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Truing and dressing grinding wheels can give operators a rough time if they're not up-to-speed on the processes' particulars.

Dressing for Success

▶ BY LARRY OLSON

The best way to keep a grinding wheel producing good parts is to true and dress it regularly. Truing involves manipulating the grinding wheel geometry to create the desired wheel profile while ensuring its concentricity. Dressing involves removing bonding material to expose the sharp grits in the wheels, thereby maintaining a consistent, quality grinding wheel surface.

For conventional abrasives, truing and dressing are usually accomplished simultaneously; as a specific profile in a grinding wheel is being produced (truing), the correct grit exposure (dressing) also is being generated.

A truing and dressing system should allow a wheel to be restored rapidly, accurately and with high repeatability.

Single-Point Truing and Dressing

The traditional method of wheel truing and dressing is to apply a single-point dresser made with diamond. Forms and surface finishes are achieved by moving a rotating grinding wheel into and across the stationary device. In some cases, the single-point dresser may have both in-feed and cross-feed motions. Sometimes, a cluster of single points or a solid block is used.

Because single-point dressers are stationary, they tend to "rub" the bonding agent away from the grinding wheel during truing and dressing. This is important to remember. The increased friction generates heat, which is transferred to the wheel. This causes the wheel to expand and affects the precision of the intended grinding wheel form. In extreme cases, the heat generated also may change the characteristics of the wheel's bonding agent, resulting in a wheel with an inconsistent or "gummy" surface.

The amount of grit a single-point dresser exposes can be controlled by changing the depth of cut and the speed at which the dresser traverses the grinding wheel (and sometimes the grinding wheel speed or direction). Single-point dressers generally take up to 0.010" from the wheel radius on each pass during the truing/dressing cycle. Removing less material extends wheel life and reduces operating expense. It also means fewer grinding wheels are required, and production times increase, because maintenance time associated with wheel replacement is reduced.

Hermann Schmidt Co.

This narrow-wheel dresser is designed to rapidly dress the sides of a grinding wheel to a very thin size. The rotating cluster diamond directs the pressure up into the grinding wheel, eliminating the side pressure of a single-point diamond. The device will dress a wheel from 1/4" to 0.040" in less than 1 minute.

Single-point dressers wear until the onset of diamond fade, during which the single-point dresser begins to wear at a rapid rate. The onset of diamond fade is unpredictable. Shortly after it begins, the single-point dresser will fail catastrophically by suddenly shattering or fracturing. When

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The information presented in the first two sections of this article derives from an article titled Rotary Dressing and Truing, *written by Curtis Brown, project engineer, G II Solutions Inc., Central, S.C.*

this occurs, the grinding wheel and the workpiece may be severely damaged. Most end users routinely replace single-point dressers long before the onset of diamond fade.

Rotary Systems

Rotary truing and dressing systems incorporate a spindle driving a diamond roll. During processing, a rotating grinding wheel moves into and across the rotating roll. As with single-point devices, the surface of the grinding wheel is affected by changing the DOC and the rate at which the roll traverses the wheel.

The key variable introduced with rotary truing and dressing is the ability to control the relative surface speeds between the truing and dressing roll and the grinding wheel. For most grinding wheels, there is a specific percentage between these surface speeds that creates an optimum surface finish. The percentage varies with grinding wheel composition.

Rotary truing and dressing is superior to single-point, cluster and stick dressing for high-volume part production and close-tolerance grinding. The process maximizes wheel life and greatly increases consistency in the wheel profile. Rotary truing and dressing can be incorporated into the grinding machine's controls to maximize production time, reduce labor costs, allow parts with more complex shapes to be ground and ensure tighter tolerances in the finished product.

GIDCO (General Industrial Diamond Co. Inc.)

This E228VM truing and dressing machine from GIDCO (General Industrial Diamond Co. Inc.) trues and dresses diamond and CBN wheels up to 14" in diameter and 1.5" wide. A comprehensive array of work spindle options, including custom nose tapers and quick-change systems, make the equipment suitable for all CNC grinding machinery. Not shown is a newly added digital readout with control panels.

Rotary dressers are able to remove as little as 0.00005" in a single pass. Most of the heat generated during dressing is transferred to the chips—not the grinding wheel. The result is less thermal expansion of the wheel while maintaining the integrity of the wheel's bonding material.

For vitrified-bond superabrasive grinding wheels, rotary truing and dressing is an absolute necessity. Superabrasive wheels provide greater flexibility and improve the grinding process, but they are harder than conventional grinding wheels. Superbrasive wheels can only be trued and dressed effectively with rotary devices.

Unlike single-point dressers—whose wear is often erratic—truing/dressing rolls wear at a consistent rate and, consequently, remove a consistent amount of material. When truing and dressing is a CNC process, the programmed depth will be closer to the actual depth for each pass, and the actual amount of material removed will be closer to the programmed amount. This ensures the actual size of the wheel is exact and part tolerances are more closely and easily maintained.

