

Low Vibration Angle Grinders

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Abstract: Grinding is the process of removing metal by the application of abrasives which are bonded to form a rotating wheel. When the moving abrasive particles contact the work piece, they act as tiny cutting tools, each particle cutting a tiny chip from the work piece. It is a common error to believe that grinding abrasive wheels remove material by a rubbing action; actually, the process is as much a cutting action as drilling, milling, and lathe turning.

Keywords: Grinding machine, metal work piece, wheel

1. Introduction

Efficient grinding depends primarily upon the proper setup of the machine being used. If the machine is not securely mounted, vibration will result, causing the grinder to produce an irregular surface.[1],[2] Improper alignment affects grinding accuracy, and it is good practice to check the security and plumb of the machine every few months. It is advisable to place a strip of cushioning material under the mounting flanges, along with any necessary aligning shims, to help absorb vibration.

When a grinding wheel is functioning properly, the abrasive grains cut very small chips from the work piece and at the same time a portion of the bond of the wheel is worn away. As long as the bond is being worn away as fast as the abrasive grains of the wheel become dull, the wheel will continue to work well. If the bond is worn away too rapidly, the wheel is too soft and will not last as long as it should. If the cutting grains wear down faster than the bond, the face of the wheel becomes glazed and the wheel will not cut freely.

2. Classes of Grinding

Precision and semi precision grinding may be divided into the following classes:

2.1 Cylindrical Grinding

Cylindrical grinding denotes the grinding of a cylindrical surface. Usually, "Cylindrical grinding" refers to external cylindrical grinding and the term "internal grinding" is used for internal cylindrical grinding. Another form of cylindrical grinding is conical grinding or grinding tapered work pieces.

2.2 Tool and Cutter Grinding

Tool and cutter grinding is the generally complex operation of forming and re-sharpening the cutting edges of tool and cutter bits, gages, milling cutters, reamers, and so forth. The grinding wheel for any grinding operation should be carefully chosen and the work piece set up properly in the grinding machine grinding speeds and feeds should be selected for the particular job. Whenever practical, a coolant should be applied to the point of contact of the wheel and the work piece to keep the wheel and work piece cool, to wash away the loose abrasive, and to produce a better finish.

2.3 Material Being Ground

The material being ground will generally determine the grain, grade, structure, and bond of wheel to be selected.[5] For example, if the wheel is too soft for the material being cut, an increase in speed will make the wheel act harder. Conversely, if the wheel is too hard, as lower speed will make the wheel act softer.

2.4 Type of Grinding Wheel

The type of grinding wheel employed for a particular operation is one of the major considerations in the proper selection of cutting speed. In general practice, the wheel will be selected for the material to be cut. The recommended cutting speed can then be determined by the wheel type, bond, and grade of hardness

2.5 Calculating Wheel Size or Speeds

Both cutting speeds in SFPM and rotational speed in RPM must be known to determine the size wheel to be used on a fixed-speed grinding machine. To determine the grinding wheel size, use the following formula:

$$D = 12 \times \frac{SFPM}{RPM}$$

Where SFPM = Cutting speed of wheel (In surface feet per minute).

RPM = Revolutions per minute of wheel.

D = The calculated wheel diameter (in inches).

To obtain the cutting speed in SFPM when the wheel diameter and RPM are given, use the same formula in a modified form:

$$SFPM = \frac{D \times RPM}{12}$$

To obtain the rotational speed in RPM when the wheel diameter and desired cutting speed are known use the formula in another modified form:

$$RPM = \frac{12 \times SFPM}{D}$$

3. Work Speed for Cylindrical Grinding

In cylindrical grinding, it is difficult to recommend any work speeds since these are dependent upon whether the

material is rigid enough to hold its shape, whether the diameter of the work piece is large or small, and so forth. Listed below are areas to consider when performing cylindrical grinding. The larger the diameter of the work piece, the greater is its arc of contact with the wheel. The cutting speed suitable for one diameter of work piece might be unsuitable for another. The highest work speed that the machine and wheel will stand should be used for roughing. The following cylindrical work speeds are only typical: steel shafts, 50 to 55 FPM; hard steel rolls, 80 to 85 FPM; chilled iron rolls, 80 to 200 FPM; cast iron pistons, 150 to 400 FPM; crankshaft bearings, 45 to 50 FPM; and crankshaft pins, 35 to 40 FPM. Higher work speeds increase the cutting action of the wheel and may indicate that a harder wheel and a smaller depth of cut be used to reduce wheel wear.

4. Work Speed for Surface Grinding

Surface grinding machines usually have fixed work speeds of approximately 50 SFPM or have variable work speed ranges between 0 and 80 SFPM. As with cylindrical grinding, the higher work speeds mean that more material is being cut per surface foot of wheel rotation and therefore more wear is liable to occur on the wheel.

5. Coolants

Most grinding machines are equipped with coolant systems. The coolant is directed over the point of contact between the grinding wheel and the work. This prevents distortion of the work piece due to uneven temperatures caused by the cutting action. In addition, coolant keeps the chips washed away from the grinding wheel and point of contact, thus permitting free cutting.

6. Polishing, Buffing and Lapping

Polishing, buffing, and lapping are three closely related methods for finishing metal parts. The three different methods of finishing are listed below.

6.1 Polishing

Polishing is an abrading process in which small amounts of metal are removed to produce a smooth or glossy surface by application of cushion wheels impregnated or coated with abrasives.[6] Polishing may be used for reduction or smoothing of the surface to a common level for high finish where accuracy is not important or it may be employed for removing relatively large amounts of material from parts of irregular contour. Rough polishing is performed on a dry wheel using abrasives of No. 60 grain (60 grains per linear inch) or coarser. Dry finish polishing is a similar process where No 70. Grains to No. 120 grain abrasives are used. Oiling is the term applied to polishing with abrasive finer than No. 120 grain. In this process, the abrasive is usually greased with tallow or a similar substance.

