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ANALYSIS OF THE PRINCIPLES OF OPERATION OF GRINDING MACHINES

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ABSTRACT

This article provides information on the types of grinding machines, the principles of operation, what parts are processed on these machines, and the quality and accuracy of the details after processing. In addition, the elements of the materials of grinding machines sandpaper and their effect on the details were explored.

KEYWORDS: *Grinding Machine, Center Less Grinding, Engineering Component, Cylindrical Surface, Smooth Surface*

INTRODUCTION

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material.Grinding is an essential process for final machining of components requiring smooth surfaces and precise tolerances.

The grinding process is known as one of the most complexes tooling processes, due to the great number of variables involved, whereas such process should be employed in finishing operations, in which good final quality, low roundness errors of the piecework are expected, being that the reduction of the diametrical wear of grinding wheel should always be looked for to reduce the costs of the process.

The grinding process requires a significant energy quantity for the material removal. Such energy, once transformed into heat, is concentrated within the cutting region. The high temperature may provide situation in which the surface burning, the superficial heating and micro-structural transformations might occur, allowing the re-temper of the material, since most grinding processes occur in tempered steels, with the formation of non-re-tempered marten site, providing undesirable and uncontrollable residual tensions, reducing the strength limit to the exhaustion of the tooled component. Besides, the uncontrolled expansion and retraction of the mechanical piece during the grinding operation are the most outstanding cause of roundness errors.

The cylindrical grinder is a type of grinding machine used to shape the outside of an object. The cylindrical grinder can work on a variety of shapes. However, the object must have a central axis of rotation. This includes but is not limited to such shapes as a cylinder, an ellipse, a cam, or a crankshaft.

Grinding is a costly machining process which should be utilized under optimal conditions. The usual optimization objective in cylindrical plunge grinding is to minimize production time while satisfying work piece quality constraints.

The time for a typical cycle **(figure 1)** includes t; for roughing with a fast programmed in feed velocity u1, and t2 for finishing with a slower velocity u2, and t3 for spark-out (u3=0). Additional production time is required for wheel dressing, part loading/unloading, set-up, and wheel change.

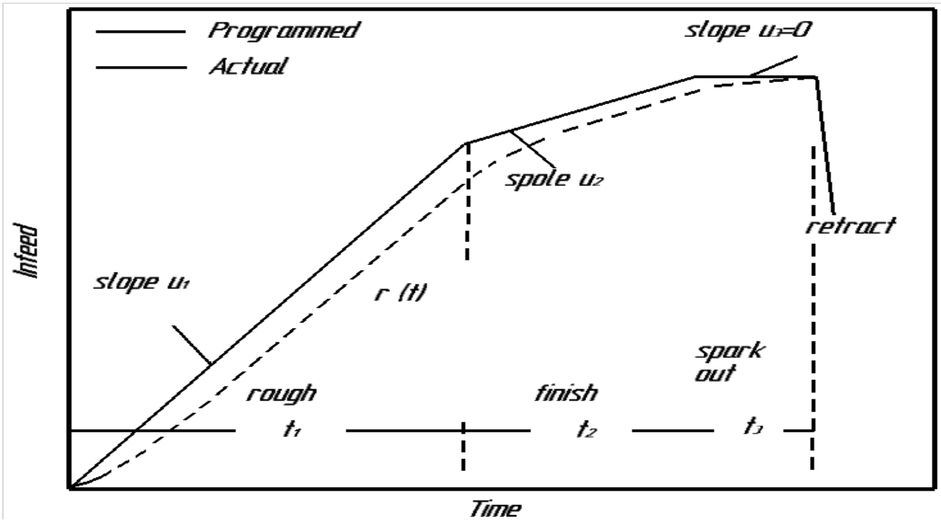

Figure 1: Grinding cycle with roughing, finishing and spark out stages

SURFACE ROUNDNESS

One of the most important fundamental forms for engineering components is the circular cross-section. Circular forms arise in many applications, particularly in bearing surfaces. The measurement of out-of-roundness (usually referred to simply as “roundness”) is an extremely important assessment.

For example, a rotational bearing whose components are not accurately round will tend to be noisy and is likely to fail prematurely. Accurate roundness measurement is therefore vital to ensure correct function of such parts.

