

pH of the water were measured using pH meter. Turbidity was subjectively assessed as high, medium or low.

Figure 1. pH-meter

Total dissolved salts (TDS), were determined by filtering 100 ml of water and then evaporating it gradually in pre-weighed crucibles. The change in weight was used to determine the dissolved salts.

Chemical oxygen demand (COD) was determined by titration method, using ferrous ammonia sulphate and ferroin as indicator.

The concentration of sulphates (SO_4^{2-}) in water samples was determined by using the turbidimetric procedures based on the precipitation of sulphate from the water using a conditioning reagent and barium chloride dihydrate.

The concentrations of the heavy metals and anions in the samples were determined according to standard procedures. The concentrations of the heavy metals were determined by using spectrophotometer DR/2000.

Figure 2. Spectrophotometer DR/2000

RESULTS

To determine the efficiency of wastewater management in continuous casting department and to identify the impact that industrial wastewater can generate upon the degree of contamination of surface water where they are being discharged, and therefore upon the natural emissary, various samples were taken and the following indicators were analyzed: pH, the total suspended solids (TSS), fixed residues, sulphates and heavy metals (Fe, Cd, Cr, Cu, Mn, Ni and Pb). The maximum admissible values of the analyzed parameters, according to NTPA 001/2005 (GD, 2005).

The results for monthly and quarterly monitoring of wastewater physical and chemical parameters when discharged into emissary during 2011-2012 are in figures 3-13 using an Access database.

DISCUSSION

The pH varied between pH 6.93 and 8.02. The highest value was obtained in September while the lowest was obtained in May (Figure 3).

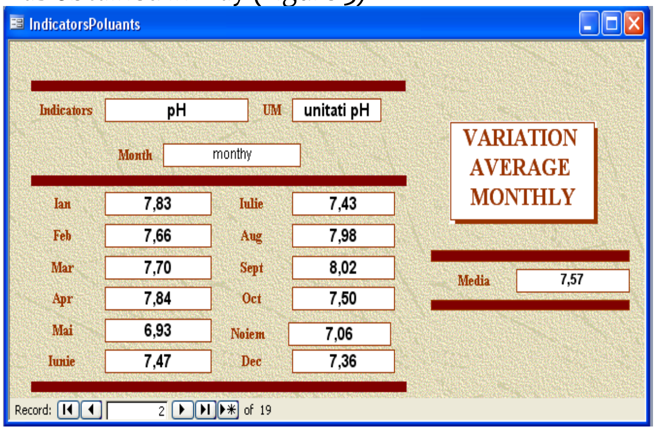

Figure 3. Variation average monthly from pH

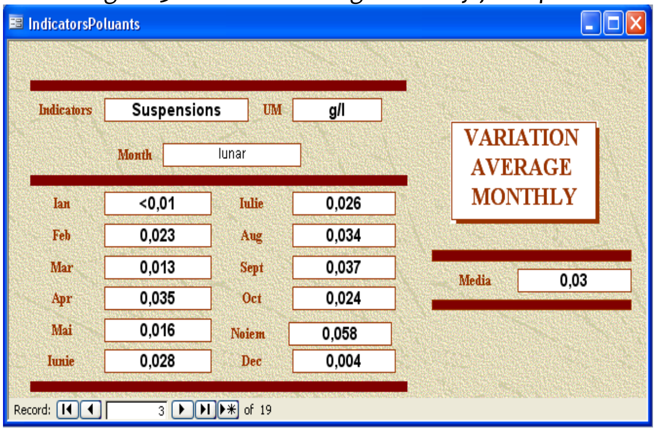

Figure 4. Variation average monthly from suspension

The total suspended solids (TSS) varied between 4 and 58 mg/l (Figure 4). The highest value was obtained in November while the lowest was obtained in December. Comparing with NTPA 001/2005 (GD, 2005), it was observed that the TDS values in effluents were within the permissible limits.

