Study of dependence of cutting energy on process parameters at parts superfinishing

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Abstract. The existing methods of abrasive processing differ not only in constructive features, but also in modes of processing. The performed studies allowed to carry out an analysis of specific cutting energy consumption for different types of abrasive processing and to define the dependence of cutting energy on tools oscillation frequency at different graininess of bars, forces, pressing bars to processed surfaces, circumferential speed of workpiece rotation, at different values of a bar profile radius, the value of a bar working surface clogging coefficient [1,2,3,4,5]. Based on the developed mathematical models, the algorithms and programs for the calculation of margin removal and processed surfaces roughness for different types of abrasive processing were made. The adequacy of these mathematical models was validated by comparing the calculated values of margin removal and obtained roughness of processed surface at superfinishing of ring-like parts with experimental values. The calculated values are within a confidence interval of experimental values dispersion built at confidence probability of 0.95 [6,7,8,9,10].

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Keywords: specific energy consumption, cutting energy, tool oscillation frequency, bars pressing force, bar profile radius, bar working surface clogging coefficient.

Introduction

The performed studies allowed to carry out an analysis of specific cutting energy consumption for different types of abrasive processing. As can be seen from the graph shown in Figure 1, the lowest cutting energy at 1 micron margin removal is required for cbn and normal superfinishing (with tools of 63C type), which is 70 – 75 J, and the maximum is required for cbn honing (with tools of 63C type) which is 90 J (due to high circumferential speed of a workpiece and significant tool oscillation frequency).

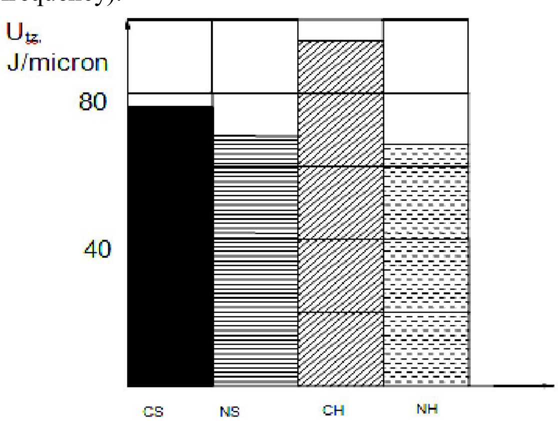

Fig.1. Energy consumption U_{tz} for 1 micron margin removal for different types of abrasive processing: UH – normal honing, CH – cbn-honing, NS – normal superfinishing, CS – cbn-superfinishing.

One of the aims of this work is to perform the study of the dependence of cutting energy at crankshaft journals superfinishing. Crankshaft journals superfinishing is to be performed at the following modes of process equipment operation: P_y = 520 – 800N, ϑ_d = 470 mm/sec, ϑ_{bo} =1310 mm/sec, n_b = 3 – 5 Hz. In order to carry out a comparative analysis of influence of tool graininess and a bar profile radius on margin removal, as well as on bulge and roughness of processed surface, the studies were carried out for bars of M7, M14, M28 graininess and with profile radius r_b =40, 140 and 329 mm.

When performing the studies of dependence of cutting energy on processing modes, the range of processing parameters was somewhat widened in order to get influence dynamics, however, technological parameters of crankshaft journals superfinishing are included in this range.

In Fig. 2 dependences of cutting energy on tool oscillation frequency at different graininess of bars are presented. As can be seen from the graph, at an increase in oscillations frequency n_b from 3 up to 30 Hz, for three values of tool graininess, the quantity of energy consumption is reduced almost by 700 J, which is connected with better conditions of pores cleaning from cut chips.

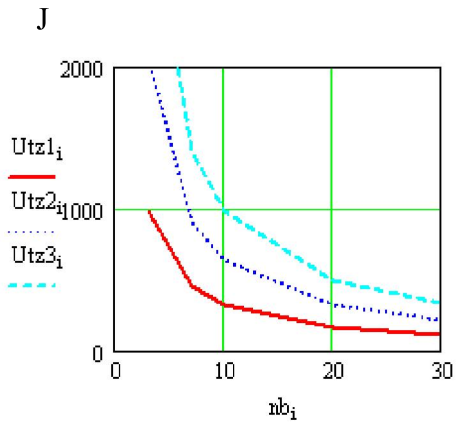

Fig.2. Dependence of cutting energy U_{tz} (J) on tool oscillation frequency n_b (Hz) for bars of different graininess: 1 – M7, 2 – M14, 3 – M28.

In Fig. 3 the graph of dependence of cutting energy on force of bars pressing the processed surface is presented. The graphs depict that in general energy consumption increases if a bar pressing force is increased for every studied tool graininess. An increase in energy consumption for cutting is due to an increase in cutting depth and greater volume of removed chips, thus an increase in tool pressing force from 200 to 1000N gives an increase in cutting energy consumption by 1600 J, which indicates the considerable influence of this parameter on the formation of the value of common energy consumption.