ROUNDNESS MEASURING METHODS

1) Diameter measurement

2) Vee-Block Method

3) Coordinate Measuring Machine (CMM)

4) Rotational Datum Method

CYLINDRICAL GRINDING MACHINE

Cylindrical grinding is used to grind the external or internal diameter of rigidly supported and rotating work piece. Although the term cylindrical grinding may also be applied to center less grinding, it generally refers to work which is ground in a chuck or between supporting centers. Cylindrical grinders can be used to grind all types of hard or soft work pieces to a high degree of accuracy and very-fine surface finishes.

Figure 2: Cylindrical Grinding MachineSource: GTDMC Machining *EXTOMAX* (OCD-3260)

There are few parts of cylindrical grinding.

Headstock

The work headstock unit is located at the left-hand end of the swivel table and is equipped with a variable speed motor to rotate the work at the desired speed. The headstock spindle nose is bored to a standard taper in which a center can be mounted for supporting work held between centers as shown in Figure **3**.

The center is usually of the dead center type, that is, the spindle and center remain stationary and the driving plate revolves around the locked spindle on anti-friction bearings. The use of fixed centers of this type gives greater rigidity and, provided the centers are accurately ground, assures greater accuracy of roundness and eliminates any possible eccentricity that my result from center run out.

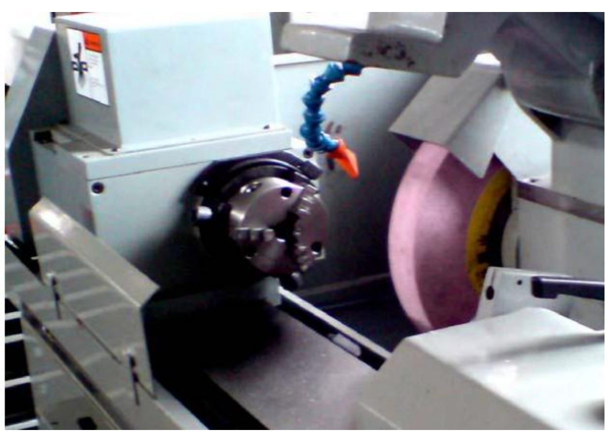

Figure 3: Headstock Position on Cylindrical Grinding Machine. Source: GTDMC Machining *EXTOMAX* (OCD-3260)

Wheel Head

This is a self-contained unit mounted on a slide base fixed to the machined surface of the bed. A flat surface, machined at the rear of the wheel head is provided for mounting the motor for driving the wheel spindle.

The spindle bearings are contained in the front of the wheel head. Cylindrical grinders require rigid bearing arrangements with zero clearance and with a very accurately running wheel spindle. The radial bearings are usually double-row cylindrical roller bearings with one angular contact thrust ball bearings to give axial location.

The spindle is made from high-grade alloy steel, hardened and ground to extremely close limits of concentricity and straightness. Tapers are provided at each end for the mounting of the wheel and driving pulley.

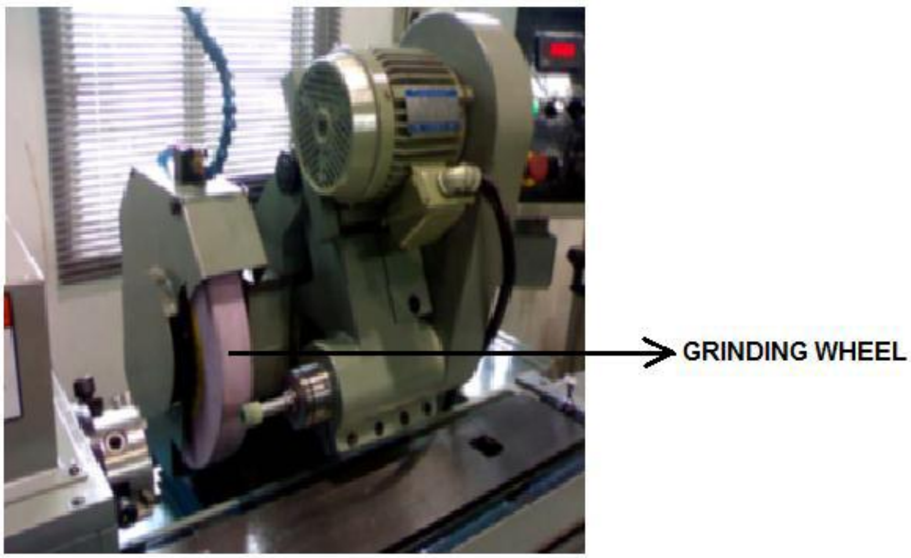

Figure 4: The Grinding Wheel Head on cylindrical grinding machine Source: GTDMC Machining *EXTOMAX* (OCD-3260)

TYPE OF CYLINDRICAL GRINDING

Outside diameter grinding

OD grinding is grinding occurring on external surface of an object between the centers. The centers are end units with a point that allow the object to be rotated. The grinding wheel is also being rotated in the same direction when it comes in contact with the object. This effectively means the two surfaces will be moving opposite directions when contact is made which allows for a smoother operation and less chance of a jam up.