Rotary dressing and truing spindles may be powered hydraulically, pneumatically or electrically. Although electric spindles are slightly more expensive, they can incorporate manual and automatic features that allow the user to maintain precise spindle speed, regardless of applied forces. In most hydraulic/pneumatic cases, a speed is approximated—and is not easily identified—by setting an oil or air pressure. Once forces are applied during the truing and dressing cycle, the speed decreases.

System Selection Guidelines

There are a number of things to consider when choosing a truing/dressing system. Construction must be rigid and compact, and the system should be simple to operate and flexible enough to accommodate a variety of wheels and wheel packs (by utilizing rapidly adaptable mounts). If part requirements are tight, the wheel would have to be profiled stringently. Truing and dressing systems, therefore, would need to incorporate the requisite instrumentation.

According to Lee O'Malley, product manager for General Industrial Diamond Co. (GIDCO) Inc., Whippany, N.J., lower-cost, free-standing systems are user-friendly and designed for simple angles and flats. "For more complex shapes, video measurement is best," he said. "This gives the operator the ability to generate, measure and inspect the wheel shape and profile with greater speed and accuracy."

The following companies contributed to this article:

AGT-Applied Grinding Technology Inc.
(248) 437-7800
www.appliedgrinding.com

G II Solutions Inc.
(800) 948-5478
www.giisolutions.com

General Industrial Diamond Co. Inc. (GIDCO)
(800) 736-2500
www.gidco.com

Hermann Schmidt Co.
(860) 289-3347
www.hschmidt.com

Hybco International Inc.
(440) 352-1001
www.hybcoinc.com

"Educating the grinding system user is fundamental," explained Jim Greenwood, president of AGT-Applied Grinding Technology Inc., Wixom, Mich. "With so many different applications, the user has to be aware of the many grinding alternatives, especially different abrasives and bonding systems."

Greenwood warned users not to take a short cut by using form bars. "Quality and tighter tolerances demand improved dressing. With ceramic, CBN and all the combinations of materials for the different types of wheels, CNC truing and dressing is required to make accurate, complex shapes. Form bars are just not accurate enough. The harder wheels require rotary diamond discs. In fact, that is the only way for CBN wheels." He also strongly recommended buying a sensing system to determine if contact is made over the whole wheel.

Curtis Brown, project engineer for G II Solutions Inc., Central, S.C., is a proponent of electrical spindle control. "These systems provide consistent, precise results, greater wheel wear life and overall lower roll wear. Having more variables under control delivers more precise dimensional tolerance and finish control."

G II Solutions' electric spindles feature brushless DC electric motors integral to the shafts and bearings. These compact motors deliver a maximum speed of 25,000 to 30,000 rpm and programmable servodrive speed controls that hold constant under varying load conditions. Some spindle designs feature ceramic balls in the bearings that provide 30 percent greater system rigidity.

The Price for Precision

Truing and dressing system costs relate directly to the application and complexity of the equipment.

Mike Dickson, general manager of Hermann Schmidt Co., East Hartford, Conn., said, "Our systems cost from $620 for the model NWD narrow-wheel dresser to $1,560 for the model KR radius and angle dresser. Both are designed for use right on the grinding machine."

Not surprisingly, free-standing truing and dressing machines are more costly. GIDCO's free-standing models can run from $24,000 to more than $50,000.

Freestanding CVD-diamond rotary (left) and stationary (right) dressing tools offer enhanced fracture toughness and strength. This optimizes the tool's life and dimensional stability.

AGT's PC-based control systems run between $30,000 and $40,000. Its high-volume production machines cost up to $80,000. "Sophisticated features for high-production systems make the difference," the company's Greenwood said. "For example, in-process truing and dressing with CNC has the advan-

Truing diamond wheels with lasers

Lasers are currently used as non-contact, micromachining tools for a variety of manufacturing applications. They have many advantages when cutting hard, brittle and high-temperature materials because of their salient characteristics, such as high intensity, directionality and spatial coherence.

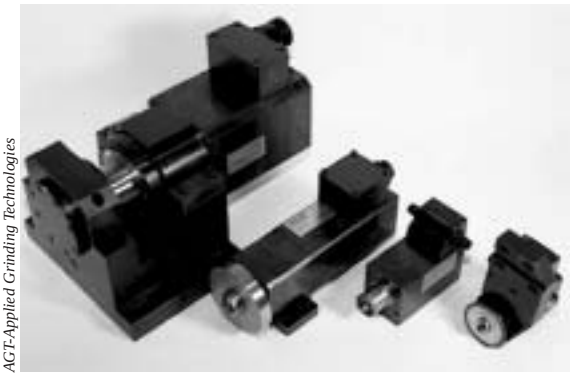
The idea of using a laser as a non-contact dressing tool for superabrasive grinding wheels was proposed by R.K. Kang, J.T. Yuan, Y.P. Zhang and J.X. Ren of the Department of Aircraft Manufacturing Engineering, Northwestern Polytechnical University, Xi'an, China. Their investigations and studies of laser-dressing diamond wheels were described in a paper published in *Advances in Abrasive Processes, Year 2001*. These studies and the paper describe the application of a laser for truing metal- and resin-bond diamond wheels.

