Higher Grinding Efficiency

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Trending toward Higher Grinding Efficiency

In recent years, the manufacturing industry has experienced extremely robust markets, and there is a need to raise production volumes and respond to demand with shorter delivery times. Improving productivity is a major focus. Demand for high-precision and high-performance products has increased the use of materials with characteristics such as high strength, high heat resistance and high toughness. These types of materials are classified as hard to grind materials. In order to grind those materials with high precision, productivity usually gets sacrificed.

To produce as many products in as little time as possible, manufacturers are reviewing their manufacturing processes. Occasionally, these reviews lead to a decision to buy additional equipment. This also results in additional labor force and operating cost increases. With the constant demand for operating cost reduction, many companies are unable to invest significantly in improving processes and in many cases production efficiency declines.

However, considerations can still be made to increase grinding wheel effectiveness by changing specifications or grinding conditions. These considerations continuously drive demand for more efficient grinding wheels, since this can increase production capacity without any significant cost or personnel increases.

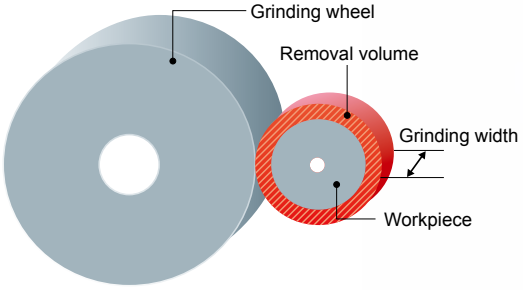
There are several ways to improve grinding efficiency. Let's review a few of them.

Approaches to Higher Grinding Efficiency ①
～Increase Cutting Speed and Depth～

The most common approach for improving grinding efficiency is to increase cutting rate and depth. However changing these grinding conditions may cause various problems, such as inaccuracies, grinding burn, and reduced grinding wheel life. Therefore it is important to consider all conditions: dressing, workpiece peripheral velocity and also to select the optimal grinding wheel. In making efficiency considerations, don't forget about the workpiece material, required accuracy and dressing interval.

Before any changes take place, it is essential to know the current grinding wheel efficiency. Grinding efficiency or Q' (Q prime) is an index for a grinding wheel's capability. Q' refers to the workpiece material volume removed per time unit and is represented by the cylindrical grinding example equation 1 (Fig. 1). Grinding a larger volume in a shorter time increases Q', indicating higher efficiency.

Fig. 1 Calculation of Grinding Efficiency

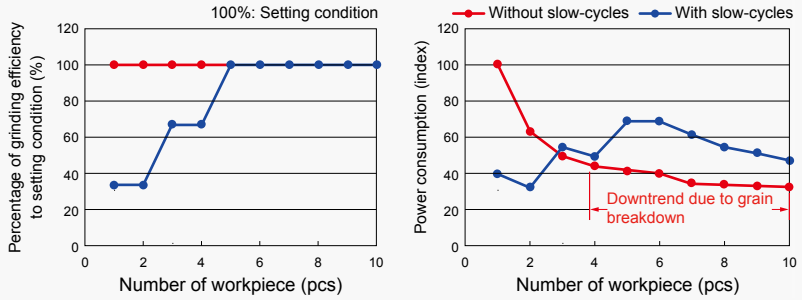


$$Q'(mm^3/mm\cdot s) = \frac{\text{Volume of workpiece removed } (mm^3)}{\text{Grinding width } (mm) \times \text{Cycle time } (s)} \quad \cdots\cdots \text{Equation 1}$$

Approaches to Higher Grinding Efficiency ②
～Grinding and Non-Grinding Time Reduction (Dress Interval Increase)～

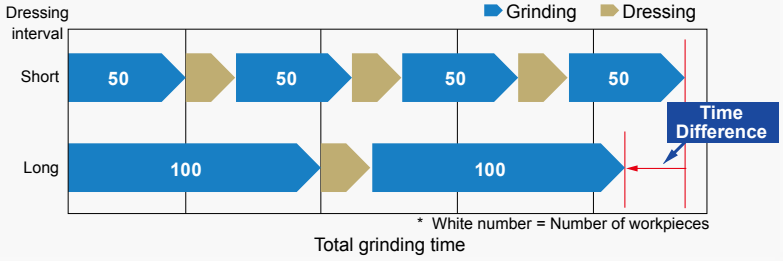
The reduction of the slow-cycle is another way to shorten grinding time. Slow-cycle is the process that stabilizes workpiece quality by purposely reducing feed rate immediately after dressing (Fig. 2). Grinding wheels with good cutting ability do not require a slow-cycle after dress, reducing overall grinding times.

