Grinding Processes, A Review

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Abstract: Grinding is an abrasive machining process which is used to improve the surface quality and to achieve dimensional accuracy of a work piece. In grinding, a grinding wheel is used as a cutting tool and material is removed from the work piece. In grinding surface roughness and material removal rate are considered important output responses for quality and quantity of production. In cylindrical grinding out-of-roundness is another important output parameter. It is radial run out of the cylindrical work piece and it is difference between minimum and maximum radius. In the present study various grinding processes are discussed.

1. Introduction:
Grinding process is used as finishing process as well as the machining process. In grinding, a grinding wheel is used as a cutting tool and material is removed from the work piece using similar principles to that of milling or turning. However instead of having one large cutting edge there are numerous small cutting edges formed by grits on the grinding wheel surface, with all of them working together at high speeds. Each grit is then able to remove a small amount of material from the work piece. Since the size of the chip produced by each grit is small and there is large number of grits, a high surface finish and high tolerances can be achieved on the component. Broadly, grinding has two different processes namely rough grinding and fine grinding. The rough grinding is used to grind castings and weldments using portable grinders or pedestal grinders while fine grinding also known as precision grinding is used to machine those materials or jobs that are too hard to be machined by other machining operations or when high surface finish and precise tolerances of the order of ± 0.02 mm are required (Kaushish, 2010). Grinding is usually the last finishing operation to be completed on the work piece and hence any deviations in quality such as geometrical errors and surface finish cannot be passed on to the next operation. In grinding surface roughness and material removal rate are major output parameters. Surface roughness is the finely spaced textured irregularities, left by the cutting tool. In many engineering applications very smooth surfaces are required like in pistons, piston pins, crankshafts, etc. Material removal rate is the quantity of material removed with respect to time. More material removal rate means process would take less time to complete (Agarwal, 2010).

2. TYPES OF GRINDING PROCESS
2.1 Cylindrical grinding
Cylindrical grinding is used to grind the diameters of cylindrical work pieces, cylindrical tapers, shoulders, fillets cams and crankshafts. In this process the cylindrical work piece is held between centers and rotated by means of dog or chuck. Both the work piece and the grinding wheel revolves but in opposite direction with respect to each other. The grinding wheel is fed to the work piece and work piece is traversed past the grinding wheel. This traverse of work piece is controlled by the dogs which cause the table or wheel to reverse at the end of each stroke (Alagumurthi, 2006). Two types of operations are carried out on this type of machine namely traverse grinding and plunge type grinding. In traverse grinding, the work piece reciprocates as wheel feeds to produce cylinders longer than the width of the wheel. while in case of plunge type grinding the work rotates in a fixed position as the wheel feeds to produce cylinder of the length equal to or shorter
than the width of wheel. Universal type cylindrical grinder is mostly used in tool rooms for grinding tools. The machine table can be swiveled at an angle in a horizontal plane to permit grinding of tapers on the work piece. The machine used for cylindrical grinding has been shown in Figure 2.1.

![Cylindrical grinding machine](image1)

**Figure 2.1: Cylindrical grinding machine (Priyarajan, 2015)**

### 2.2 Surface grinding

Surface grinding is the most common grinding operation and is used to grind flat surfaces. Figure 2.2 represents the working of a surface grinder.

![Surface grinding machine](image2)

**Figure 1.3: Surface grinding machine (Harry, 2012)**

In surface grinding the ferrous work pieces are held by magnetic chuck or magnetic bed attached to the work table of grinder, whereas non-magnetic materials are mostly held by special fixtures, vices, or vacuum chucks. A double sided straight wheel is mounted on the horizontal spindle of the grinder. There are two common types of operations carried out on surface grinding machine, i.e. traverse grinding and plunge grinding (Kaushish, 2010). In traverse grinding, the table reciprocates longitudinally and feeds laterally after each stroke. Whereas in plunge grinding the wheel is moved radially into the work piece and grinding table moves...
longitudinally as in the case of grinding a groove. This type of grinding is mainly used for de-burring, dimensioning of parts having flat surfaces.

2.3 Centreless grinding

Centreless grinding is similar to cylindrical grinding but in this grinding the work piece is not held between centres, rather it is supported by a combination of grinding wheel, a regulatory wheel and a work rest blade. Work piece is revolved and traversed across the face to grinding wheel while being supported on the work rest blade. The pressure of the revolving grinding wheel and regulating wheel keeps the work piece in contact with the rest blade. To give axial movement to the work the axis of the regulating wheel is inclined at an angle 2° to 10° vertically (Kaushish, 2010). The number of times the work piece has to pass between the wheels is determined by the amount of metal to be removed. Figure 2.3 shows centreless grinding process. This type of grinding is mainly used for grinding of work pieces having simple cylindrical surfaces without steps (Cameron, 2010).

![Figure 2.3: Centreless grinding technique (Priyaranjan, 2015)](image)

2.4 Internal grinding

The internal bores which may be straight or tapered are finished to correct size and shape with the help of internal grinders (Kibbe et al., 1997). Generally there are three types of internal grinding (Chi, 2016).

2.4.1 Chucking type internal grinding:

Chucking type internal grinders are used for internal grinding of cylindrical work pieces of medium sizes. In this type of internal grinder the work piece is chucked and rotated in direction opposite to the direction of rotation of the grinding wheel (Chidambaram, 2003). This type of internal grinding is shown in Figure 2.4.1

![Figure 2.4.1: Chucking type internal grinder (Fiehl, 2012)](image)
2.4.2 Planetary type internal grinding:
In this type of grinder the work is mounted on the reciprocating table and is not revolved. Instead, the grinding wheel is given rotary and eccentric motions to grind cylindrical holes. Planetary internal grinders are used to grind holes in large, irregular shape and heavy work (George, 2013). In these types of grinders small grinding wheels running at very high speeds are used. The planetary type internal grinding is shown in Figure 2.4.2 Planetary Internal Grinding is often utilised where the component cannot be mounted in a conventional Chuck. It is similar to Horizontal Boring where the component remains stationary whilst the tool, in this case a grinding spindle, orbits within the bore.

![Planetary type internal grinding](image)

Figure 2.4.2: Planetary type internal grinding

2.4.3 Centreless type internal grinding:
In this type of grinding the work is supported by three rolls; pressure roll, supporting roll and a regulatory wheel, all the three moving in same direction. The speed of rotation of the work piece is controlled by increasing or decreasing the speed of regulating wheel (Jagtap, 2011). The grinding wheel comes into contact with the inside diameter of the work piece. The pressure applied by the pressure roll is responsible for proper contact of the work piece with regulating wheel and the pressure roll is adjustable to permit loading and unloading of work piece. The centreless type internal grinding is shown in Figure 2.4.3

![Centreless type internal grinding](image)

Figure 2.4.3: Centreless type internal grinding (Kaushish, 2010)
Conclusion: In Cylindrical grinding, various input parameters such as the work piece speed, grinding wheel speed and feed rate has more significant effect for surface roughness and depth of cut has least effect on Material removal rate. In surface grinding the high temperatures encountered at the ground surface create residual stresses and a thin martensitic layer may form on the part surface; this decreases the fatigue strength.

References: