MAIN FEATURES OF THE MECHANISM OF FORMATION THE SURFACE GRINDING WITH THE PERIPHERY OF A STRAIGHT DISK

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ABSTRACT

The article deals with the problem of stationary provision of grinding surface by creating the uniform abrasive impact on it. Mechanisms of forming the non-uniform abrasive action on machined surface grinding with the periphery of a start disk have been defined. It was revealed that stationary breaking of micro and macro geometry of grinding surfaces basically occurs in the areas of input of grinding disk in contact with machined surface and output from it and in the areas of configuration changes of machined surface. On the basis of analysis of analytical expressions, a new construction of the grinding disk has been worked out. It was determined that uniform abrasive action on machined surface is being provided at grinding with varied grained disk, therefore high grinding efficiency. It is explained with the concentrating on the operating surface of anisomerous grinding disk of granularity, starting with rough and ending with thin, allows combining the elements of rough and smooth grinding in one processing step. .

KEY WORDS: *surface grinding, granularity, grinding disk, abrasive, technological primitive attribute.*

I. INTRODUCTION

Stationary breaking of micro and macro geometry basically occurs in the areas of input of grinding disk with operating surface and output from it, and in the areas of configuration changes of machined surface, what due to prerequisites[1] are considered to be typical members of technological primitive attributes. In various grinding methods, the cutting action is mainly carried out with grains, which is arranged in front part of operating surface of the disk according to its size: traverse feed of motion (or double line) at surface grinding with the periphery of a straight disk; longitudinal feed on disk revolution at disk grinding; longitudinal feed on detail revolution at external disk, inner disk and centerless grinding disk.

The cut down area of detail surface in further feed is reoccurred with operating disk surface, which conduces corresponding reduction of the quality of practically operating abrasive grain. At every re-encounter of the cut down area with operating disk surface, a part of dynamic grains hits into the already cut track, that leads to their non uniform loading along the traffic circuit altitude, increase of the work of external friction of grain and bands on surface of the metal and rise of the temperature stimulus on the machined surface. These phenomena lead to ununiform abrasive impact on the length of the whole contact with operating surface, contributing the formation of no stationary micro geometry of operating surface. Beyond this, in there is a change site of contact area of grinding disk with operating surface, i.e. the area of contact is changed from zero to established quantity and vice versa technological primitive attributes of input and output from it. In this case there is a macro geometry breaking of grinding surface, causing the formation of geometric shape errors.

Arrangement of the task: For explaining the physical entity of the process of non uniform abrasive force on the machined surface and its analytical description, the operating surface of grinding disk depending on the degree of abrasive force on the machined surface, we conditionally divide into separate stripes with the breadth of appropriate feed depending on the method of grinding. A number of stripes are determined in correlation of the height of the disk to the feed H / S_n.

It must be taken into consideration that at every re-encounter of abrasive disk with already cut surface, a part of active abrasive grains hit into cut down areas, i.e. each conditional stripe in its correct location from front stripe has re-encounter with the machined surface. Consequently, the first stripe is front and performs the cutting function, meeting with rough surface, and following stripes in course of the location from it, carries out the sparking out, reoccurring with already machined surface. The sparking out ability of conditional stripes of grinding disk with increasing number of re-encounter with already cut down surface, i.e. with the rise of height of the disk and reduction of the feed.

II. THEORETICAL REQUISITES

Taking into account that surface grinding of the periphery of a straight disk is one of the widespread methods of grinding and generalizes main peculiarities of other methods. Let us analyze the mechanism of non uniform abrasive force in its example (fig.1). Total amount of practically operating grains on working surface of grinding disk is determined according to the formulae.

$$i_{\phi} = i + iq + iq^2 + iq^3 + ... + iq^{\frac{H}{S_n}-1} , \qquad \textbf{(1)}$$

Where i – is the number of practically operating grains on the frontal stripe with the width of traverse feed $S_{П}$; q –is the coefficient of considering hit of cutting grains into existing truncations; H - is the height of grinding disk, mm.