Fig. 2 Slow-Cycle



Depending on the application, reducing non-grinding time also leads to high efficiency grinding. Non-grinding time includes the time required for grinding wheel replacement, dressing due to wheel breakdown, and the time required for the grinding wheel and workpiece to come into initial contact. These reductions, which seem to be far from the term high efficiency grinding, lead to shorter overall grinding times when considered throughout the manufacturing process. Extending the dressing interval of the grinding wheel greatly contributes to reducing grinding wheel change and overall dressing time. The longer the dressing interval, the shorter the total machining time (Fig. 3). Depending on the factors that determine the dressing interval, if the workpiece has poor geometric accuracy, a grinding wheel with a higher shape retention will be required. If the surface roughness or roundness deteriorates due to a decrease in the cutting ability of the grinding wheel, a grinding wheel with an excellent cutting ability must be considered.

Fig. 3 Dress Interval's Impact on Grinding Time



Approaches to Higher Grinding Efficiency ③
～Changing the Grinding Method～

Increased efficiency may be achieved by reviewing the grinding method. For example, when the top and bottom surfaces of the workpiece are ground one-at-a-time by using the surface grinding method, the process can be changed to the double-disc surface grinding method. This will significantly reduce grinding time (Fig. 4). Also, changing the cylindrical grinding method to the centerless grinding method (through feed) may reduce the workpiece replacement process (Fig. 5).

Fig. 4 Double-Disc Surface Grinding Method

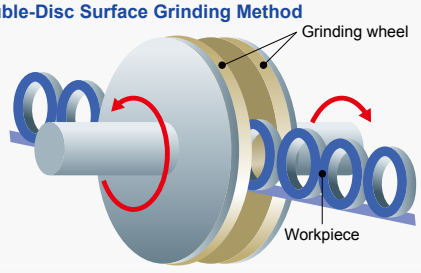
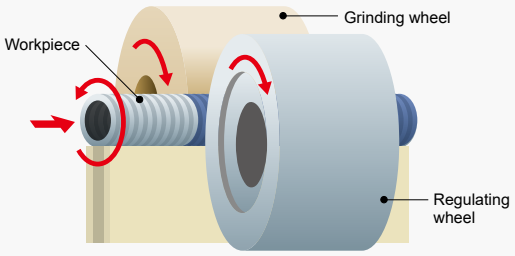


Fig. 5 Centerless Grinding Method



Recently, market demand has increased for simultaneous grinding using multi-axis grinding machines.

Although there are restrictions based on workpiece shapes and tools, reviewing the grinding method may lead to shorter grinding times.

We have presented three possible approaches to improving efficiency. Increasing grinding efficiency always carries with it a risk of creating unwanted issues. Therefore, optimizing the grinding wheel and grinding conditions must be done according to the degree of efficiency and accuracy required. Noritake has developed a variety of new products for improving grinding efficiency (Fig. 6). Refer to specific product feature section for more details.

Fig. 6 Approaches to High Efficiency Grinding and Recommended Noritake Products

		Required grinding wheel characteristics	Recommended Noritake product (Grinding method in < >)
Approach ①	Increase cutting speed Increase cutting depth	Improve shape retention Improve wheel life Improve workpiece quality Prevent grinding burn	・Super Uniform* ・Nonclotty* ・CZ grinding wheel ・Mega Life wheel* ・VP wheel* ・CXE series (resin bond)* ・BWC series ・Metal Honing (MHB)
Approach ②	Extend the dressing interval	Improve cutting ability Improve shape retention	・Life King* ・Flatdy* ・I-Queen
Approach ③	Grinding method changes		<Centerless grinding method> <Double-disc surface grinding method> ・NeoEpox ・BRZ

* Refer to the NORITAKE TECHNICAL JOURNAL 2018 for details.