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EVALUATION SURFACE ROUGHNESS ON PRODUCT FROM STAINLESS STEELS AT CUTTING

Abstract:
Engineering manufacturing is one of the key factors of dynamic development of our industry. Automated production, reducing of manufacturing costs, new advancements in the area of tools development, changes in the design and construction of engines and designing optimum technological procedures result in more dominant status of machining technologies. Present state of machining technology and prospective trends prove machining core position in engineering manufacturing.There is a perpetual task for increasing production efficiency. One of the principal preconditions of achieving it is effective machining process. In order to attain efficiency it is necessary to find optimum formation of chips especially in drilling materials with specific properties.

Keywords:
cutting, surface roughness, cutting tool, product

INTRODUCTION

Optimum process of machining is a precondition of effective employing of optimal working conditions. When deciding on cutting conditions of various materials it is necessary to take into consideration the characteristics of material properties and cutting conditions. Machinability is one of such characteristics. In the current market there is a demand for high quality products of corresponding properties. Only materials with specific physical, chemical, mechanical and other properties can meet the criteria of resistance to various aggressive environment, thermal and heat influence and high mechanical load. The above class of steel is applicable especially in the following industrial branches: constructing of power reactors, energy blocks, crude oil refinery, basic organic production, food technological devices, transport, civil engineering. Technological processing of the steels assigned to the group of materials with low machinability rating, though brings difficulties in machining [1], [2], [5], [6].

CHARACTERISTIC OF MATERIAL

Defined as special steels with good resistance to corrosion under normal or higher temperature. They contain minimum 12% of chromium, sometimes exceeds 30% nickel or 20% manganese and often many others alloy elements, especially molybdenum, copper, titanium, niobium etc. They are called anti-corrosion or acid resistant steels, stainless steels and non-corroding steels. The development of new types of steel with regards to the growing competitiveness on market customers' demand resulted in adjustments of steel classification.

According to more authors current classification is as follows: martensitic steels, ferritic steels, austenitic-ferritic steels, austenitic steel. Chromium is a basic alloy element. Its impact on resistance to corrosion is multiplied by adding other alloy elements like nickel, molybdenum and copper. Some of the steels may contain high portion of manganese. Nickel as one of austenites is of great importance for its electrical-chemical character. Molybdenum increases passive and active corrosion resistance. One of few austenite elements is copper. Impact of copper is in enhancing effect of molybdenum on resistance to corrosion especially in aggressive environment. Manganese is, similarly to nickel austenite element. Combining main alloy elements it is possible to produce corrosion resistant steels with higher index of resistance to corrosion. Dominant residual element in these steels is carbon. It is contained in most of the steels. Generally, it negatively imparts steels properties since chromium is fixed, thus corrosion resistance is reduced. Manganese and silicon can also be classified as residual elements if their content does not exceed 2%. Increased silicone content reduces weldability in this category of steels. Titanium and niobium are also of great importance. Their affinity to carbon results in creating particular carbides. Content of phosphorus and sulfur is determined by particular type of corrosion resistant steel. In some cases increase in sulfur imparts machinability. Alternatively, selenium can be used. Their content is lesser than few hundredths percent. They are elements as: lead, tin, antimony, bismuth and arsenic. For this category of steel oxygen, hydrogen and nitrogen is also important. Trace elements have no larger effects on corrosion resistance and their content in stainless steel composition is rarely entered. Machinability as complex characteristics of a material in the process of machining is determined by the following factors: mechanical, and physical properties, way of working, material's microstructure. These factors affect the intensity of cutting tool wear, cutting temperature, chip formation, cutting forces and surface finish and integrity of workpiece. According to Sifrin and Reznicky (1964), workability depends on mechanical and physical properties, chemical composition, heat treatment and MFTP-technological system. Cutting process is characterized by accompanying features as cutting forces, tool wear, surface finish, vibration and chip formation. Especially the process of tool's cutting edge wear and its interaction to workpiece [3] is of high importance in cutting process analysis. Experiments results point out at the factors that influence cutting tool wear and its durability. The properties of workpiece are reflected in machinability. The term machinability implies qualitative condition of workpiece from the aspect of its ability to yield to the effects of cutting tool [4]. Machinability can also be articulated in volume of material removed in a period of time under efficient cutting conditions, constant section of removed part and arbitrary working conditions. Variable costs of machining from the aspect of machinability depend on cutting speed, technologically allowed of working feed, power consumption and secondary time for tool change and cleaning working place of chips. It is obvious that machinability can not be articulated by one feature only. When discussing properties which determine machina-bility the two aspects must be differentiated – complex and relative machinability. Complex machinability assumes all factors which can be mathematically formulated in relation to tool life, cutting forces etc. Depending on cutting conditions of explored material. This paper present one criterium from complex machinability, surface roughness on the part from stainless steel at drilling.