It is obvious that a formula (1) is considered to be geometric progression. The common ratio of geometric progression is the coefficient *q*. The value Значение *q* comes from $q=0,4 \div 0,6$ [1], $|q|<1$, i.e. the given geometric progression is considered to be decreasing.

Total number of practically operating grains on working surface of the grinding disk is determined by the formula [1]

$$i_{\phi} = \frac{i\left(1 - q^{\frac{H}{S_n}}\right)}{1\text{-}q} \qquad (2)$$

Where *i*- the number of operating grains in front stripe with the width of traverse feed is $S_{П}$; q – efficiency, taking into account of hitting of cutting grains into existing cuts; *H* – the height of grinding disk is mm.

In the work [2] with enough precision for the practice and taking into account parameters of crooked normal distribution, following analytical expressions for defining the number of active grains of 1 mm² of disk surface have been offered.

$$i \approx 0,167 \frac{\beta}{\alpha^{3/4}\sqrt{tg\gamma}} \frac{\sqrt{k}}{\overline{X}^2\sqrt{1\text{-}\varepsilon}} \sqrt{\frac{\omega}{1000V_k}} \qquad (3)$$

Where β - is the correction on symmetric position of crooked distribution of flight of grain apex flight on working layer of the disk; γ –is the half of probable value of the edge of cutting grain apex; V_k - is the speed of grinding disk, м/с; ω –is specific productivity, mm/s; *k*- is concentration, %; α – is a grain form coefficient; $\overline{X}$ – is the middle value of grain size of grind powder.

We will determine the current value of the quantity of practically operating abrasive grains within the limits of contact space of i_k, by means of multiplying the practically operating grains on working disk surface on the ratio of the arc length of grain contact with processing surface L_k on the length of grinding disk circumference

$$i_k = 0{,}167\frac{\beta}{\alpha^{3/4}\sqrt{tg\gamma}}\frac{\sqrt{k}}{\overline{X}^2\sqrt{1-\varepsilon}}\sqrt{\frac{\omega}{1000V_k}}S_{п}\left(1\pm\frac{V_u}{60V_k}\right)\sqrt{Dt}\left(\frac{1-q^{\frac{H}{S_n}}}{1-q}\right) \qquad (4)$$

Where V_d –is the speed of the detail, m/min, t – is the depth of cutting, mm, the sign «+» is accepted at two-axis vector grinding, the sign «-» at down grinding. Thus, the quantity of practically operating abrasive grains in the contact area of abrasive wheel with processed surface, within the limits of technological primitive attribute of the entry is increased from zero to arranged dimension and is determined due to the formula

$$i_k = 0{,}167\frac{\beta}{\alpha^{3/4}\sqrt{tg\gamma}}\frac{\sqrt{k}}{\overline{X}^2\sqrt{1-\varepsilon}}\sqrt{\frac{\omega}{1000V_k}}S_{п}\left(1\pm\frac{V_u}{60V_k}\right)\sqrt{Dt}\left(\frac{1-\mathrm{q}^{\frac{\mathrm{X_i}}{\mathrm{S_п}}}}{1-\mathrm{q}}\right) \qquad (5)$$

$0 < X_i \le H$

In technological primitive attribute of the arranged grinding, the quantity of practically operating abrasive grains is stabilized and remains fixed. There is a reverse process in technological primitive attribute of the output, i.e. the cutting frontal stripe with prevailing number of active grains of the grinding wheel´s working height is the first that quits the contact and further growing stripes with killing degree of abrasive force on the already cut down areas.

Current value of the number of practically operating abrasive grains in the contact zone of technological primitive attribute exit will be

$$i_{k\,вых} = 0{,}167\frac{\beta}{\alpha^{3/4}\sqrt{tg\gamma}}\frac{\sqrt{k}}{\overline{X}^2\sqrt{1-\varepsilon}}\sqrt{\frac{\omega}{1000V_k}}\left(1\pm\frac{V_u}{60V_k}\right)\sqrt{Dt}\mathrm{S_п}\mathrm{q}^{\frac{\mathrm{X_i}}{\mathrm{S_п}}}\left(\frac{1-q^{\frac{H-X_i}{S_n}}}{1-q}\right) \qquad (6)$$

$0 < X_i \le H.$

As an example, the number of practically operating grains within the limits of the contact area with the periphery of grinding disk at technological primitive attributes of the input, established grinding and output of grinding disk from the contact with machined surface are calculated.

