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THE EVALUATION OF CUTTING LIFE OF BLANKING TOOLS

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ABSTRACT

The paper presents research of experimental parameters, which influence on the magnitude of burr at blanking. Measuring of the burr on the blanks and influence of number of blanks on the wearing are discussed. Mathematical model of wear characteristics of blanking tool are established.

1. INTRODUCTION

The production technology of blanks for magnetic circuit has the special state at the production of electric rotary machines. With the aim to increase the work productivity, machine productivity and decrease the production cost, the high-speed automatic machines have been used. These machines can reach 400 or more strokes per minute. Therefore it is necessary to select the most suitable technological and design parameters of blanking tools when operate these machines [4], [10].

Good results at the construction and production of shearing (blanking) tools have been reached at our workplace. Using suitable materials, new technologies of production of blanking tools, and optimal technology of heat treatment and good technical state of presses bring very good results. The tool life and performance have been considerably increased.

We can make a statement, that the technical level of blanking tools, which we were used in our conditions at the production of blanks for magnetic circuit, can be compared with the tools, which produce the prominent producers of electric motors in abroad.

2. PARAMETERS INFLUENCED ON WEAR OF BLANKING TOOLS

The wear of cutting parts of tool occurs when cutting. The wear is determined by the mass loss of active parts in the area of cutting edge, which is in determined relation with the number of produced blanks. When we cut the blanks from the same sheet with various tools, the best durability has that tool, on which the smallest wear and the smallest burrs occur at the same number of produced blanks. When we cut the blanks from various sheets with one tool, the best

Shear ability has the sheet, on which the smallest wear of tool occurs and also on which the smallest growth of burr on the blanks have been shown at the same number of produced pieces.

The wear of active parts of cutting tools is depended on physical and metallurgical and technological parameters and service character, too [5].

The physical and metallurgical parameters and their influence on the wear of active parts of tools can be divided into two groups:

1. The physical and metallurgical properties of shearing material, which determined the resistance against the forming and the inclination of material to hardening around the shear area.
2. The physical and metallurgical properties of material, from which are made the active parts of tool namely the hardness, resistance to the cyclic stress, wear resistance and ability to contact with the shear material.

Among the technological parameters which influence the possibility of produce of tool with the balance of shear clearance around the perimeter of blank type and design of tool, durability of press and tool, belong the magnitude of shear clearance and shape complexity of work piece. The insufficient durability causes the rapid tool wear. Here belongs also the speed of blanking, which influences the width of the reinforced area and magnitude of burr.

To the parameters of service character belong the technical state of press and its mechanism, gripping of tool on press and lubrication manner [2].

3. BURR CREATION ON THE BLANKS

Formation of burr is incidental effect of shear and it is not possible to prevent against it. The burr on rotor and stator sheet has negative influence on the properties of electric rotary machines. Owing to burrs, there are the conductive joints on the rotary and stator packs occurred. They increase the iron loss and increases grow of the temperature of electric joints, etc. Therefore, it is necessary to produce the stator and rotor sheets with the smallest burrs; also it is necessary take into account the profitable production.

The latest experimental observation shows that the height of burr cannot overstep 10% of the width of material. Most of well-known producers of electric rotary machines from abroad, give the burr height between 0,05 – 0,08 mm at the width of sheet 0,5 mm. Some of them give more strict or narrow burr height 0,02 – 0,04 mm [11]. The burr magnitude, which occurs on the blanks, depends on magnitude of shear clearance, degree of tool wear, mechanical properties of shear material and on the speed of shearing.

From the obtained measured results follows the dependence of tool wear, burr height “ h” and the number of blanks “ x “,can be expressed by increasing function in range of interval x > 0, such as, (see Fig. 1.)

$$h_j = a + b \,.\, x_j$$

h_j – theoretical burr height
x_j – number of blanks

The coefficient " a" determines the point at the graphic description, in which the line crosses the vertical axis. This is theoretical mean magnitude of burr immediately after tool resharpening.

