Project on

<u>" ANALYSIS OF GRINDING WHEEL"</u>

Prepared by :

Submitted to :

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1. Introduction Grinding Process

1.1 Introduction

Manufacturing is derived from the Latin word manufactus, means made by hand. In modern involves making products from raw material by using various processes, by making use of hand tools, machinery or even computers. It is therefore a study of the processes required to make parts and to assemble them in machines. The study of manufacturing reveals those parameters which can be most efficiently being influenced to increase production and raise its accuracy.

Grinding is a metal removal process that employs an abrasive GW whose cutting elements are grains of abrasive materials of high hardness and high refractoriness The sharp-edged and hard grains are held together by bonding material. Projecting grains (Figure 1) abrade layers of metal from the work in the form of very minute chips as the
wheel rotes at high speeds of up to 60 m/s.

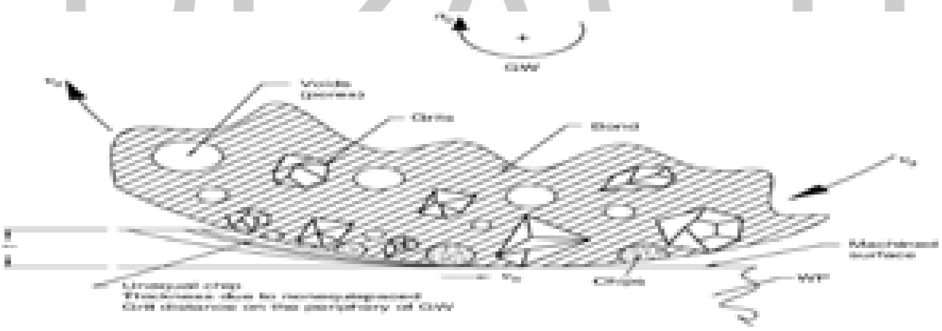


Figure 1. Cutting Principles and Main Variables of a Surface

1.2 Grinding Process

System Elements - The system elements consist of inputs, disturbances, productive outputs, and non-productive outputs. The elements of a grinding system are illustrated in figure 2. Work piece material, Shape, hardness, stiffness, thermal.

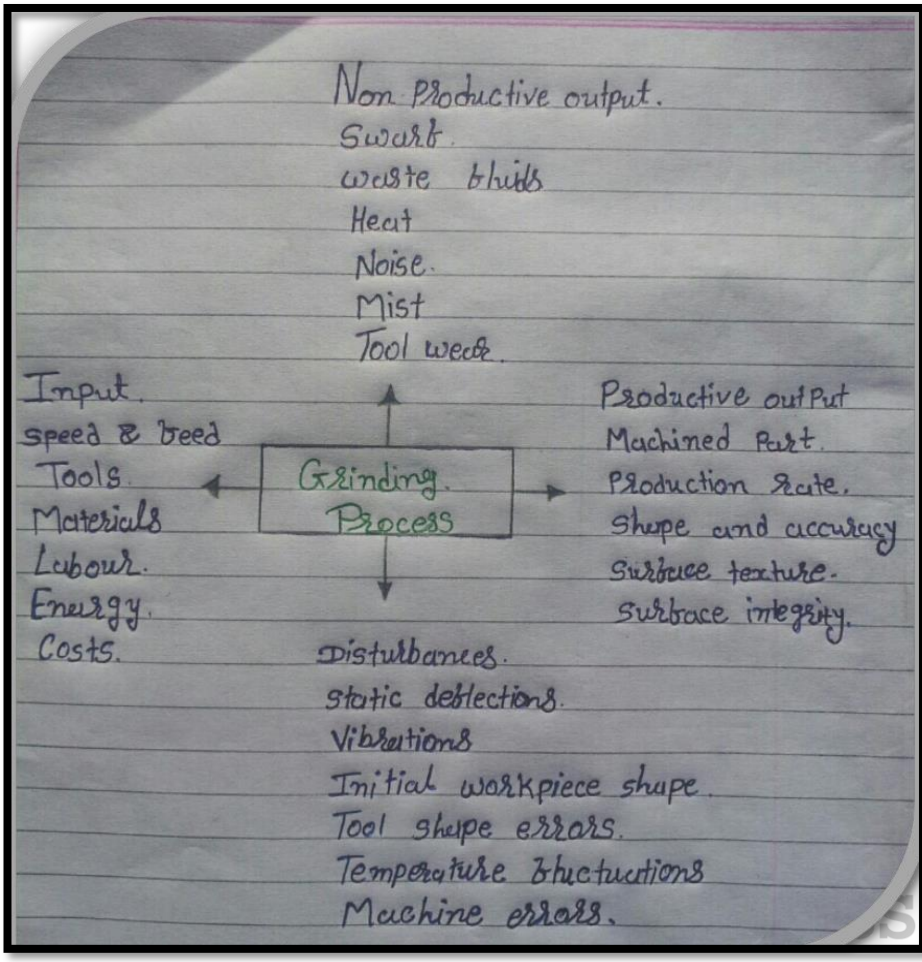


Figure 2. Inputs and Outputs of a Grinding Process

1.2.1 Properties.

- Grinding machine: Type, control system, accuracy, stiffness, temperature stability, vibrations.