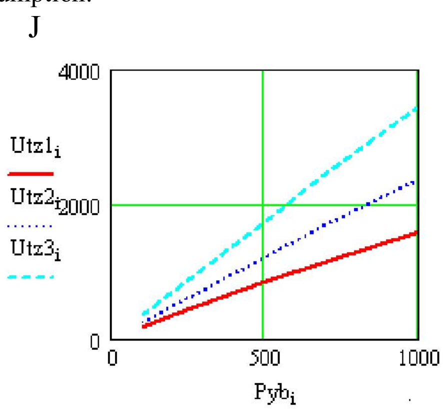

Fig. 3. Dependence of cutting energy U_{tz} (J) from bars pressing force P_y (N) for different graininess of bars: 1 – M7, 2 – M1, 3 – M28

With an increase in circumferential speed of a workpiece rotation its influence on cutting energy is not so significant as in comparison with a tool pressing force and oscillation frequency, but a strong dependence of cutting energy on a tool graininess with an increase in a circumferential speed can be seen – thus at an increase in graininess from M7 to M28 the cutting energy (at circumferential speed of 1000 mm/sec) increases from 800 to 5800 J in connection with an increase in removed margin. (Fig. 4).

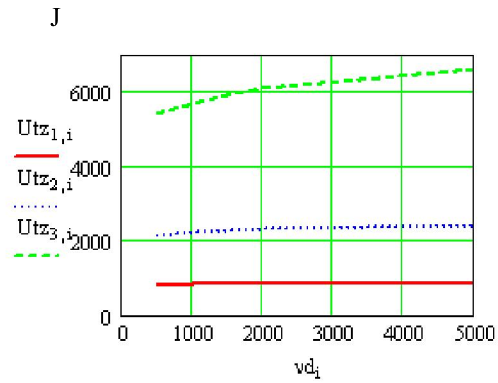

Fig.4. Dependence of cutting energy U_{tz} (J) on a workpiece rotation speed vd (mm/sec) for different bar graininess: 1 – M7, 2 – M14, 3 – M28

Graphs of dependences of cutting energy on a bar oscillation frequency at different values of a bar profile radius are shown in Figure 5. As can be seen from the results, at an increase in a bar profile radius the value of energy consumption increases from 300 to 900 J (at n_b =10Hz), as a contact area is increased, and hence a margin removal, but at an increase in oscillations frequency the cutting energy consumption is reduced for all the variants of a bar profile radius, due to better conditions of pores cleaning from chips.

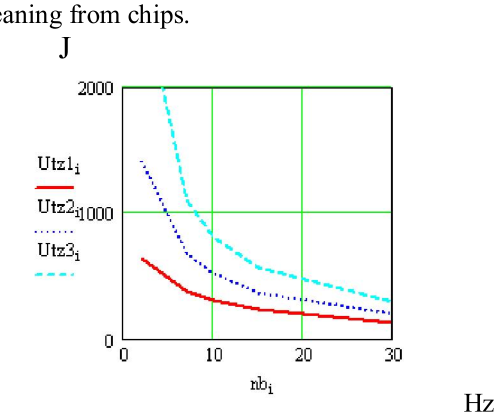

Fig. 5. Dependence of cutting energy U_{tz} (J) on tool oscillation frequency n_b (Hz) at different bar profile radius: 1 - r_b = 40 mm, 2 - r_b = 140 mm, 3 - r_b = 329 mm

As it was noted above, the value of a bar working surface clogging coefficient influences greatly on the value of margin removal and processed surface roughness. The value of a bar working surface clogging coefficient, in its turn, is influenced by both the bar characteristics and technological processing modes.

In Fig. 6 the dependence of cutting energy on clogging coefficient is presented. From graphs we can see that at an increase in the value of the clogging coefficient the cutting energy consumption increases as well for three values of tool graininess, which is understandable, i.e. the number of active cutting grains and, as a consequence, margin removal are increased. The performed studies of dependence of the clogging coefficient on technological processing modes showed that at an increase in a bar pressing force the clogging coefficient is considerably reduced, especially for a fine-grained tool. If at an increase in a tool pressing force from 100 to 1000 N the clogging coefficient of a bar with M28 graininess is decreased from 0.9 to 0.65, then at M7 graininess of a bar this decrease is more considerable – from 0.83 to 0.33, which directly decreases the value of a margin removal.