Given: abrasive grit *100/80 (x=0.086), D=200mm, H=20mm, K=100%, operating conditions:* $V_к$ *= 23m/s, V = 4m/min, t=0.01mm,* S_n *= 5 mm/d.pass , q= 0.6.*
Material of cutting grains - elbor, joint *B.*
We find *ε= 0.78* according to table2.43 [2]
Specific performance with one mm^2 of surface disk

$$\omega = \frac{1000\cdot 4}{60}\sqrt{\frac{0.01}{200}} = 0.47\,мм/с$$

At *α= 0,6, β= 1,63,* $2\gamma=80^0$ for technological primitive attribute of established grinding will be found

$$i_{k_{уст}} = 0{,}167\frac{1.63}{0.6^{3/4}\sqrt{tg40}}\frac{\sqrt{100}}{0{,}086^2\sqrt{1-0{,}78}}\sqrt{\frac{0{,}47}{1000\quad 23}}(1\pm\frac{4}{60\quad 23})\sqrt{200\quad 0.01}\times$$

$$\times 5(\frac{1-0.6^{20/5}}{1-0.6}) = 92{,}568 \approx 93$$

Distribution of practically operating grains according to conditional stripes of working surface of the grinding disk.

$$i_{k_{eck_1}} = 42{,}5; i_{k_{ecn_2}} = 25; i_{k_{ecn_3}} = 15; i_{k_{ecn_4}} = 9.$$

For technological primitive attribute of input

$$i_{k_{\text{вх}}} = 0{,}167\frac{1{,}63}{0{,}6^{3/4}\sqrt{tg\,40}}\,\frac{\sqrt{100}}{0{,}086^{2}\sqrt{1-0{,}78}}\sqrt{\frac{0{,}47}{1000\cdot 23}}\left(1\pm\frac{4}{60\cdot 23}\right)\times$$

$$\times\sqrt{200\cdot 0{,}1}\cdot 5\left(\frac{1-0{,}6^{\frac{X_i}{5}}}{1-0{,}6}\right)$$

at

$$X_i = 5 \qquad i_{k_{\text{вх}1}} = 42,$$
$$X_i = 10 \qquad i_{k_{\text{вх}2}} = 68,$$
$$X_i = 15 \qquad i_{k_{\text{вх}3}} = 83,$$
$$X_i = 20 \qquad i_{k_{\text{вх}4}} = 93.$$

For technological primitive attribute of output

$$i_{k_{\text{вых}1}} = 0{,}167\frac{1{,}63}{0{,}6^{3/4}\sqrt{tg\,40}}\,\frac{\sqrt{100}}{0{,}086^{2}\sqrt{1-0{,}78}}\sqrt{\frac{0{,}47}{1000\cdot 23}}\left(1\pm\frac{4}{60\cdot 23}\right)\times$$

$$\times\sqrt{200\cdot 0{,}1}\cdot 5\cdot q^{j}\left(\frac{1-q^{\frac{H}{S_n}-j}}{1-q}\right)$$

at

$$X_i = 5 \qquad i_{k_{\text{вых}1}} = 50,$$
$$X_i = 10 \qquad i_{k_{\text{вых}2}} = 24,$$
$$X_i = 15 \qquad i_{k_{\text{вых}3}} = 9,$$
$$X_i = 20 \qquad i_{k_{\text{вых}4}} = 0.$$

Charts (fig.2), built on the basis of formulae (4), (5) and (6) confirm the accuracy of proposed theoretical perquisites. As it is seen in figure 2, current significance of practically operating grains in the contact area within the technological primitive attribute of input is changed from zero till steady significance, and within the technological primitive attribute of output (fig.2,b) from steady dimension till zero. Wherein, the consistent pattern of growth of practically operating grains in TP input differs from the consistent pattern of decrease in TP output. (fig. 2, a, b)

Wherein, from probable potential 170 active abrasive grains acting in the contact area along the whole height of grinding disk in technological primitive attribute of established grinding at q=0.6, only 54% of them participate in the process of cutting, but the rest fall into cut down grooves and at first and last leads accordingly of 25 and 5%.