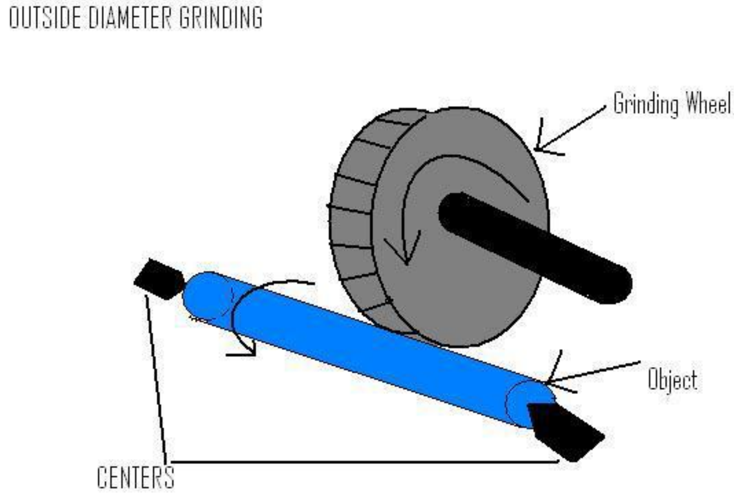

Figure 5: Outside diameter grinding Source: Wikipedia

Inside diameter grinding

ID grinding is grinding occurring on the inside of an object. The grinding wheel is always smaller than the width of the object. The object is held in place by a collet, which also rotates the object in place. Just as with OD grinding, the grinding wheel and the object rotated in opposite directions giving reversed direction contact of the two surfaces where the grinding occurs.

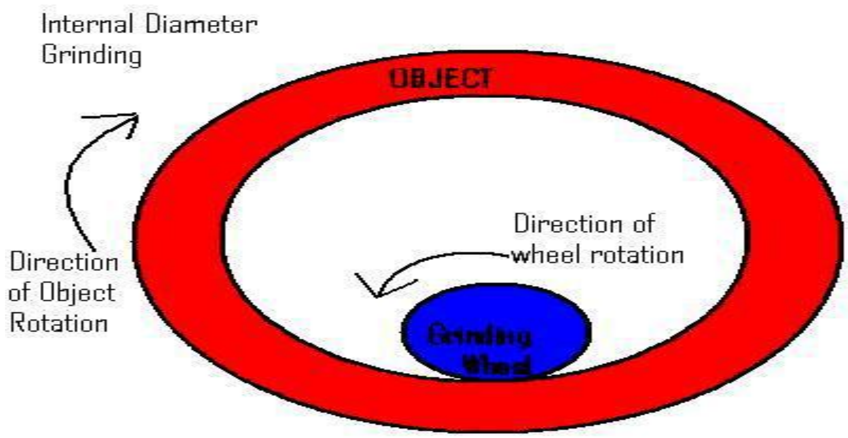

Figure 6: Inside diameter grinding Source: Wikipedia

Center less grinding

Center less grinding is a form of grinding where there is no collet or pair of centers holding the object in place. Instead, there is a regulating wheel positioned on the opposite side of the object to the grinding wheel.

A work rest keeps the object at the appropriate height but has no bearing on its rotary speed. The work blade is angled slightly towards the regulating wheel, with the work piece centerline above the centerlines of the regulating and grinding wheel; this means that high spots do not tend to generate corresponding opposite low spots, and hence the roundness of parts can be improved.

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Center less grinding is much easier to combine with automatic loading procedures than centered grinding; through feed grinding, where the regulating wheel is held at a slight angle to the part so that there is a force feeding the part through the grinder is particularly efficient.

