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Research of Influence Electric Conditions Combined Electro-Diamond Processing by on Specific Consumption of Wheel*

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Abstract. The paper presents results of stability research of cutting properties of diamond abrasive tools in metal binder for grinding high-strength composite materials, as well as the need to reduce the specific consumption of wheel, as one of the most important economic indicators of processing. Shows a comparative analysis of the results of preliminary researches of various methods diamond processing, in which determined that the minimum specific consumption of wheel reached by combined electro-diamond grinding, combining electrochemical grinding with simultaneous continuous electrochemical correction surface wheel. Were conducted more research directed at identifying the specific consumption the diamond wheel on metallic binder depending from electric conditions combined electro-diamond processing. Researches have established the advantages of combined electro-diamond of hard alloys processing and define rational modes to ensure a satisfactory consumption of the diamond wheel, as well as significantly increasing quality and performance.

Introduction

Improving technology the processing of products from high-strength materials is an important task in conditions of modern machine-building production [1…10]. Methods final processing used in enterprises and are widely distributed abrasive tools in many cases do not allow reach the required performance characteristics of the finished products. Using the productive tool from super hard abrasive material, in this case limited, in view of the problems associated with the recovery of their cutting properties [1, 2, 7, 11]. As is known, wear resistance diamond tool determines performance and the cost of processing. Grinding of materials abrasive tool is accompanied by brining diamond layer of products processing, which leads to loss of cutting properties tool and affects the quality indicators of finished products. Achieve stability of cutting properties diamond grinding wheel probably due to additional corrections, but it increases the consumption of abrasive material and increases processing costs. Thus, one of the most important economic indicators of machining process is the specific consumption of diamond wheel. Using the combined technologies allowing combine in

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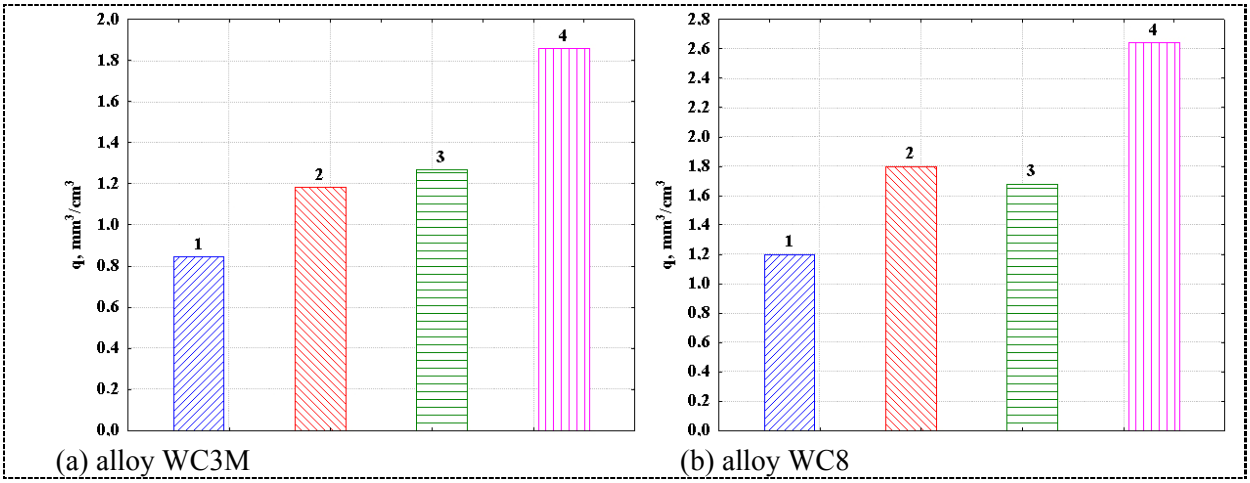
a single process several methods in various combinations, leads an increase to processing efficiency [11, 12, 13, 14]. The authors noted that the use of electrochemical grinding with continuous electrochemical corrections wheel and combined electro-diamond grinding allows for a long time maintain the cutting ability of diamond wheels. Therefore considerable interest is the research the features of the influence of electric modes combined electro-diamond processing on the specific consumption of diamond grinding wheels.