Such a huge spread in quantity changes of active operating grains in technological primitive attributes of one changeover, in realization of converse changeover without implementation of feed over the depth, causes appropriate uneven abrasive influence on processed surface, and consequently, for formation of non-stationary anisotropy macro and micro profile of machined surface.

The analysis taken from analytical expressions (4), (5) and (6) consistent pattern changes of the growth of practically operating abrasive grain within the limits of technological primitives of the entry, installed grinding and exit show that almost all parameters of grinding process, starting from characteristics and structure of circle grinding and finishing with cutting regime elements influence on quantity changes intensity of practically operating abrasive grain and thereby on margin output intensity within the limits of this or that technological primitive attribute. All these peculiarities in common lead to uneven abrasive influence on machined surface in the grinding process.

III. ELABORATION

A uniform abrasive force on machined surface is provided by abrasive disk of a new construction, consisting of various granularities [3]. Granularity of every following stripe is less than the previous one. The difference of the granularity of stripes is determined due to the condition of uniform abrasive force.

The number of practically operating abrasive grains is defined according to the condition of uniform abrasive force

$$i_{ф} = i_1 + i_1 \frac{1}{q} + i_1 \frac{1}{q^2} + i_1 \frac{1}{q^3} + ... + i_1 \frac{1}{q^{\frac{H}{S_п}-1}} \qquad (7)$$

Average size of grains in each stripe, consequently the granularity is determined on condition of the equality of practically operating grains number in every conditional stripe taking into account the hitting into already cut down areas. The equality is provided owing to decrease of middle size of grains, i.e. increase of their numbers in accordance with ordinal number of current stripe relative to front.

$$i_{фj} = \frac{0,167\beta}{\alpha^{3/4}\sqrt{tg\gamma}} \frac{\sqrt{k}}{\overline{X}_j^{2}\sqrt{1-\varepsilon}} \sqrt{\frac{\omega}{1000V_k}} \pi D S_{П} q^{j-1} \qquad (8)$$

At $0 < j \le \frac{H}{S_п}$.

Conditions of uniform abrasive force require changes of parameters $\overline{X}$ and q entering the equation (8), in transition from one stripe into another one.

at $0 < j \le H / S_{П}$,

Where

$$\overline{X}_j = \overline{X}_1 \quad \text{at} \quad j = 1$$

$$\overline{X}_j = \overline{X}_2 = \overline{X}_1\sqrt{q} \quad \text{at} \quad j = 2$$

$$\overline{X}_j = \overline{X}_3 = \overline{X}_1 q \quad \text{at} \quad j = 3$$

$$\overline{X}_j = \overline{X}_{H/S_{П}} = \overline{X}_1\sqrt{q^{\frac{H}{S_{П}}-1}} \quad \text{at} \quad j = \frac{H}{S_{П}}$$

$$\overline{X}_{Ф_j} = \overline{X}_1\sqrt{q^{j-1}} \; .$$

Accordingly, on setting the middle size of grains of front stripe, middle size of grains is $\overline{X}$ can be determined and therefore, the number of granularity of every next stripe of grinding disks.

Example: The average size of grain and granularity of every stripe of grinding disk with varied grained is determined for checking the trustworthiness of the received analytical expressions.