The coefficient " b" (statute of the regressive line) gives how the measured unit of burr means height changes the dependence of number of shearing, when shearing increase about one unit. This coefficient named as " regress coefficient" gives information about the functional behavior of monitored parameters. Accordingly, the index of correlation was calculated for the expression to indicate the suitability of functionality type [3].

From the sharpness of this curve in can be considered the inclination of determined sheet to creation of burrs. The optimal time for tool sharpening has been determined from the formula [4]:

$$x = f\ (h_{max})$$

Where: h_{max} – maximal allowed burr height
x - number of blanks, when the height h_{max} will be obtained

Accordingly, the selected regress line is suitable type of function for expression the functionality of h_i and z_i , and it was verified by F - test of independence on the level $\alpha = 0{,}05$.

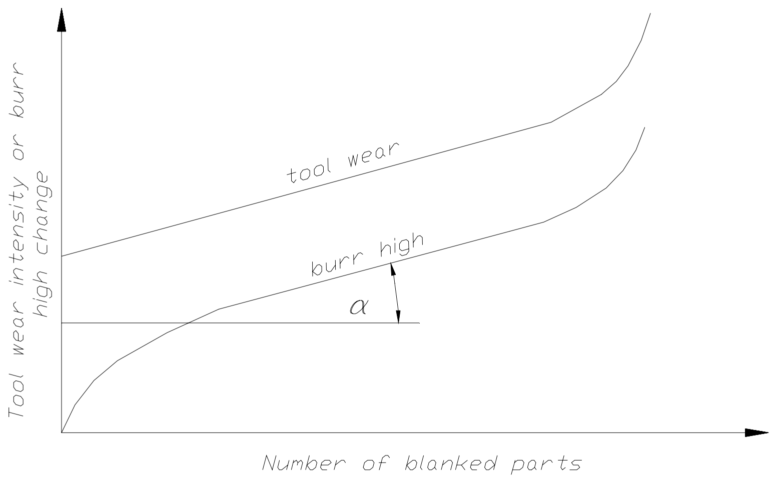

Fig.1 The dependence of the burr height " h " on the number of blanks "x"

4. EXPERIMENTAL RESEARCH OF SHEAR TOOL WEAR

4.1 The aim of experimental research

The aim of experimental research was to determine the criteria of evaluation of cutting edge and to determine the time of limited wear, when it is necessary to sharp the punch and die tools.

4.2 Testing material

The experimental research was realized on two types of sheets:

- Material Ei70,
- Material, marked as 719, width 0,65 mm.

The chemical structure of testing material is shown in the Tab.1. and its mechanical properties are in the Tab.2.

Tab.1 The chemical structure of testing material

Material	C	Mn	Si	P	S	Al	N
Ei70	0,06	0,35	1,60	0,049	0,014	0,168	0,009
719	0,03	0,35	1,10	0,090	0,009	0,155	0,007

Tab.2 The mechanical properties of testing material

Material	Direction of rolling	R_e [MPa]	R_m [MPa]	R_e/R_m	A80 [%]	HV5	HV10	Number of bending
Ei70	II	297,27	434,00	0,684	32,2	156	154	26
	⊥	308,43	453,10	0,679	25,6			16
719	II	248	383	0,648	34,0	130	120	20

4.3 Testing tool

The blanking tool M 6028 was used in the experimental measurements, which served for the production of blanks for rotor and stator packs; from which one-phased asynchronous electric motors DPC 100 for power- drive in washing machines are produced.

4.4 The method of taking in the samples

The samples of blanking were taken in just after sharpening of blanking tool and after each 25 000 pieces of sheared blanks to wear of tool and it was done in three after following series.

5. THE MATHEMATICAL MODEL OF CHARACTERISTICS OF WEAR OF BLANKING TOOL

The determination of blanking tool wear is mostly realized by indirect method (measurement of burr on the blanks), therefore it is necessary to determine new method of wear evaluation. The results of measurements are characterized by considerable dispersion, therefore it is necessary to realize the approximation of measured functionality, where the simplest mode is to put regress line into the graph [1].

