BRASS GRAPHITIZING DURING WIRE ELECTRICAL DISCHARGE MACHINING

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ABSTRACT: Wire Electrical Discharge Machining is a cutting method used for obtaining parts with complex geometries or for cutting hard metals. This paper will highlight how the materials from which the wire is made graphite on the surface of the workpieces. Thus, a visual analysis will also be presented with a microscope regarding the type of bedding graphite. This paper seeks to emphasize the importance of this unconventional technology and more specifically the importance of knowing the parameters of a process before planning the production of a benchmark. This paper draws attention to the fact that the surfaces resulting from the unconventional machining process by WEDM are not real and rigid surfaces. They are covered with a brass coating that can be removed by various mechanical, chemical or mechano-chemical processes. The type of coating depends on the material from which the wire is made. The entire analysis was performed by cutting cylindrical tungsten carbide bars.

Keywords: WEDM, brass wire, brass grapihitizing.

INTRODUCTION

In 1943, a former Soviet scholar Lazarenko and his wife created the Electrical Discharge Machining. The working principle is to use the tool electrode like a wire and workpiece between constant pulse discharge is produced by high temperature. The process is also called electrical discharge machining or electric erosion machining because during machining the metal oxidizes and begins to corrode. The most used electrode in EDM machines is the wire. Wire cutting is most often used because it offers high productivity. When making a wire EDM machine it is called WEDM - wire electric discharge machining. [1]

The main concept behind WEDM is about the way in which an electric arc can erode the surface of a material. These electric arcs form when the voltage difference between two closely separated objects, called electrodes, becomes high enough to overcome the resistance of the gap between them. When this occurs, a current of up to 500 A flows through a microscopically small area, vaporizing the surface of the electrodes. This vaporization separates some material from the larger workpiece, leaving a pit on the surface. As numerous arcs occur, this pitting erodes the surface over a large area, shaping it in the desired manner. [2] WEDM is based on complex, discontinuous and localized erosive effects of repetitive pulsed electric discharges between the workpiece and the electrode. As mentioned earlier, only materials that have electrical conductivity can be processed. [3]

1. Experimental procedure

The experimental tests, as mentioned in the abstract, were performed by cutting Ø18.8 metal carbide bars. Metal carbide contains 10% Cobalt (Co) and the size of theTungsten (W) grains reaches a maximum of 0.5 µm. There is also Carbon (C) with black, Titanium (Ti) and Tantalum (Ta). The cutting of the tungsten carbide bars was done on the AgieCharmilles AC Progress V4 machine. With this WEDM machine whose control is based on a CNC system with coordinates in absolute or incremental system, it is possible to process parts with complex geometries. The machine has 3 + 2 axis.

On the AC Progress V4 machine, the WEDM operation is performed with a electric potential voltage between 20 and 82V. The current frequency is approximately 5kHz. The electrical curent can have a value of 40A at a maximum period of 300µs. The tool temperature is between 8000...12000°C. The material will be removed at a maximum feed rate of 4 mm/min. Dielectric filtration is done with 4 filters capable of filtering microparticles with dimensions between 2...5-µm.

The wire with which the cutting was made is a CobraCutA. The CobraCut® series of coated wire electrodes has been developed together with AGIE. They are suitable for a number of AGIE wire cutting machines and a variety of applications. The main features of this brass wire are:

- Hard zinc coated EDM wire electrode
- For highest demands on reproducible precision and surface quality
- High straightness for proper automatic threading

Table 1. Mechanical characteristics of the wire

Item	Core Material	Coating Material	Tensile Strength	Elongation	Color
CobraCut A	CuZn36	Zinc treated	900 N/mm^2 130,000 PSI	1%	Bright Silver

As can be seen in the chart below, the CobraCut A wire ensures a very high finish and cutting precision - over 80%. The main disadvantage of machining with this wire is the cutting speed, which must be low. Otherwise, the quality of the surface – roughness will not be in the parameters. The price of this CobraCut A, due to its high performance, is quite high. However, the quality of the pieces obtained is very good.