EVALUATION AND ANALYSIS OF METAL CUTTING OF HARD MATERIALS

Machinability is not generally valid and defined standardized property, [1], [2], [7]. The term machinabi-lity of material implies the set of material's properties from the aspect of its suitability for manufacturing components of by particular way of working. It is meant how easy it is to machine workpiece with applied cutting tools. The term machinability is not explicitly defined due to variability of machining operations and improving cutting tools. It is also not easy to measure machinability on the basis of data comparison. Considerably more accurate, though more demanding is to compile a working table comprising all workpiece material properties that have impact on *machining process. Not all suppliers dispose with detailed data. Metallurgy, chemistry, mechanics, determines material's machinability of workpiece as well as heat treatment, type of alloy element and character of surface finish. Other important factors imparting machinability are quality of cutting edge and holder, machining device and machining conditions. The valuables irrelevant for machinability can even in profound scrutiny serve only as secondary values for further optimization. It is important for user not only to know detailed properties of workpiece material to be machined but also ways and means which enable evaluation of successful machining performance. There often occur superior priorities as costs per a workpiece, productivity of labour, but also calculated durability of tool bit, which secure specific quality of machined surface and efficiency of machining. These are principles for evaluating machinability in particular concepts of machining depending on manufacturing. Machinability can be improved by enhancing quality of cast, by using automatic steel, change of cutting tool material, cutting wedge geometry, clamping method, cutting fluid etc. In wider sense, machinability is functional value of tool / workpiece relation, for which following criteria apply: cutting edge durability, chip formation, surface finish, power of working, cutting force / power consumption, tendency to buckle. The combination of knowledge about material properties and machinability tests provide a solid base for machinability assessment in relation to either specific cases or whole manufacturing. Other factors to be considered are additives for machinability improvement, microstructure, hard abrasive elements, tendency to adhesive bonding etc. Machinability can be classified as "good" if using particular tool type material it is possible to work certain workpiece material. Main material groups in the domain of machining are SANDVIK: 1.Steel, 2.Non-corrosive steel, 3.Cast-iron, 4.Refractory alloys, 5.Non-ferrous metals, 6.Quenched steels, 7.Titanium. Continuous ribbon-like chips are undesirable from the aspect of operating machining device. They entangle around spindle and can be harmful. Their removal is time consuming and hinders operation. They can also damage the tool (chipping of the cutting edge) or any mechanical failure that increases surface roughness. Prior to machining process start, the machinability of workpiece material should be assessed and verified to establish a degree to material's adaptability to optimal cutting conditions. It is necessary to concentrate on substantial properties with respect to used material and the way they impart to machining process. Following diagrams represent changes in four mechanical properties linear to carbon contents: Tensile Strength, Hardness, Flexure Strength, Ductility. Generally, Low index of hardness and strength is useful with the exception of materials forming long chips which, due to a tendency to buckle, result in poorer quality of surface finish. Low ductility index usually have positive impact on chip formation which enables greater efficiency of machining device. The higher hardness the lower ductility and vice-versa. Good machinability is often a resultant of compromise between hardness and ductility. High thermal conductivity means that heat energy created in machining is swiftly abducted from a shear zone. High index is than from the aspect of machinability beneficial.Thermal conductivity can play a key role with respect to machinability. However, in certain group of alloys it is less effective. Worked area is created as a resultant of geometric and kinetic relations of tool and workpiece. In considering the created area it is necessary to take into account the fact that machining represents technological process in which new surface is created by removing parts in the form of chips. Therefore the identification of processes accompanying chip formation is needed. Chip as a result of complex processes of elastic deformation and heating caused by friction with tool face is curling in various ways and deformed in various geometric shapes. Such mechanism is called chip forming. Suitable form of chip is attained through adjustments of cutting wedge. Accuracy and reliability of mechanisms and devices is affected by qualitative aspects of machined surfaces of particular components. Surface finish represents a set of microscopic irregularities measured at given length. Real profile of machined surface is a result not exclusively of geometric copying of tool's cutting tip but also irregularities in cutting edge. Apart from it, the surface finish is conditioned by plastic deformation of friction and chatter and vibration of MFTP technological system. The* *characteristics corresponding to theoretical value Rz is the maximum height of irregularity, defined as a distance between spline and cavity line in the range of basic length. Most widely used characteristic is mean arithmetic aberration of profile Ra. It is mean value of profile aberration within the range of basic length.*

EXPERIMENTAL PART

For experimental verification the austenitic corrosion resistant Cr20Ni10Ti steel was chosen, in table 1.