- Kinematics: The geometry and motions governing the engagement between the grinding wheel and the work piece.
- Grinding wheel: Abrasive, grain size, bond, structure, hardness, speed, stiffness.
- Dressing conditions: Type of tool, speeds and feeds, cooling, lubrication.
- Grinding fluid: Flow rate, velocity, pressure, physical, chemical properties.
- Atmospheric environment: Temperature, humidity, and effect on environment.
- Health and safety: Risks to the machine operators and the public.
- Waste disposal.
- Costs.

Dry-machining - some Factors for Consideration [7]

• Adopting a ‘dry machining’ strategy will only make sense, if all the cutting processes in the part’s manufacture can be performed without coolant,

• Only by utilizing specialized cutting tool geometries, can‘dry-machining’ be possible and effective,

• Tooling typically having special hard multi-layered, or diamond-like coatings, etc., to isolate heat and create minimal thermal conduction across the tool/chip interface,

• Employing cutting tool materials producing sharp edge geometries – to reduce heat,

• For drilling operations, utilize ‘soft-glide’ coatings –for lubrication, with the necessary and appropriate efficient chip transportation geometries,

1.3 THE TAGUCHI SYSTEM OF QUALITY ENGINEERING

The major steps of implementing the Taguchi method are:

1)to identify the factors/interactions,
2) to identify the levels of each factor,
3) to select an appropriate orthogonal array(OA),
4) to assign the factors/interactions to columns of the OA,
5) to conduct the experiments,
6) to analyze the data and determine the optimal levels, and
7) to conduct the confirmation experiment.

1.4 SIGNAL-TO-NOISE RATIO

In the field of communication engineering a quantity called the signal-to-noise (SN) ratio has been used as the quality characteristic of choice.The SN ratio transforms several repetitions into one value which reflects the amount of variation present and the mean response. The discrete case will be explained later.

1) Nominal is Best Characteristics
2) Smaller the Better Characteristics
3) Larger the Better Characteristics

1.5 ORTHOGONAL ARRAYS

An orthogonal array is a fractional factorial matrix which assures a balanced comparison of levels of any factor or interaction of factors. It is a matrix of numbers arranged in rows and columns where each row represents the level of the factors in each run, and each column represents a specific factor that can be changed from each run. The array is called orthogonal because all columns all columns can be evaluated independently of one another.

1.6 Advantages & Applications

Advantages

- Dimensional accuracy
- Good surface finish
- Good form accuracy

Application

- Descaling, deburring
- Finishing of flat as well as cylindrical surface
- Grinding of tools and cutters and resharpening of the same.
- Surface finishing

2. Introduction about IDP

2.1 CONSTRUCTION OF A GRINDING WHEEL

- In order make the grinding wheel suitable for different work situations, the features such as abrasive, grain size, grade, structure and bonding materials can be varied.
- A grinding wheel consists of an abrasive that does the cutting, and a bond that holds the abrasive particles together.

2.2 Abrasives

- Abrasives can be natural or manmade.
  - Natural include:
    - Sand stone
    - Emery
    - Diamond
    - Garnet
    - Quartz

  Manmade (1891 time frame most commonly used today)

    - Silicon Carbide
    - Aluminum Oxide
    - Cubic Boron Nitride

2.3 Bonding materials

- Vetrified bonds
- Mineral bonds
- Organic bond

2.4 Types of grinding wheels

According to bonding material:

a) Vitrified grinding wheel

b) Silicate grinding wheel

c) Elastic grinding wheel

d) Resiniod grinding wheel

e) Welkenize grinding wheel

f) Oxy chloride grinding wheel

2.5 According to wheels grade:

a) Soft grade wheel

b) Hard grade wheel

According to structure:

a) Open structure wheel

b) Closed structure wheel

c) According to shape of grinding wheel

Selection of grade depends on hardness of workpiece material, grinding speed, contact area of grinding wheel with the workpiece, capability of grinding machine. Grinding wheels are named as soft, hard or medium hard wheels depending on their grade. Abrasives of hard grinding wheels get blunt quickly so these are recommended to grind workpiece of low hardness and soft grinding wheels are recommended for hard material workpieces.