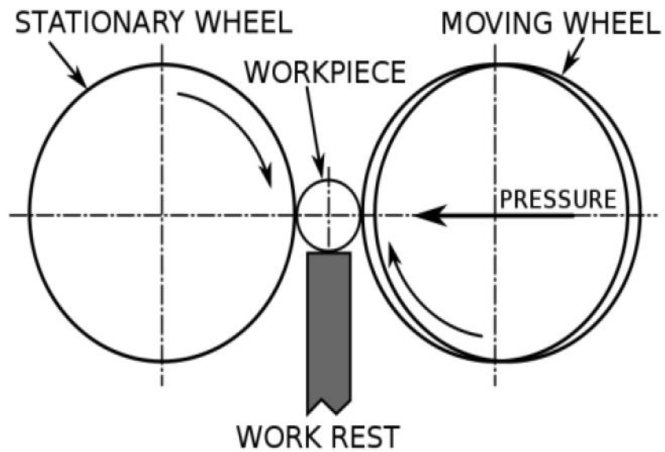

Figure 7: Center less grinding machine Source: Wikipedia

TYPES OF ABBRASSIVES

Aluminium oxide and Silicon carbide are the two major abrasives used in the manufacture of grinding wheels. These synthetic or manufactured abrasives allow accurate control over the form and physical characteristics of the abrasive grain. It is therefore used in the manufacture of grinding wheels with very specific requirements of performance allied to application needs.

Aluminium Oxide

Most abrasives used in industry are synthetic. Aluminum oxide is used in three quarters of all grinding operations, and is primarily used to grind ferrous metals.

Silicon Carbide:

It is used for grinding softer, non-ferrous metals and high density materials, such as cemented carbide or ceramics.

Super abrasives, namely cubic boron nitride or "CBN" and diamond, are used in about five percent of grinding. Hard ferrous materials are ground with "CBN", while non-ferrous materials and non-metals are best ground with diamond.

The grain size of abrasive materials is important to the process. Large, coarse grains remove material faster, while smaller grains produce a finer finish.

➢ The binders that hold these abrasive grains together include:

- Vitrified bonds, a glass-like bond formed of fused clay or feldspar
- Organic bonds, from synthetic resins, rubber, or shellac
- Metal or single-layer bond systems for super abrasives

GRINDING WHEEL

A **grinding wheel** is an expendable wheel that is composed of an abrasive compound used for various grinding (abrasive cutting) and abrasive machining operations. They are used in grinding machines.

The wheels are generally made from a matrix of coarse particles pressed and bonded together to form a solid, circular shape. Various profiles and cross sections are available depending on the intended usage for the wheel. They may also be made from a solid steel or Aluminium disc with particles bonded to the surface.

The manufacture of these wheels is a precise and tightly controlled process, due not only to the inherent safety risks of a spinning disc, but also the composition and uniformity required to prevent that disc from exploding due to the high stresses produced on rotation.

Characteristics:

There are five characteristics of a cutting wheel: material, grain size, wheel grade, grain spacing, and bond type. They will be indicated by codes on the wheel's label.

Abrasive Grain, the actual abrasive, is selected according to the hardness of the material being cut.

GRINDING PROCESS

Grinding may be classified in two groups as rough or non-precision grinding and precision grinding. Snagging and offhand grinding are the common forms of thorough grinding where the metal is removed without regard to accuracy.

In precision grinding, according to type of surface to be ground, it is classified in to external or internal grinding, surface and cylindrical grinding. If the process planner has a prior knowledge about the product quality likely to be produced on a component during Grinding, optimum process sequence design and process parameter selection is feasible. A need therefore exists to develop intelligent predictive product quality performance and the process conditions.

The qualities of machined parts play a crucial role in the functional capacity of the part and, therefore, a great deal of attention should be paid to keep consistent tolerances. The achievement of desirable values a very critical process as the parts have already passed through many machining stages. In order to maintain quality, the variables the affect the grinding process must be defined experiment.

1) Speed of grinding wheel

2) Speed of work

3) Feed rate

4) Depth of cut

Speed of work

An increase causes the wheel to act softer because the specific load on the individual grains is raised.

- Varying the work speed is, perhaps, the most convenient and effective way to modify the operational conditions in cylindrical grinding. The implementation of work speed variations is facilitated by the infinitely variable work head speeds, extending over a wide range, which are available on modern cylindrical grinding machines. Varying the peripheral speed of the work piece has to be applied, however, within limits, which depend on

a) The potentially adverse effects of higher work speed on the finish, and

b) The development of chatter caused by excessive work speed.

CONCLUSION

Grinding is one of the most important tools used to grind the surface by machining the details of the grinding machine. The details are machined on sanding machines depending on the operating conditions. This article provides information on different types of sanding machines and their advantages and disadvantages, and the importance of machining parts on the inner and outer surfaces. In addition, accuracy in processing is important.

They are as follows:

- grinding machine, depending on the material of the detailsit is recommended to choose the right sandstone.

- generality of work of the machine

- machining accuracy

- power consumption of the machine.

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