Methods of research

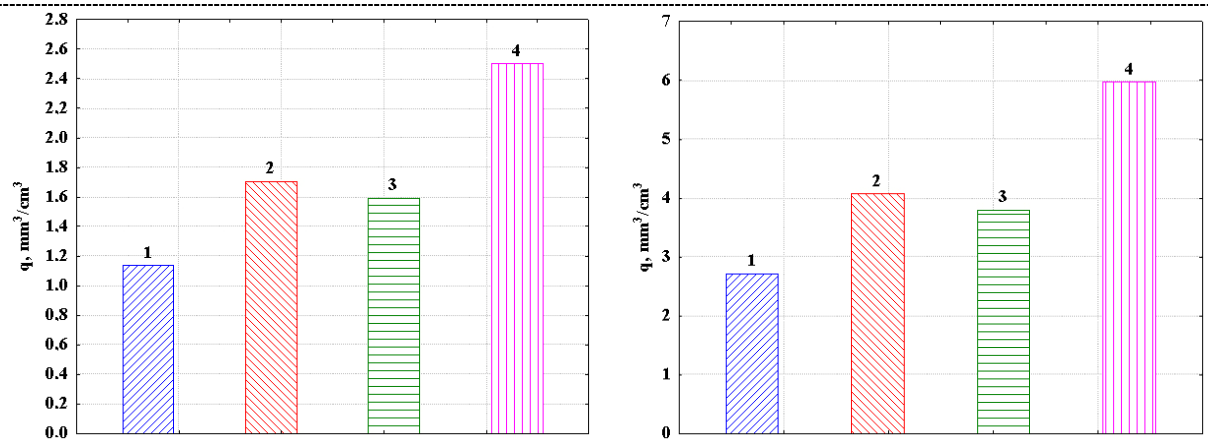
Performed researches of the influence electrical modes of processing hard alloys on the specific consumption wheel at combined methods of diamond grinding. For an objective assessment are compared the following methods [13, 14]:

1. Combined method of electro-diamond processing, combining electrochemical diamond grinding with simultaneous continuous electrochemical corrections of wheel surface.
2. Grinding of with continuous electrochemical corrections diamond wheel. Herewith, diamond grinding wheel on metal bond is connected to the positive pole of a constant current source, a special cathode - to negative and processed material is electrically neutral.
3. Diamond electrochemical grinding in which the work piece is connected to the positive pole of a constant current source, and diamond grinding wheel on metal bond – to the negative. In this case, the electric circuit is closed through the electrolyte to be fed into the nip formed between the diamond grains and the work piece.
4. Grinding of diamond wheels on metal bond without the use of electro-physical and electrochemical processes, which is widely used in enterprises for processing products of hard alloys.

To determine the effect of diamond processing methods on consumption of wheel, selected widely used in engineering products and designs of the cutting tool hard alloy grades: WC3M, WC8, WC15 and TN20, which grinded using diamond wheels brand 12A2, abrasive AC6, metal binder M2-01, under similar conditions and processing modes.



(a) alloy WC3M (b) alloy WC8



(c) alloy WC15 (d) alloy TN20

Figure 1. Consumption diamond wheel in processing of the hard alloys various methods diamond grinding
1 – combined electro-diamond grinding; 2 – diamond grinding with electrochemical wheel corrections; 3 – electrochemical diamond grinding; 4 – diamond grinding

Since at conventional diamond grinding (method 4) and diamond electrochemical grinding (method 3), intensively are salted down wheel, so from time to time was required periodical corrections surface wheel of multi-pass of rigid method – whetstone of carbide silicon green, to maintain the working capacity of the abrasive tool.

After each method of processing, wheel starred from the machine and using of the special adaptation by the linear method was measured by consumption, as the ratio of the volume consumed a diamond wheel (mm^3) to volume of removed material (cm^3).

The research results are presented in the form of comparative histograms for each brand of hard alloy (Figure 1).

According to results analysis of research results noted that the minimum consumption is observed in the method combined electro-diamond grinding (method 1).

Thus, for detection rational electrical conditions: current density of correction wheel i_{st} [A/cm^2] and the current density the etching i_{et} [A/cm^2], which mainly determined by the consumption of diamond wheel q [mm^3/cm^3], selected method of combined electro-diamond grinding.

As a rational technological modes of processing, are taken modes which defined by the results of previous researches [3, 4]: stride S = 1.5 [m/min], transversal feeding t = 0.02 [mm/d.s], rate of cutting V = 35 [m/s].

Results

According to the results of the research and follow statistical of processing of the data were obtained adequate mathematical dependences of the consumption of diamond wheel on the metal bond from electrical modes combined electro-diamond grinding (Figure 2).

