Three Faces of Creep-Feed Grinding

The use of creep-feed grinding has grown dramatically to meet the need for greater production efficiency. Of the three basic types, one or more may be just right for you.

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Creep-feed grinding is an abrasive machining process mainly used to produce slots or intricate forms in difficult-to-grind materials such as prehardened tool steels and high-temperature nickel-base aerospace alloys. The process utilizes a grinding wheel to impart forms previously associated with milling or broaching operations into a workpiece in one pass, at full depth of cut and very slow table speeds. The use of creep-feed grinding has grown to meet the need for increased productivity and greater production efficiencies.

Creep-feed grinding has two main advantages over machining. First, it can work materials that are difficult and costly to shape by other methods. Second, it is easier to modify the form on a grinding wheel than it is on a broach or milling cutter, enabling rapid design alterations and changeovers.

The process also has several advantages over conventional reciprocating surface grinding:

More actual grinding time. Time lost with the wheel not in contact with the workpiece while reversing the table in conventional grinding, can exceed the actual time required to grind the part.

Less tendency to chatter. The increased depth of cut associated with creep-feed grinding produces a grater interface between the wheel and the workplace. This increased interface, combined with slower table speeds, has a tendency to stabilize any vibration generated during the grinding process.

Increased form-holding characteristics. The wheel enters the workpiece slowly and only once, generating complete form that equalizes the load over the entire wheel face. Entering slowly and only once eliminates the shearing of abrasive particles that occurs as the wheel repeatedly strikes the edge of the workpiece in conventional reciprocating grinding.

Less thermal damage. In conventional surface grinding, with higher depths of cut and increased spindle and table speeds, heat is generated (and transferred into the workpiece) in impulses. But in creep-feed grinding, the heat is a constant moderate influx distributed over a much grater area. The result is that a greater volume of the workpiece material is

heated to lower average and maximum temperatures. Although the maximum temperature may reach a point high enough to cause thermal damage ahead of the grinding wheel, the disturbed material will be removed during, the grinding process.

Types of Creep-feed Grinding

Three basic types of creep-feed grinding are used in U.S. industry today: Pseudo creep feed, true creep feed, and continuous-dress creep feed. Each method is utilized for specific grinding applications.

Pseudo creep-feed grinding is used for workplaces with narrow cross sections. The piece is ground at full depth, but because of the narrow cross section the full length arc contact experienced in true creep-feed grinding is not generated.

The narrow cross section of the workplace allows the use of conventional grinding machines with hydraulic drives. Table speeds, although slow by conventional reciprocating standards, do not require the precise mechanical drives of true creep-feed grinders. Pseudo creep-feed grinding can provide greater productivity than conventional reciprocating grinding, but it cannot compete with true creep-feed grinding.

Wheels used for pseudo creep-feed grinding need not be as highly porous as true creep-feed wheels, because the coolant application and swarf removal requirements are not as demanding. In some cases, conventional wheels will perform acceptably, although very porous wheels will provide the best performance. Wheel speeds for pseudo creep-feed grinding are typically in the area of 6500 sfm.

True creep-feed grinding, utilizing machines especially designed for the process, offers high metal-removal rates with full-depth-of-cut, one-pass grinding. It offers great potential for increased productivity and accuracy. The workpiece can start out as hardened blank stock, be fixtured only once, and end up as a finished part. The process also offers improved dimensional stability and freedom from adverse thermal effects in the workpiece.

True creep-feed grinding maximizes the length of arc of contact between the wheel and the workpiece. For this reason it demands a specially designed grinding wheel and machine tool specifically built for creep-feed grinding. In pseudo creep-feed grinding, a surge in the table can cause the wheel to exit the part; in true creep-feed grinding, a table surge can actually cause the wheel to burst.

Because of the increased area of contact, wheels for true creep-feed should be softer than conventional wheels. In addition, high metal removal rates and increased demand to transport coolant into the grinding interface require as open a wheel structure as possible.

Rigidity is essential to creep-feed grinding machines. They must withstand increased forces resulting from crush forming the grinding wheel for close-tolerance, form-grinding

repeatability. Wheel speeds should be variable, while table speeds should be mechanically driven to ensure stick-free, slip-free operation.

In continuous-dress grinding, the wheel is sharpened and profiled while actively grinding the workpiece rather than between grinding cycles. This type of grinding can provide greater metal removal rates than those of true creep feed. More important, continuous-dress grinding increases form-holding and dimensional stability.

Continuous-dress grinding requires specially designed machines. They must have all the attributes of true creep-feed grinding machines and also be equipped with compensating-speed wheel spindles. These are necessary to automatically increase the speed of the wheel as its diameter decreases during operation. The compensating spindles ensure that the grinding wheel operates at a constant surface speed.

The rate at which the dressing device is fed into the wheel and the rate at which the wheel is fed into the workplace must also be perfectly synchronized to compensate for wheel wear, otherwise it will be impossible to grind the workpiece parallel.

The dressing operation resharpens dull abrasive grains or releases them from the bond system. Selection of the type of diamond roll dressing device to use----hand-set or reverse-platted---depends upon the desired form, grit size, and wheel grade. Although diamond roll dressing will not produce as aggressive a wheel as will crush-truing, continuous dressing will maintain the wheel at a constant percentage of its full potential. This produces steadier and lower average grinding forces, resulting in more efficient use of abrasive materials and shorter cycle times.

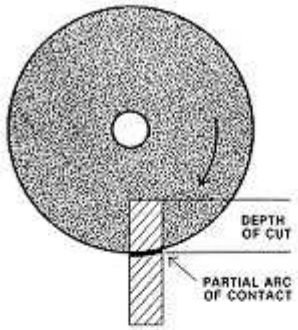
In review, creep-feed grinding can provide significant productivity improvements without requiring investment in specialized machinery. The process can be implemented on conventional machines for workpieces that have narrow cross sections.

True creep-feed grinding requires specially designed machinery, but can provide high metal-removal rates while producing a workpiece of better quality. The process is especially beneficial in applications where close tolerances and repeatability are important.

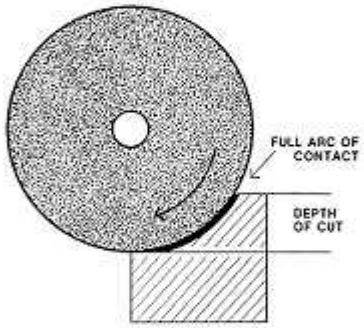
Continuous-dress creep-feed grinding offers the highest metal removal rates and the best form-holding and dimensional stability. The grinding system must be carefully controlled, however, to ensure successful operation.

All of these grinding techniques require consideration of the total grinding system. Factors that can affect system performance and productivity include workplace fixturing; wheel types and speeds; infeed rates; coolant placement, volume and pressure; truing and dressing systems;and, most important, the grinding machine itself. Careful coordination of these elements into a total creep-feed grinding system can yield substantial quality and productivity benefits for manufacturers of difficult-to-grind components.

PSEUDO CREEP FEED



TRUE CREEP FEED



CONTINUOUS DRESS
SYNCHRONIZED INFEEDS