Technical Spotlight

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Machine	Makino EDNC65
Electrode	POCO EDM-3
Application	Speaker Grill

We have tested many materials, but we like the performance of EDM-3. It has low wear and produces a good surface finish. The electrodes for this job were fabricated by ultrasonic machining. The electrode has 8,900 holes.

There are 300 EDM hours in this job. Roughing takes 150 hours, then we redress the electrode and finish the cavity. Surface finish is .15 Ra micro meter. Thick ribs are .01 mm and thin ribs are .005 mm on this job. The cavity is .5mm deep.

Electrode Material Selection Critical to Success

High-speed, graphite machining centers are big news. Operators that weren't interested in machining graphite are taking a second look. Operators that have been machining graphite can see an increase in productivity with these centers because electrode fabrication is fast and accurate. And high-speed machining centers are extremely clean and efficient.

High-speed machining centers have made it possible to machine intricate detail into almost any grade of graphite, a task that is often impossible using manual or CNC machining equipment. The high-speed spindles, making multiple passes with smaller chip loads, allow thin ribs to be machined without putting pressure on the rib. Materials with low compressive or flexural strength are more likely to break and chip while being machined into thin ribs on conventional equipment. These same materials can be machined on a high-speed machining center without any problems.

The ability to use a high-speed machining center to put fine detail into almost any grade of graphite means the EDMer needs to consider how the electrode will perform as the cavity is cut. EDM performance still relates to the physical properties and characteristics of the graphite grade.

The ideal graphite grade for thin ribs should have a flexural strength above 10,000 psi (703 kg/cm2) and compressive strength above 15,000 psi (1055 kg/cm2). Materials that have these properties are normally found in the Angstrofine and Ultrafine classifications. Without adequate flexural strength, thin-ribbed electrodes can be deflected by flushing pressure or can break during orbiting. Graphite made of tightly-packed small particles will be able to resist erosion at the corners and edges of the electrode better than a material with large particles and pores. Average particle size is the criteria for the different classifications of graphite. Materials can be grouped into four classifications as shown in Table 1.

Within each graphite classification, there are a number of grades produced by different graphite manufacturers. Each grade has its own unique physical properties and microstructure. Typical physical properties that can determine machining characteristics include flexural and compressive strength and hardness. Graphites with a consistent grain size, pore size, and uniform particle distribution are harder to produce, but offer improved EDM performance in the areas of surface finish and electrode wear.

To illustrate the importance of the physical properties and characteristics of the different graphites, we asked Makino to cut roughing and finishing electrodes on their high speed-machining center. Electrodes were produced from three graphite classifications – Ultrafine, Superfine, and Fine, as shown in Table 2.

The electrode shape is a thin-rib design, testing the ability of the material under machining and EDMing conditions.

Electrode Fabrication

Electrodes were machined from 4" x 4" blocks. The machining program used the following roughing sequence: outside profile, inside profile, I.D. circle, and O.D. circle.

Rough Machining – A 0.5" (12mm) 4-flute standard end mill was used to rough machine at 1200 rpms with a feed rate of 185 ipm. Machine time was 1 minute and 50 seconds. Tool change took 30 seconds.

Finish Machining – A 0.25" (6 mm) 2-fluted high helix (50 degree) end mill was used to finish machine at 15,000 rpms and a feed rate of 150 ipm. A high-helix mill must be used or the rib will chip and the surface finish will be poor. Machine time was 7 minutes and 10 seconds. Total machine time was 9 minutes and 30 seconds.

Because the Ultrafine graphite is harder than the other two graphites, this material was run at 80 percent of the above speeds and feeds. The rough machining took 2 minutes, 9 seconds and the finish machining took 8 minutes, 39 seconds with 30 seconds for tool change out. Total machine time was 11 minutes and 18 seconds.

No problems were encountered during the graphite machining and the completed electrodes were virtually identical.

EDMing of Cavities

Testing was designed to evaluate the performance of the graphites. The electrode ribs were .020" and the depth of the cut was 1 inch. Flushing was not used, as it would cause the electrode to vibrate. Starting at .750" depth, pulsing was used to allow the debris to clear the gap. The roughing electrode was plunged to depth and orbited to open the cavity for the finishing electrode.

Two cuts were planned – Cut A was a fine setting cut at 13 amps and Cut B was at 21 amps for production speed. The results are shown in Table 3.

Conclusion

Graphite from all three classifications was very easy to machine into the desired electrode shape. The differences in physical properties and EDM characteristics were very apparent in their EDM performance (Table 3). The graphite with the smaller particle size and higher strength produced cavities without the electrode failing during the EDM process. Although the cost of the electrode material is higher, the EDMer can depend on consistent results using the proper material for the intended application.