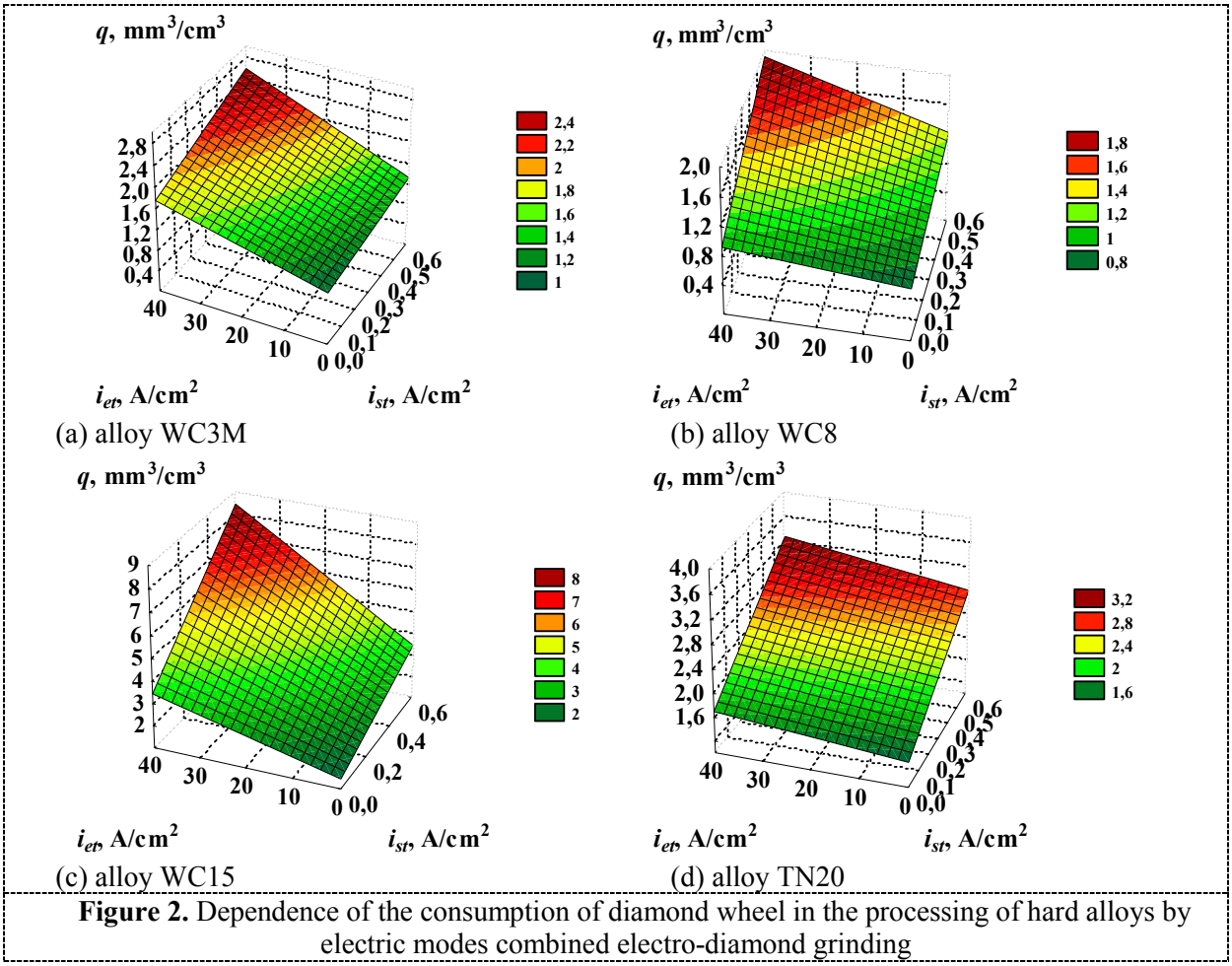


Figure 2. Dependence of the consumption of diamond wheel in the processing of hard alloys by electric modes combined electro-diamond grinding

Dependence the consumption of diamond wheel q [mm^3/cm^3] from electrical modes i_{st} [A/cm^2] и i_{et} [A/cm^2] for alloy WC3M has the form:

$$q = 0.9875 + 0.5611 i_{st} + 0.019 i_{et} + 0.0207 i_{st} i_{et}$$

The surface of a response in this case is presented in Fig. 2 (a).

Obtained dependence the consumption of diamond wheel q [mm^3/cm^3] from electrical modes i_{st} [A/cm^2] и i_{et} [A/cm^2] for alloy WC8 has the form:

$$q = 0.723 + 0.8325 i_{st} - 0.005 i_{et} + 0.0206 i_{st} i_{et}$$

The surface of a response of the examined parameter is presented in Fig. 2 (b).

Dependence the consumption of diamond wheel q [mm^3/cm^3] from electrical modes i_{st} [A/cm^2] и i_{et} [A/cm^2] for alloy WC15 has the form:

$$q = 1.4455 + 3.3383 i_{st} + 0.05 i_{et} + 0.125 i_{st} i_{\text{et}}$$

The surface of a response in this case is presented in Fig. 2 (c).

Obtained dependence the consumption of diamond wheel q [mm^3/cm^3] from electrical modes i_{st} [A/cm^2] и i_{et} [A/cm^2] for alloy TN20 has the form:

$$q = 1.417 + 2.2877 i_{st} + 0.007 i_{et} + 0.0078 i_{st} i_{\text{et}}$$

The surface of a response of the examined parameter is presented in Fig. 2 (d).

Discussion

Achieve high performance and quality of processing of high-strength materials is possible, on account of conditions that ensure the stability of the cutting properties of abrasive tools on metal bond. Such conditions is possible provide due to use of combined electro-diamond methods processing.

Research has revealed that the minimum consumption of diamond abrasive tools at the combined electro-diamond method of processing, that combines electrochemical grinding with simultaneous continuous electrochemical surface corrections wheel. During processing of this method occurs a continuous process of electrochemical corrections, which leads to the dissolution of a greasy layer formed on the surface of the wheel, diamond grains for a long time are operable because processed electrochemical softening surface. With the loss of cutting properties, diamond grains under the effect of increasing cutting forces leaving a binder.

Analysis of the results additional research allowed us to determine the rational electrical modes of combined processing that provide a satisfactory consumption diamond wheel: i_{st} = 0.2…0.3 A/cm^2 и i_{et} = 20…30 A/cm^2.

Processing of high-strength materials on recommended modes can significantly improve the quality and performance.

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