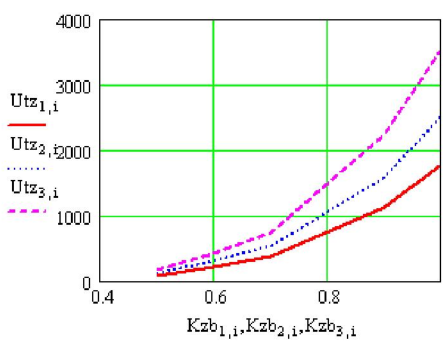

Fig.6. Dependence of cutting energy U_{tz} (J) on a tool clogging coefficient Kzb at its different graininess: 1 – M7, 2 – M14, 3 – M28

Based on the developed mathematical models, the algorithms and programs for the calculation of margin removal and processed surfaces roughness for different types of abrasive processing were made. A research of influence of abrasive processing and tools characteristics on energy parameters was also performed.

The adequacy of these mathematical models was validated by comparing the calculated values of margin removal and obtained roughness of processed surface at superfinishing of ring-like parts with experimental values obtained by A. V. Koroliev, O. Y. Davydenko, A. M. Chistyakov and A. A. Koroliev (Fig. 7 and Fig. 8).

micron

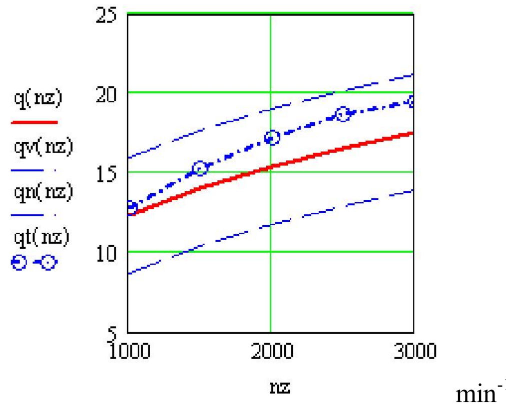

Fig. 7. Dependence of margin removal q (micron) on a workpiece rotation speed nz (min^{-1}): $qt(nz)$ is a theoretical dependence; $q(nz)$ is an experimental one; $qv(nz)$ and $qn(nz)$ are confidence limits.

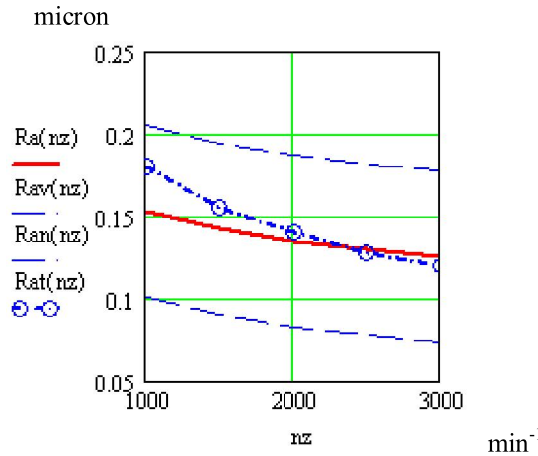

Fig. 8. Dependence of surface roughness R_a (micron) on a workpiece rotation frequency nz (min^{-1}): $Rat(nz)$ is a theoretical dependence, $Ra(nz)$ is an experimental one; $Rav(nz)$ and $Ran(nz)$ are confidence limits.

The calculated values are within a confidence interval of experimental values dispersion built at confidence probability of 0.95.

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References

1. Tyurin, A.N., 2007. Energy Parameters of the Processes Superfinishing Processing. (Monograph). West-Kazakhstan Agrarian-Technical University, pp: 109.
2. Tyurin, A.N., 2009. Probatilistic Calenlation of the Stress within Binder Bridges Inabrasive Tools. Russian Engineering Research, Vol. 29, 1: 55-60.
3. Tyurin, A.N., 2009. The Cutting Energy and the Rate of Removal of the Margin in Abrasive Superfinishing. Russian Engineering Research, Vol. 29, 5: 477-479.
4. Korolev, A.V., A.A. Korolev and A.N. Tyurin, 2011. Nonuniformity of Margin Removal in Superfinishing. Russian Engineering Research, Vol. 31, 5: 469-470.
5. Tyurin, A.N., 2011. Dependence of the Cutting Energy on the Parameters in Superfinishing. Russian Engineering Research, Vol. 31, 7: 657-659.
6. Tyurin, A.N., 2012. Dependence of the Surface Roundness on the Cutting Energy in Abrasive Superfinishing. Russian Engineering Research, Vol. 32, 3: 266-268.
7. Demaid, A.P and A.I. Mather, 1972. Hollow-Ended Rolls Reduce Bearing Wear. Des Eng, 11: 211-216.
8. Heydepy, M. and R. Gohar, 1979. The Influence of Axial Profile on Pressure Distribution in Radially Loaded Rollers. Journal of Mechanical Engineering Science, 21: 381-388.
9. Kannel, J.W., 1974. Comparison between Predicted and Measured Axial Pressure Distribution between Cylinders. Trans. ASK8 (Suly), pp: 508.
10. Welterentwichelte DKFDDR Zylinderrollenlager in leistung gesteigerter Ausfuhrung ("E"-Lager), 1985. Hansa, 5: 487-488.

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