An experiment was carried out on a CNC laser machine. A diamond wheel was mounted on the worktable, and pulsed laser radiation was focused onto the diamond wheel. The laser was a pulsed Nd:YAG laser operating at a wavelength of 1,060nm with four classes of pulse width: 0.2 milliseconds, 0.5 milliseconds, 2 milliseconds and 5 milliseconds. The laser had a beam divergence of less than 0.002 radians and was operated to deliver different pulse energies at different pulse frequencies, from 2 to 20 Hz, to produce a maximum average power of 100 watts.

In laser truing, the resin bond is decomposed, the bronze bond is made molten or vaporized, and the diamond grains that are less damaged are removed, accompanied by a sputter of the bond materials. After one truing cycle, the surface topography of the wheels was acceptable, with the roundness of the wheels indicating that they were properly dressed. A second truing cycle further improved the surface topography.

The surface topography of both resin- and bronze-bond diamond wheels was examined with a scanning electron microscope after laser truing, as were the chips collected from the diamond wheels during truing. In addition, a roundness instrument was used to measure the roundness variations of the diamond wheels after laser truing. Measurement of the diamond wheels after truing determined that the expected geometric shape and accuracy was achieved by controlling the laser irradiation parameters and the diamond wheel motions relative to the laser beam.

—L. Olson



AGT-Applied Grinding Technologies

Electric motorized dressing spindles are popular for many of today's dressing applications. These small, high-performance spindles, from AGT-Applied Grinding Technologies Inc., will maintain constant speed within 5 rpm and constant truing ratios. The spindles are said to be extremely smooth running at speeds of 100 to 16,000 rpm.

tage of providing wear compensation."

Bob Richman, manufacturing engineer for Hybco International Inc., Mentor, Ohio, added: "The cost of dressing options is usually justified by the complexity of the particular grinding application. The attachments for our grinding systems range from straight dressers to custom designs for V-dressing wheels—no crush rollers. The systems that are designed for production often feature wear compensation for reduction in wheel size."

Single-point dressers are usually replaced on a regular basis—often once each week. Dressing and truing rolls wear at such a slow rate that one roll may last an entire year, even in high-production situations. While single-point dressers are often discarded with unused material remaining, dressing and truing rolls should be used in their entirety.

"Say the cost factor for two single-points per week is $180," G II Solution's Brown offered. "That is nearly $10,000 for an entire year. By contrast, an electric rotary system with spindle and rolls costs on average $10,000 and may last for 3 to 5 years. Also, each time a roll or single-point dresser is replaced, the system must be re-indicated, and changeover time for single-points may take up to an hour." With a rotary system, changeover time is eliminated.

Hence, when comparing one setup per year with rolls to 50 to 100 per year with single-point dressers, the difference in production costs is significant.

Grinding Out Productivity

Operators must remember that the whole grinding process must be analyzed to achieve optimum results. That includes truing and dressing. Sometimes, changing wheels is necessary.

"Conventional aluminum oxide wheels for demanding applications may not be good enough," AGT's Greenwood stated, "even with improved on-machine truing and dressing. A more cost-effective solution, primarily driven by tolerance and quality requirements, might be to upgrade to a more modern alternative wheel and bonding system. Different abrasives and bond systems can improve changeover and dressing cycle times, for example, by a factor of three."

He cited an instance in which a customer wanted to grind a 1mm profile in glass to extremely fine tolerances with a resin-bond diamond wheel. Repeated attempts at truing were unsuccessful. Analysis indicated offline dressing was not able to achieve the desired result. Changing from a resin-bond diamond wheel to a vitrified-bond diamond wheel and adding on-machine truing and dressing was very successful. "The number of process steps was reduced from six to two," Greenwood explained. "Productivity of the operation improved to such an extent that the number of machines required for production was cut from 18 to eight."

Hermann Schmidt's Dickson said, "Thinning a wheel with our narrow-wheel dresser utilizes a cluster diamond for stock removal to specific dimensional tolerances. This attachment runs right on the grinding machine. An operator can take a wheel from ¼" to 0.040" in 1 minute, compared to taking 20 minutes using a stick dresser."

If you're not certain which truing and dressing tools are right for the job at hand, consult an expert. Fight off any inclination to gloss over the importance of a properly adjusted and specified wheel. Remember: dress for success, and stay true to your task.

About the Author

Larry Olson is a freelance writer who has written extensively about manufacturing-related topics.