6.2 Buffing

Buffing is a smoothing operation which is accomplished more by plastic flow of the metal than by abrading. The abrasives are generally finer than those used in polishing

and instead of being firmly cemented to the wheel are merely held by a "grease cake" or similar substance.[3] Buffing is used to produce a high luster or color without any particular regard to accuracy of dimension or plane. Cut down buffing produces a rapid smoothing action with fast-cutting abrasives and relatively hard buffing wheels. It is accomplished with high speeds and heavy pressures to allow a combined plastic flow and abrading action to occur. Color buffing is the imparting of a high luster finish on the work piece by use of soft abrasives and soft buffing wheels.

6.3 Lapping

Lapping, like polishing, is an abrading process in which small amounts of material are removed. Unlike polishing, however, lapping is intended to produce very smooth, accurate surfaces, and is never used instead of polishing or buffing when clearance is the only consideration. Lapping is accomplished by charging metal forms called laps with flour-fine abrasives and then rubbing the work piece with the lap. The lap may be of any shape and may be designed to fit into most power machine tools. The only requirements of the lap are that it be of softer material than the material being lapped, and that it is sufficiently porous to accept the imbedded abrasive grain. Common materials for laps are soft cast iron, copper, brass, and lead. Some laps are flat and others are cylindrical to fit on steel arbors for internal lapping of bores. Cutting oil is recommended for most lapping operations.

6.4 Polishing and Buffing Speeds

The proper speed for polishing and buffing is governed by the type of wheel, work piece material, and finish desired. For polishing and buffing in general where the wheels are in perfect balance and correctly mounted, a speed of approximately 1,750 RPM is used for 6-inch to 8-inch wheels; up to 6-inch wheels use 3,500 RPM. If run at a lower rate of speed, the work tends to tear the polishing material from the wheel too readily, and the work is not as good in quality.

6.5 Polishing Abrasives

The abrasive grains used for polishing must vary in characteristics for the different operations to which they are applied. Abrasive grains for polishing are supplied in bulk form and are not mixed with any vehicle. The abrasives, usually aluminum oxide or silicon carbide, range from coarse to fine (1 to 20 grains per inch).

6.6 Buffing Abrasives

Buffing abrasives are comparatively fine and are often made up in the form of paste, sticks, or cakes; the abrasive being bonded together by means of grease or a similar vehicle. The abrasive sizes for buffing are 280, 320, 400, 500, and 600. Some manufacturers use letters and numbers to designate grain size such as F, 2F, 3F, 4F, and XF (from fine to very fine). Pumice, rottenstone, and rouge are often used as buffing abrasives.

6.7 Lapping Abrasives

Only the finest abrasives are used for lapping. These may be either natural or artificial. Abrasives for lapping range from No. 220 to No. 600 or No. 800 which are very fine flours. Lapping compounds are generally mixed with water or oil so that they can be readily applied to the lap.

6.8 Three common uses for grinder

1. Probably the most obvious is grinding.[7] Most angle grinders are equipped with a 5mm thick metal disk that are perfect for grinding down just about anything you need. If you come across some really tough material, you may need a grinding disc with diamond edges.
2. You can also use your angle grinder for sanding. The sanding disc usually has rough fiber padding with a plastic backing. Equipped with this plastic disc, you will have the perfect sanding tool.
3. The final way you can use your angle grinder is for paint removal. These circular discs come with pads that are a lot softer than the standard angle grinder disc, but this tool does an excellent job at removing paint.

7. Weld Dressing and Fitting of Metal Fabrication

7.1 Problem

At one ship yard bulk of this work is done with 225 mm electric high frequency angle grinders. These are large heavy tools with often have to be held overhead or in awkward position by the operator an average 1 to 3 hours a day. The company has just under 200 of these tools which product average vibration magnitudes of 7 m/sec², given a potential exposure of average of over 4 m/s²

7.2 Solution

The long term requirement was to use a grinder with both high performance and low vibration. In house engineer reviewed all the grinders available on the market at the time and decided that a new design of pneumatic 225mm grinder featuring automatic correction for disk unbalance should be bought initial test should that these new tools using the companies usual grinding disk achieved a lower metal removal rate compared old electric grinders. Further testing revealed that by changing to as after grade of disc the pneumatic grinders could give a metal removal rate 40%by the old tool/disc combination.

The use of the new tools significantly increased the requirement for compressed air in the shipyard and it was necessary to upgrade the air distribution system to cope with the extra demand.

8. Result

- Vibration magnitudes are lower. In extended testing on real jobs in the yard, the grinders produced an average vibration magnitude of 3.5m/s².
- Efficiency is improved because of the higher rate of metal removal.
- The tools are much lighter and so they are easier and less

tiring to operate.

- There are fewer risks associated with trailing electrical leads in the working area.

9. Conclusion

The utility grinding machine is intended for offhand grinding where the work piece is supported in the hand and brought to bear against the rotating grinding abrasive wheel. The accuracy of this type of grinding machine depends on the operator's dexterity. Skill and knowledge of the machine's capabilities and the nature of the work. The utility grinding machine consists of a horizontally mounted motor with a grinding abrasive wheel attached to each end of the motor shaft.

Grinding wheels wear unevenly under most general grinding operations due to uneven pressure applied to the face of the wheel when it cuts. Also, when the proper wheel has not been used for certain operations, the wheel may become charged with metal particles, or the abrasive grain may become dull before it is broken loose from the wheel bond. [n these cases, it is necessary that the wheel be dressed or trued to restore its efficiency and accuracy.

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