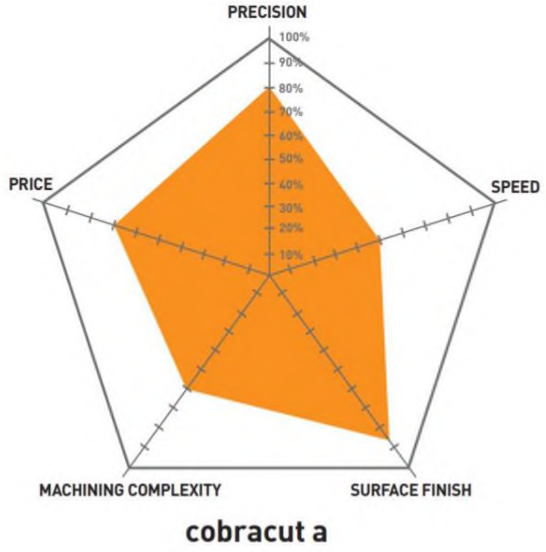

Figure 1. Technical characteristics of the wire

The Ø18.8 metal carbide bar was taken and fixed on the machine table. For fixture was used a bridle with screw.

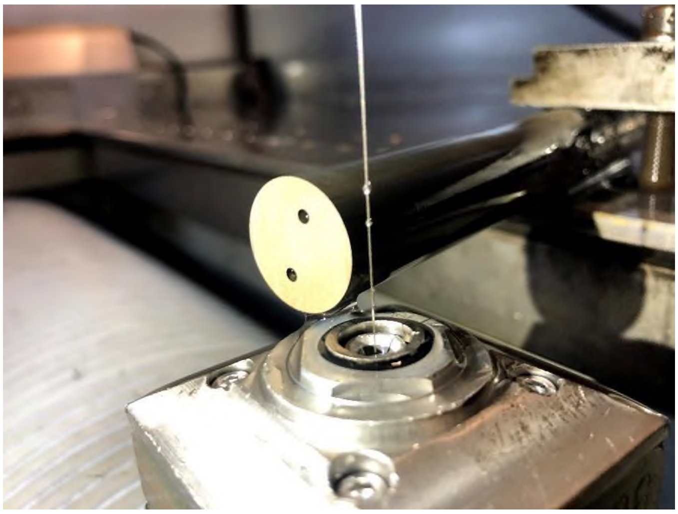

Figure 2. Technical characteristics of the wire

After a few cuts it could be seen that the cut surface does not have the original color of tungsten carbide - an opaque gray. On the contrary, a yellow color is observed. This phenomenon is called graphitizing. The surface of the workpiece is covered with a coating of brass. Knowing the effects of electric current on materials with high electrical conductivity, as well as the environment in which this process takes place, it was possible to easily identify the origin of the coating: it represents the microparticles of brass wire - Cu-Zn - which come off and graphitizing on the cut surface of the workpiece due to high temperature.

To remove the brass layer from the cut surface of the workpieces, immerse the workpiece for 30 seconds in a basin with phosphoric acid concentration 75...80%. [4]

In the figure below you can see the color difference that piece 1 has compared to the other 5 pieces. Except for the first part, all the others are devoid of metallic luster. The only piece with an authentic color is the first piece that was cut using conventional technologies.

Figure 3. Parts cut by EDM

The thickness of the brass coating deposited on the surface of the workpieces is assumed to be less than 0.2 micrometers. It has been shown that this brass coating does not have a very good adhesion to the surface of tungsten carbide. In this sense, the coating can be easily removed by mechanical or chemical actions. Thus, the coating can be removed with the help of felt strips or by placing the pieces in a basin with high concentration of acid.

In the die-making industry, this brass coating is not removed from the mold component plates for two reasons:

- The thickness of the coating is insignificant;
- During the processing of the first part, due to the frictional force that appeared at the contact of the part with the punch and the mold plate, the coating is completely removed. [5]

CONCLUSIONS

It is very important for the industry to prepare a complex library that will help engineers prevent any possible deviations due to the WEDM processing process. As we have shown in this paper, the thickness of the brass coating deposited on the surface of the part can influence the machining accuracy. However, before establishing a processing regime as well as highlighting the effects of processing, the role of the part must be clearly specified.

In conclusion, it should be noted that studies showing different effects of unconventional procedures should continue. Only in this way will the industry be even better prepared for the complex demands of humanity. If a possible graphitizing is undesirable, the material of the part or wire must be replaced with a more heat-resistant or non-graphite one. But, as we have shown, the influence of graphite brass coating is not high and can be easily removed.

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