2.6 Wheel Forms

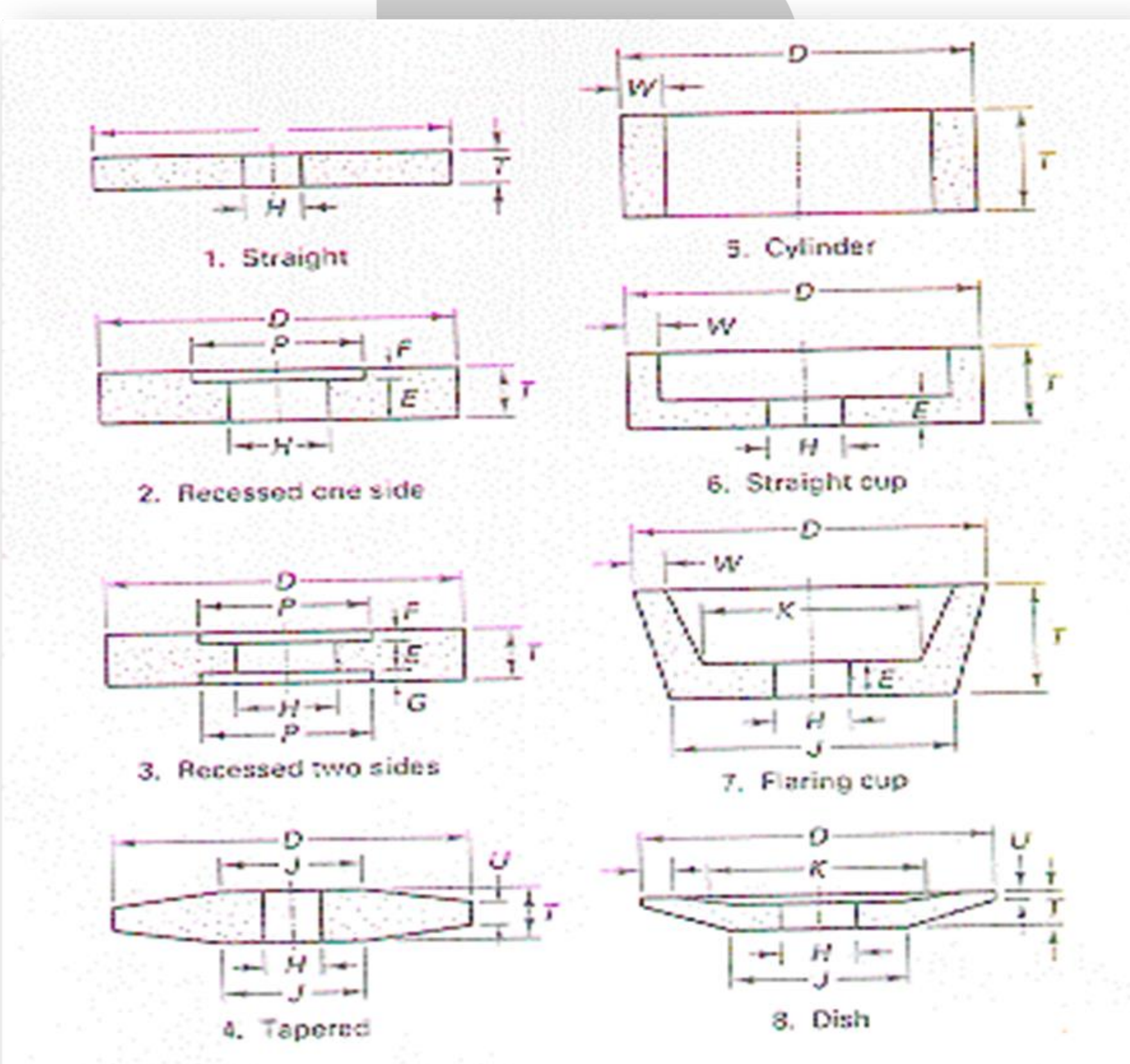
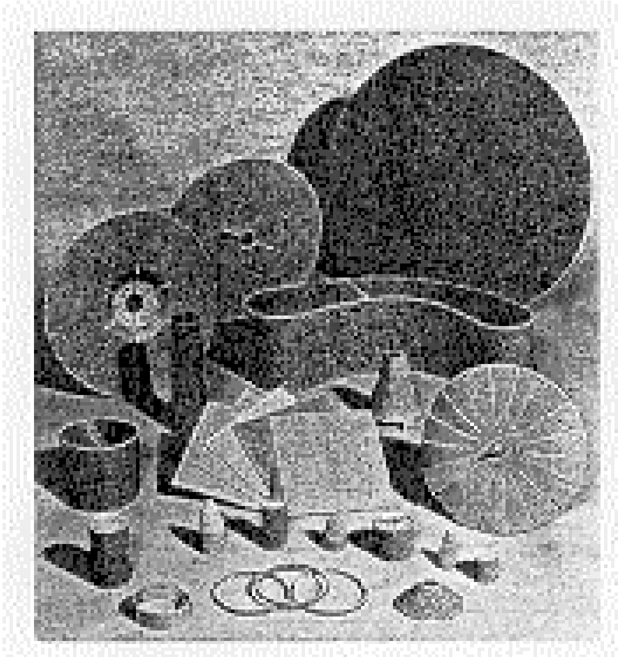


