Comparing Cutting Times of Selected Diamond Wheel Types

1.0: Purpose

A comparison of cutting times for various diamond wheel types is necessary to help further investigate the advantages of certain wheel types over others. By cutting different material types one can determine the efficiency of certain diamond wheel types and their advantages over others. The data compiled will be used as a guide for consumers to assist in selecting diamond wheels for certain applications.

2.0: Experiment and Procedure

There are many types of diamond wheels which range in diameter, diamond concentration, diamond particle size, and width. In this experiment, the effect that diamond particle size has upon cutting properties will be investigated. Using three different materials, namely Aluminum, Brass, and Quartz, cuts will be made to determine cutting times for Coarse, Medium, and Fine sized diamond wheels.
The data collected will then be plotted and compared to determine the effects of diamond particle size on cutting time. Using a Model 650 Low Speed Diamond Wheel Saw, each diamond wafering blade was used for cutting the specified materials. Each specimen cut was a 1” diameter rod of material, helping maintain consistency during the cutting process. Specimens were first mounted onto a graphite plate, which was then mounted to an aluminum mounting block. The entire system was then placed into the Model 65001 Single Axis Goniometer specimen mount of the Model 650. Specimens were mounted using MWH 135 low melting point wax (melting point at 100 degrees Celsius). The following diamond wheels were used in this experiment:

Diamond Wheels

1. 4” diam.; 0.012” thickness; Fine diamond wheel; high concentration. (DWH 4123)
2. 4” diam.; 0.012” thickness; Medium diamond wheel; high concentration. (DWH4122)
3. 4” diam; 0.012” thickness; Coarse diamond wheel; high concentration. (DWH 4121)

Each diamond wheel was used to make three cuts on each sample, with a total of nine cuts total per wheel. The diamond wheels were dressed with a silicon carbide dressing stick immediately prior to cutting. The following cutting parameters were used for each of the cuts made.

Cutting Parameters

Load:	80 grams	Blade Dressing:	Prior to each cut
Wheel Speed:	10 (maximum on dial)	Coolant Density:	30:1

Each cut was timed and recorded, with each cut averaged for each sample and then plotted in a graph. Based upon the data collected, the following graph was generated.

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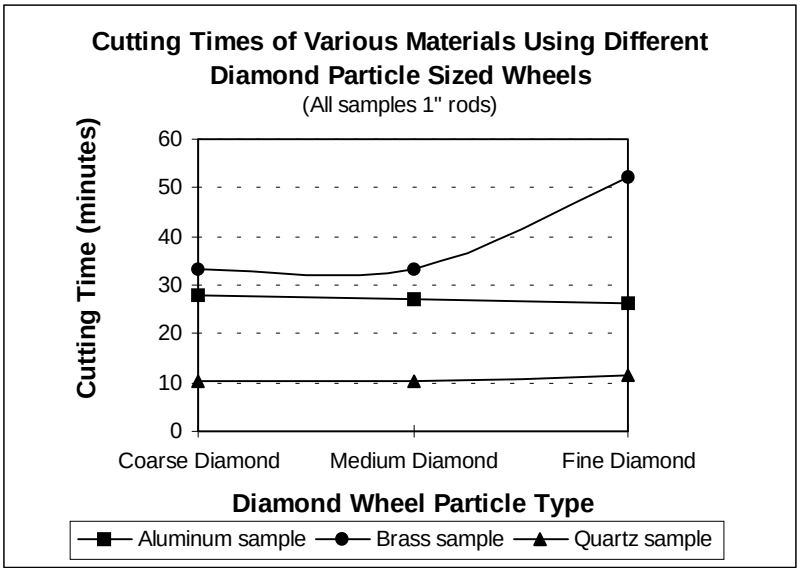

Chart 1: Graph illustrating the effect of diamond particle size on cutting speed of various material types. The graph shows for both Quartz and Brass, cutting time increases as the diamond particle size is decreased. This is due to the smaller diameter of the diamond particles removing less material than the larger sized diamonds. In the aluminum sample, however, a slight decrease in the cutting time was observed at the fine diamond size.

Conclusions

Based upon the data collected in this experiment it was found that diamond particle size does have a noticeable effect on cutting times. In the samples observed in this experiment, the fine sized diamond wheels cut slower than the medium and coarse sized diamond wheels, with the coarse diamond wheels cutting the fastest. It was also observed that Brass cuts much slower than Aluminum and Quartz, with Quartz cutting the fastest of the three materials.

The cutting time for the coarse vs. fine diamond wheels can be explained by the particle size of the diamonds. The coarse diamonds are larger than the fine diamonds (by definition) and will remove more material per diamond than the finer diamonds. This means that coarse diamond wheels are more aggressive for material removal than the finer diamond wheels. However, the larger diamonds also come at the cost of increased subsurface damage. If cutting fragile, more delicate materials then the finer diamond particle sized wheels should be used.

For the materials aspect of cutting times, the variation in cutting speed is primarily due to the mechanism behind cutting specific material types. Ductile materials are removed by shearing forces caused by the diamonds. The coarse wheels remove more material per unit area than do the fine wheels, but can also contribute to blade loading effects. Brittle materials, which are removed by chip formation and brittle fracture, are cut much more efficiently because the diamonds can easily initiate chips in any ceramic or brittle material due to it's high hardness value.

Therefore it has been shown that two main mechanisms involved in cutting will greatly affect the cutting time of specimens:

1. Diamond particle size
2. Material type

Another factor which may affect cutting is diamond concentration. This should be investigated in future experiments.

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