Initial data: Granularity of front stripe is 250/200, the average size of grains is $\overline{X}_1 = 0,2076$, coefficient ,taking into account the hitting of cutting grains into available cut is $q - 0,6;$ the height of grinding disk is $H - 20mm;$ the traverse feed is $S_п = 5$ mm/d. line.

$$\overline{X}_2 = \overline{X}_1\sqrt{0,6} = 0,2076\sqrt{0,6} \approx 0,1661 \text{ at } j = 2,$$

$$\overline{X}_3 = \overline{X}_1\sqrt{0,6^2} = 0,2076\sqrt{0,6^2} \approx 0,1246 \text{ at } j = 3,$$

$$\overline{X}_4 = \overline{X}_1\sqrt{0,6^3} = 0,2076\sqrt{0,6^3} \approx 0,0934 \text{ at } j = 4 .$$

According to the work [2], we will determine the granularity, relevant to the average size of grains in every stripe.

$$\overline{X}_1 = 0{,}2076 \approx 200/200,$$
$$\overline{X}_2 = 0{,}1661 \approx 200/160,$$
$$\overline{X}_3 = 0{,}12456 \approx 160/125,$$
$$\overline{X}_4 = 0{,}0934 \approx 125/100.$$

Grain-rich abrasives are chosen for cutting front stripe in appliance with the suggested method, within the limits of the possible removing the granularity of grinding powder from it, is diminishing in appropriate increase of practically operating grains for very conditional stripe (figure 3).

IV. CONCLUSION

1. Conditions of the grinding disk with machined surface are mainly characterized by the area of the contact and its parameters along the length of the whole technological primitive attribute. The contact area is formed in the result of the confluence of two irregular profiles of the tool and machined surface and has space characteristics.
2. Stationary breaking of micro and macro geometry of grinding surfaces, generally occur in the areas of input of the grinding disk in contact with machined surface and output from it and in the areas of configuration changes of machined surface.
3. The uniform abrasive force on the machined surface is provided in grinding with varied grained grinding disk, and therefore highly grinding efficiency by means of decrease of the work of external friction of grains and bands on metal surface. It is explained with the concentration on machined surface of varied grained grinding disk, the granularity of number 5, starting with rough and ending in granular, allows combining the elements of preparatory.

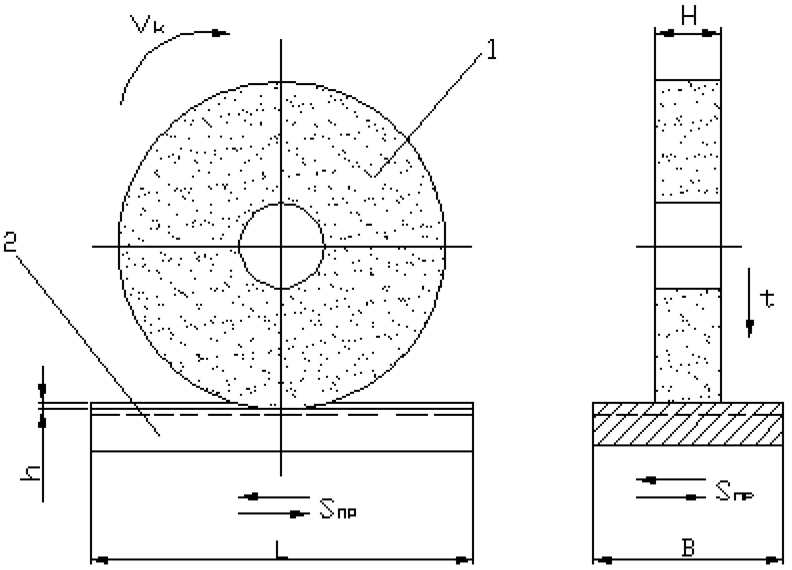
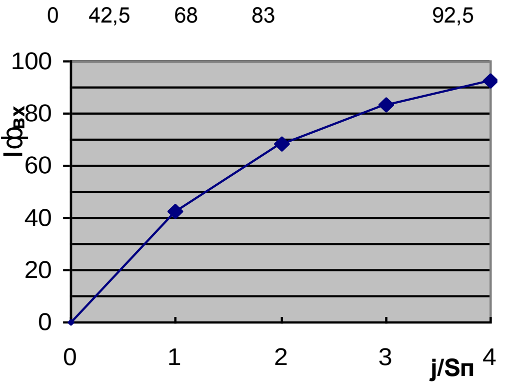


Fig.1. Graphic pattern of surface grinding with the periphery of a straight disk

and super finish grinding in one operating step.