Tab.1 Chemical composition of Cr20Ni10Ti steel

Additive element (%)						
C	Cr	Ni	Ti	Si	P	S
0.07	20.0	10.0	0.50	1.0	0.045	0.03

The WMF 1000 CNC drilling machine was used for experimental measuring Fig 1.

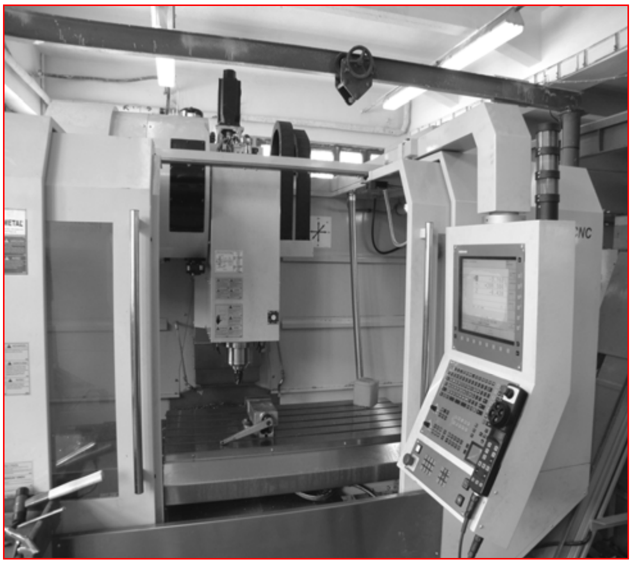

Fig.1 Experimental place WMF 1000 CNC

The following cutting tools were used for experimental tests: twist drills from rapid steel with 10 mm in diameter, by the cutting conditions described in resulting graphs. Experimental measurement underlie because definition and construction graphic depend videlicet: depend surface roughness Ra [μm] about feed f [mm], depend surface roughness Rz [μm] about feed f [mm], depend surface roughnees Ra [μm] about evolution n [min^{-1}], depend surface roughness Rz [μm] about evolution n [min^{-1}].