The bases utilized for research were measured in production process conditions at the stamping/pressing of sheets for electric technology (rotor and stator sheets).

On the base of mean values of burr heights, it is possible to determine the graphical dependence of wear of blanking tool, Fig.2.

From the dependence of measured functionality it is shown, that the shape of curves considerably comes near to characterized curve (Fig.1). Measured results show, that the wear of blanking tool could be characterized by the burr height on the blank.

Tab.3 Arithmetic average of measured values

Average values	Values of burr heights [μm]			
	Various direction			
	Rotor 0°	Rotor 90°	Stator 0°	Stator 90°
0	0	0	0	0
1	15	12,7	10,3	4,7
25000	9,7	11,7	9,7	3,7
50000	12,7	13,3	12	9,3
75000	15,7	18	16,3	12,7
100000	39,7	33	20,3	24
125000	49,3	44,3	39	37,7

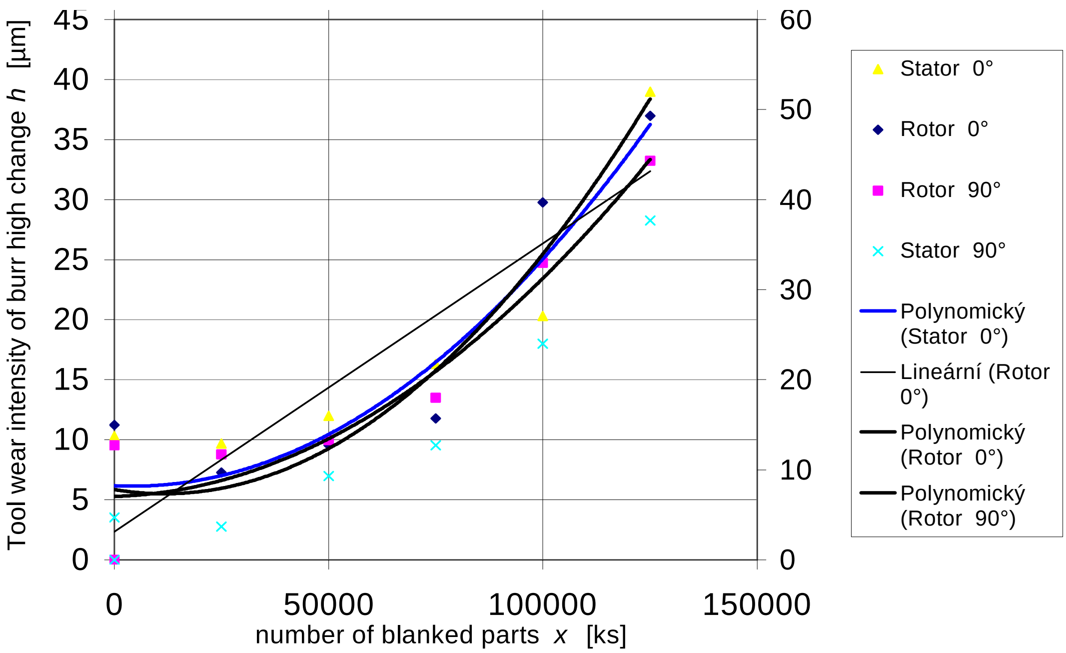

Fig.2 The dependence of burr magnitude on the number of blanks

The regress line was the most often used one (Fig.1 and Fig.2) with the basic type of formula $y = a + b.x$ at the last evaluation of wear functionality. When we compare the wear curves of tool, expressed by growing of burr magnitude and the curve of linear regression, expressed by formula $y = 3,1436 + 0,0003.x$, there is shown marked difference in their functionality (Fig.2).

This difference we can express by value of regression reliability, which is characterized by covering of original curve flow by regression curve. The reliability value moves in interval (0,1). The reliability value $R^2 = 0,7925$ refers to regression curve, which determine the process of blanking tool wear when blanking of rotor sheet 0º, shown in Fig.6. There have been used the polynomial regression of 2-nd and 4-th degree, because of the used type of regression curve did not characterize exactly the flow of original wear curve, which can be seen from the reliability value.