Length of Tp input

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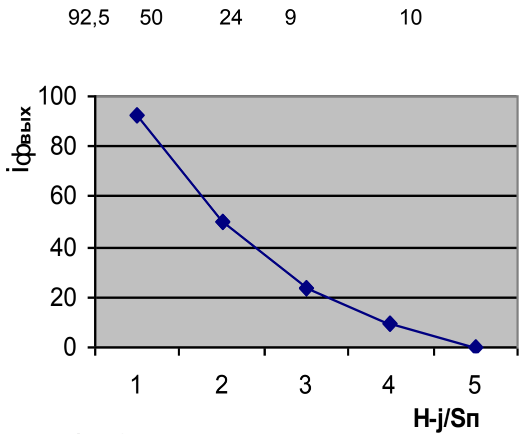

Length of Tp output

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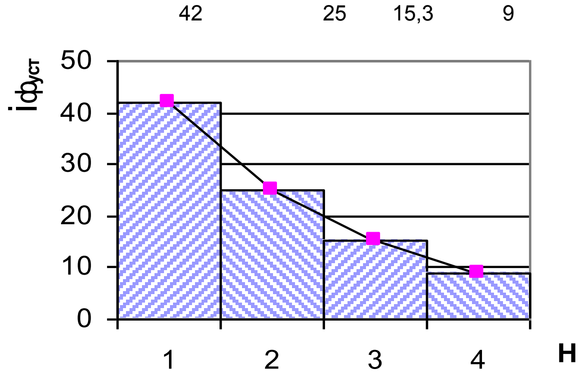

Height of grinding disk.

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Figure 2. Graphic changes of quantity of practically operating abrasive grains in technological primitive attribute; a- input; b- output; c- steady grinding

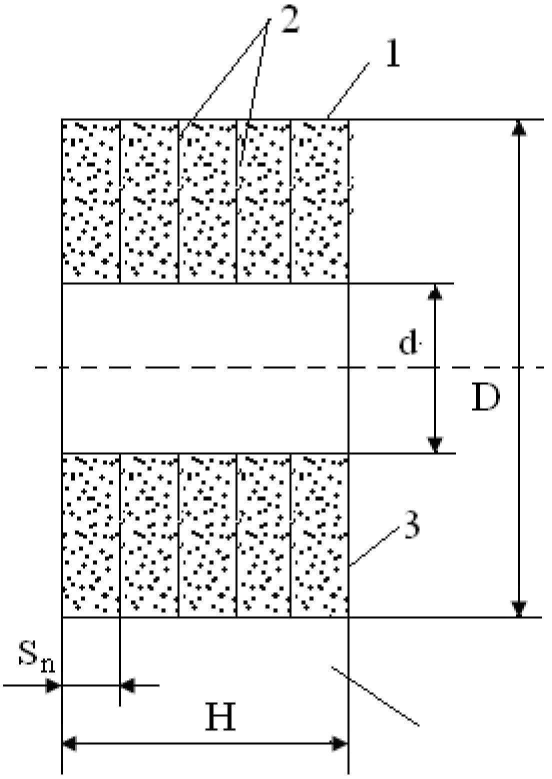

Figure 3. Varied grained abrasive disk: 1- stripe with varied granularity; 2- blotters.

REFERENCES

[1]. Gusseinov G. A. Program control like machine processing. Baku. Chashioqli.2000, p. 281.
[2]. Abrasive and uncut diamond processing of materials. Reference book/edited by Dr.of Tech. Scien, prof. A.N. Reznikova. M. Machinery construction, 1977, 391.p. 4. Loading automation of round grinding machine with N.P.C. p.42.
[3]. S.A. Bagirov, G.A. Gusseinov. Abrasive disk for processing the details, Patent, invention №I 2012 0008 The Azerbaijan Republic, Baku,2012

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