Fig.2 The cutting tool example for experiments

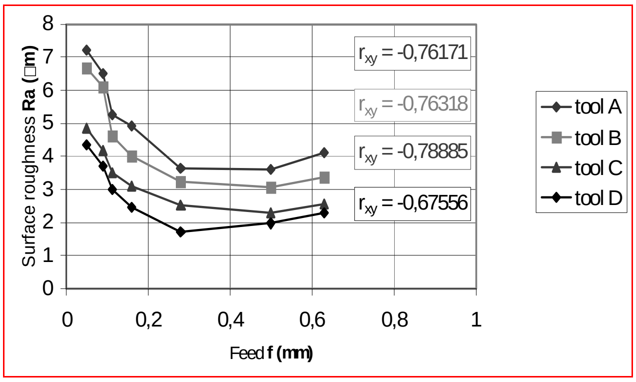

Fig.3 Dependence Ra [μm] - feed f [mm], n=125 min^{-1}

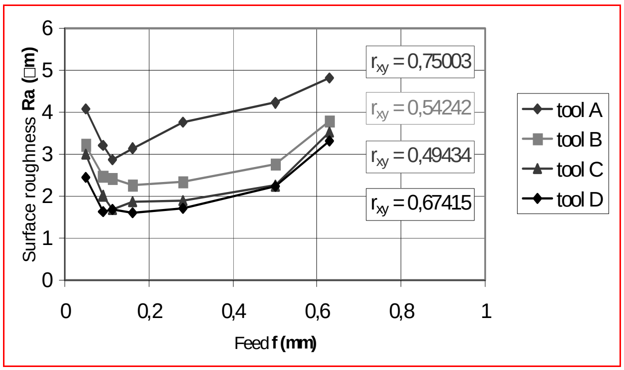

Fig.4 Dependence Ra [μm] - feed f [mm], n=1000 min^{-1}

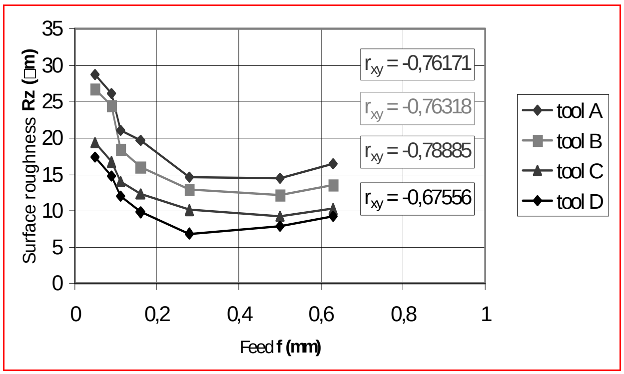

Fig.5 Dependence Rz [μm] - feed f [mm], n=125 min^{-1}

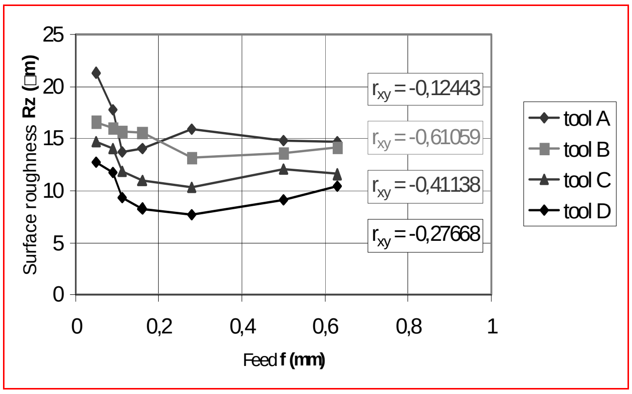

Fig.6 Dependence Rz [µm] - feed f [mm], $n=1000\ min^{-1}$

CONCLUSION

This paper was appreciation machinability of stainless steels about drilling. Know-how is possible applied at general practice, where assistance to superior and machining of stainless steels. Acquest results forth measurements comparatively true allocate cutting conditions about drilling. About accomplishment experimental measurements and comparasion results achieve clear contrast cast up chip at it, that herself bore about a cutting conditions. About analyse wear of cutting edge cant been noticeable contrast against all brand cutting tools. Present contrast herself could negative bounce about formation chip, chip form cast up kindling call accuracy and work security. Best form chip they were achieve using cutting tools businesses. At mechanical general practice these know-how can they capital chiefly about machining of stainless steels. Following these results can they material chemist allocate cutting parameters about those accomplish asked abrasiveness and brand face subduable component. Analyses and adaptation results experimental measurements accredit contrast surface rouhness hours about different cutting parameters. Measure out data they were different because single advice revolution and feeds (depth of cut been constant). Allowing averange arithmetic deviation profile Ra achieve evalues at cycle by 1,41 □m by 7,20 □m, at depend by devices cutting conditions. Account biggest altitude accident Rz have atributes at cycle by 5,64 □m by 28,80 □m, alias at depend by devices cutting parameters. About access tools be needed awake economic costs provision cutting tools. Consist accordingly about decided concrete consumer, what is accommodating back because enhancement brand generating component. In the start account would but she had not decide factor about access tools. The amin assignment have alias additional charges emergent by using certain tools, brand achieve him using, if wear existent tools. The complexity of the wear process may be better appreciated by recognizing that many variables are involved, including the hardness, toughness, ductility, modulus of elasticity, yield strength, fatigue properties, and structure and composition of the mating surface, as well as geometry, contact pressure, temperature, state of stress, stress distribution, coefficient of friction, sliding distance, relative velocity, surface finish, lubricants, contaminants, and ambient atmosphere at the wearing interface. Clearance versus contact-time history of the wearing surfaces may also be an important factor in some cases. Although the wear processes are complex, progress has been made in recent years toward development of quantitative empirical relationships for the various subcategories of wear under specified operating conditions. Adhesive wear is often characterized as the most basic or fundamental subcategory of wear since it occurs to some degree whenever two solid surfaces are in rubbing contact and remains active even when all other modes of wear have been eliminated. The phenomenon of adhesive wear may be best understood by recalling that all real surfaces, no matter how carefully prepared and polished, exhibit a general waviness upon which is superposed a distribution of local protuberances or asperities. As two surfaces are brought into contact, therefore, only a relatively few asperities actually touch, and the real area of contact is only a small fraction of the apparent contact area. even under very small applied loads the local pressures at the contact sites become high enough to exceed the yield strength of one or both surfaces, and local plastic flow ensues. If the contacting surfaces are clean and uncorroded, the very intimate contact generated by this local plastic flow brings the atoms of the two contacting surfaces close enough together to call into play strong adhesive forces. This process is sometimes called cold welding. Then if the surfaces are subjected to relative sliding motion, the cold-welded junctions must be broken. Whether they break at *the original interface characteristics, local geometry, and stress distribution. If the junction is broken away from the original interface, a particle of one surface is transferred to the other surface, marking one event in the adhesive wear process. Later sliding interactions may dislodge the transferred particles as loose wear particles, or they may remain attached. If this adhesive wear process becomes severe and large-scale metal transfer takes place, the phenomenon is called galling. If the galling becomes so severe that two surfaces adhere over a large region so that the actuating forces can no longer produce relative motion between them, the phenomenon is called seizure. Today, the usual parameters are surface texture, accuracy, tool-wear pattern, chip formation and predicted reliable tool-life. the one applied depends upon the type of operation, finishing or roughing, and often the amount of manual control and supervision involved.*

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