The polynomial regression formula of 2-nd grade is as follows:

$$y = 3 \cdot 10^{-9} \cdot x^2 - 8 \cdot 10^{-5} \cdot x + 7,8097$$

and the reliability value is expressed by the correlation coefficient $R^2 = 0,9023$.

The polynomial regression formula of 4 – th grade is expressed as:

$$y = -2 \cdot 10^{-18} \cdot x^4 + 5 \cdot 10^{-13} \cdot x^3 - 3 \cdot 10^{-08} \cdot x^2 + 0,0007 \cdot x + 7,3439$$

and the reliability of correlation coefficient is $R^2 = 0,926$.

We can see from the comparison of polynomial regressions of 2 – nd and 4 – th grade that using of polynomial regression of 2 – nd degree, the growing of reliability value is not so meaning as for linear regression. It means that the reliability value would be grow together with increasing of polynomial regression degree [1], [7], [8], [9].

6. CONCLUSION

Based on the experimental results and their mathematical processing we can make the following conclusion:

1. During the blanking it gives out progressive wear of active parts of tool by the way of roundness of cutting edges.
2. The creation of burr is around the cutting area as reasons of tool wear and the burr dimension is growing with the number of cuts.
3. In the interval between <0, 125 000> of cuts the change of burr height creates the burr as a function of number of cuts with adequate accuracy.
   It is expressed by the formulae $h_j = a + b. x_j$.
4. There will be occurred very intensive wear on active parts of blanking tool, if the number of cuts will be higher than 125 000 pieces. There will be occurred the higher roundness of cutting edges and the higher material loss when sharpening of punch and die tools. The tool life decrease.
5. Based on the results of the experimental research, the maximum number of cuts is recommended about 125 000 pieces, which can be obtained after sharpening of tool.
6. From the comparison of curve as a function of burr magnitude and number of cuts and the curve defined by linear regression (Fig.1), respectively, it is clear that the formula of linear regression can not adequate describe wear process and therefore the recommendation of other two types of approximation could be done for describing of determined functionality (polynomial regression of 2 – nd and 4 – th grades).
7. It is evident from the comparison of function of all used approximations based on the reliability values that the difference between linear regression and polynomial regression of 2

- nd grade is more expressive than the difference between the polynomial regressions of 2 – nd and 4 – th grades. That means, the using of polynomial regression is more suitable than linear one, but is important to choose the right grade, because of the reliability value will be grow further with the increasing of grade of polynomial regression. However, the difference between each grade of approximation could be smaller than the measured error.

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ODREĐIVANJE POSTOJANOSTI KOD ALATA ZA RAZDVAJANJE

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REZIME

Rad istražuje procese razdvajanja i problem postojanosti alata u tom procesu. Eksperimentalnim putem se određuje uticaj pojedinih relevantnih parametara na pojavu srha kod obradaka. Istražuje se veza između pojave srha i habanja alata, a takođe je kreiran i matematički model karakteristika habanja kod alata za razdvajanje. Na bazi eksperimentalnih i teoretskih rezultata zaključuje se sledeće:

- a. *za vreme procesa razdvajanja habanje se manifestuje "zaobljavanjem" reznih ivica alata*
- b. *stvaranje srha na obratku je u direktnoj vezi sa habanjem. Intenzivnije habanje rezultira većim srhom.*
- c. *u intervalu od 0 – 125 000 urađenih komada postoji direktna linearna zavisnost između dimenzija srha i broja urađenih komada*
- d. *iznad 125 000 urađenih komada dolazi do naglog povećanja iznosa habanja*
- e. *iz gore navedenog se zaključuje da je preporučena veličina serije u jednom oštrenju alata 125 000 komada*

Naravno, ovi zaključci važe za dati materijal (Ei70 i 719, debljine 0,65mm) i dati oblik radnog komada. Eksperimenti su urađeni na specijalnom alatu. Analizirana je izrada delova za rotor i stator elektromotora DPC 100 koji se ugrađuje u mašine za pranje veša.