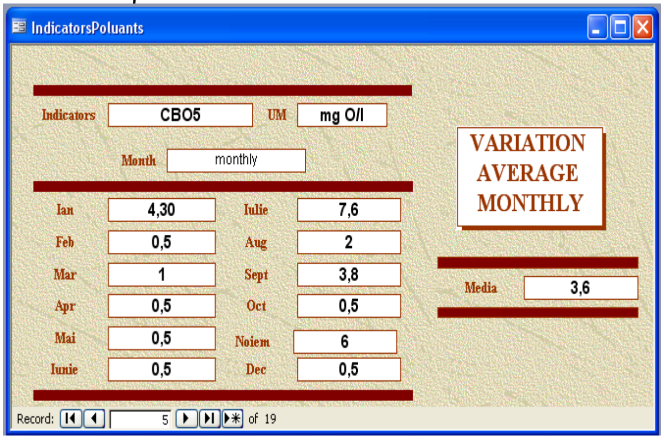

Figure 5. Variation average monthly from CBO5

Biochemical Oxygen Demand, or BOD, is a measure of the quantity of oxygen consumed by microorganisms during the decomposition of organic matter. BOD is the most commonly used parameter for determining the oxygen demand on the receiving water of a municipal or industrial discharge. BOD can also be used to evaluate the efficiency of treatment processes, and is an indirect measure of biodegradable organic compounds in water.

Sulphates: 58.13 mg/l is within the values allowed by law for discharge (600mg/l). The minimum value was measured in spring season and the maximum value was measured in autumn season, (Figure 6).

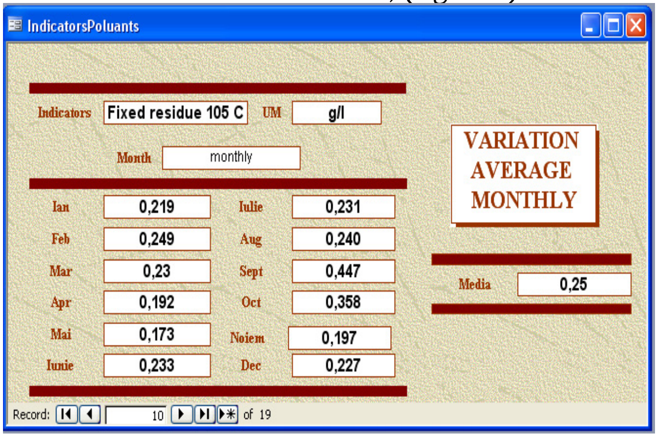

Figure 6. Variation average monthly from fixed residue

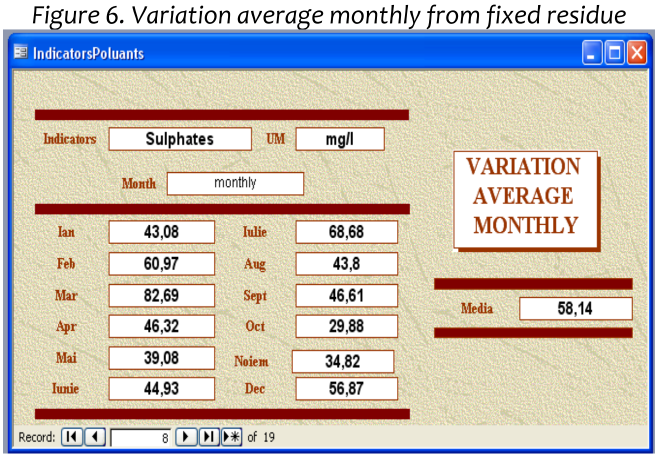

Figure 7. Variation average monthly from sulphates

For heavy metals concentration (Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn) results showed in Figure 8-13 that the levels for all were above the permissible limits compared with standards:

- *Fe : 0.04 mg/l is within the value allowed by law for discharge (5mg/l);*
- *Ni: 0.02 mg/l is within the value allowed by law for discharge (0.5 mg/l);*
- *Mn: 0.12 mg/l is within the value allowed by law for discharge (1 mg/l);*
- *Zn : 0.02 mg/l is within the value allowed by law for discharge (0.5 mg/l);*
- *Cd was not detected.*

These characteristics are dependent on the main activity developed in each sector. If untreated wastewater would be discharged in aquatic environment, some effects could take place, for example:

- *Effect of pH: organisms are very susceptible to acids and bases.*
- *Effect of biological oxygen demand: depletes dissolved oxygen from streams, lakes and oceans; may cause death of aerobic organisms (fish kills etc.); increases anaerobic properties of water*
- *Effect of total suspended solids: increases turbidity (less light-reduced photosynthesis, causes fish's gills to get plugged up); increases silting (reduces lifetime of lakes, changes benthic ecology).*

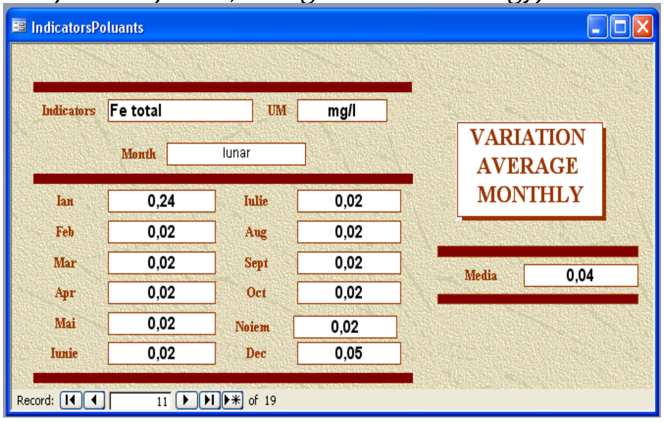

Figure 8. Variation average monthly from Fe

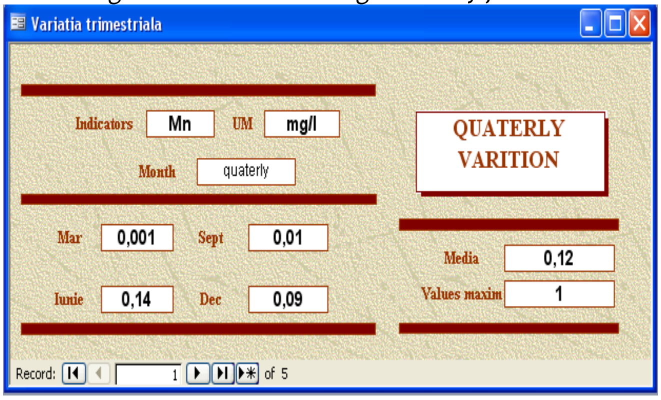

Figure 9. Quarterly variation from Mn

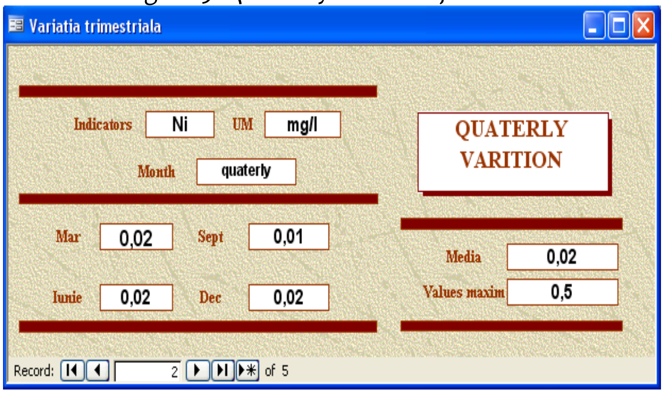

Figure 10. Quarterly variation from Ni

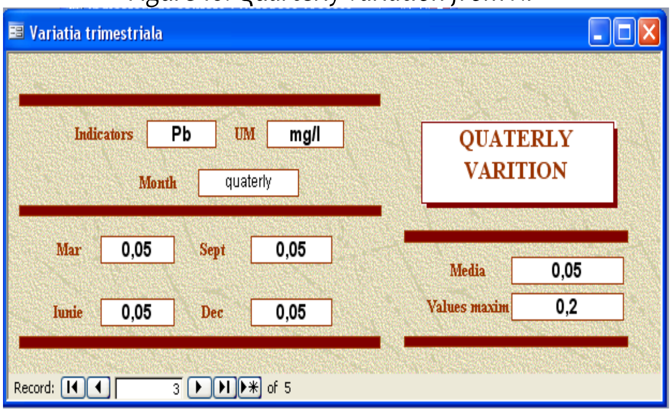

Figure 11. Quarterly variation from Pb

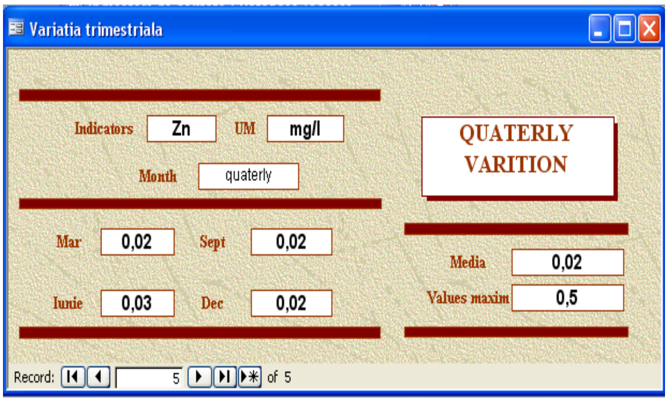

Figure 12. Quarterly variation from Zn

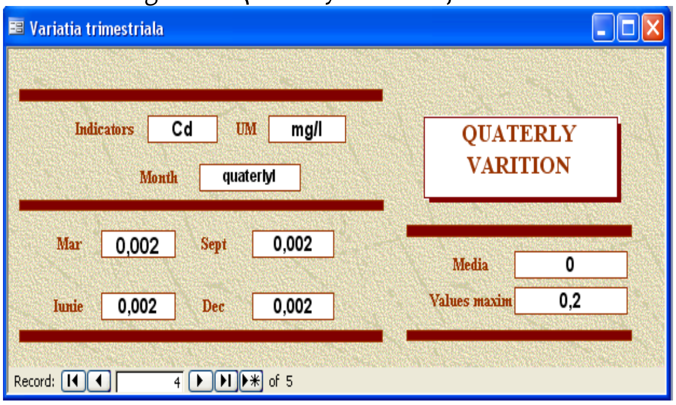

Figure 13. Quarterly variation from Cd

CONCLUSIONS

Taking into consideration the monitoring results in the industrial site, the following can be concluded:

- *The company doest not generate wastewater but water with low pollutant loading;*
- *Chemical analysis of wastewater discharged indicates that this is within the established limitations;*
- *Discharging this wastewater does not alter the quality of emissary;*
- *Wastewater discharges should be monitored daily for the listed parameters, except for metals, which should be monitored at least on a quarterly basis.*

Wastewater treatment systems typically include sedimentation to remove suspended solids, physical or chemical treatment such as pH adjustment to precipitate heavy metals, and filtration. To reduce consumption of chemicals for pH control, attempts should be made to replace dilution water with alkaline process wastewater from other process units.

The first step in a pollution prevention strategy for water is a thorough audit and characterization of wastewater from steel operations. A program of maintenance, inspection, and evaluation of production practices should be established. Significant reductions in water use can be made by implementing the following: minimizing leaks and spills, maintaining production equipment properly, identifying unnecessary washing of equipment, training employees on the importance of water conservation.

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