FIGURE 27-14 Standard grinding-wheel shapes commonly used. *(Courtesy of Carborundum Company.)*

2.7 Different shape of grinding wheel



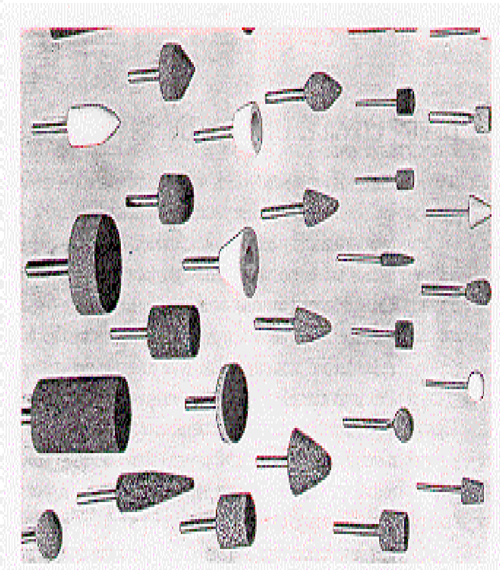


FIGURE 27-24 Examples of mounted abrasive wheels and points. (Courtesy of Norton Company.)

2.8 STRUCTURE

This indicates the amount of bond present between the individual abrasive grains, and the closeness of the individual grain to each other. An open structured wheel will cut more freely. That is, it will remove more metal. In a given time and produce less heat.

2.9 BOND

A bond is an adhesive material used to held abrasive particles together; relatively stable that constitutes a grinding wheel. Different types of bonds are:

Vitrified bond (V)

Silicate bond (S)

Shellac bond (E)

Rubber bond (R)

Resinoid bond (B)

- These bonds are being explained here in brief.

Vitrified Bond

This bond consists of mixture of clay and water. Clay and abrasives are Thoroughly mixed with water to make a uniform mixture. The mixture is moulded to shape of a grinding wheel and dried up to take it out from mould. Perfectly shaped wheel is heated in a kiln just like brick making. It this way clay vitrifies and fuses to form a porcelain or glass grains. High temperature also does annealing of abrasive. This wheel posses a good strength and porosity to allow high stock removal with coal cutting. Disadvantage of this type of wheel are, it is sensitive for heat, water, oil and acids. Their impact and bending strengths are also low. This bond is denoted by symbol 'V' in specification.

Silicate Bond

Silicate bonds are made by mixing abrasive particles with silicate and soda or water glass. It is moulded to required shape, allowed to dried up and then taken out of mould. The raw moulded wheel is baked in a furnace at more than 200oCfor several days. These wheel exhibits water proofing properly so these can be used with coolant. These wheels are denoted by 'S' in specification.

Shellac Bond

These are prepared by mixing abrasive with shellac than moulded by rolling and pressing and then by heating upto 150oC for several hours. This bond exhibit greater elasticity than other bonds with appreciable strength. Grinding wheel shaving shellac bond are recommended for cool cutting on hardened steel and thin sections, finishing of chilled iron, cast iron, steel rolls, hardened steel cams and aluminium pistons. This bond is denoted by 'E' in specifications.

Resinoid Bond

These bonds are prepared by mixing abrasives with synthetic resins like backelite and redmanol and other compounds. Mixture is moulded to required shape and baked upto 200oC to give a perfect grinding wheel. These wheels have good grinding capacity at higher speed. These are used for precision grinding of cams,rolls and other objects where high precision of surface and dimension influence the performance of operation. A resinoid bond is denoted by the letter 'B'.

Rubber Bond

Rubber bonded wheels are made by mixing abrasives with pure rubber and sulpher. After that the mixture is rolled into sheet and wheels are prepared by punching using die and punch. The wheels are vulcanized by heating then infurnace for short time. Rubber bonded wheels are more resilient and have larger abrasive density. These are used for precision grinding and good surface finish. Rubber bond is also preferred for making thin wheels with good strength and toughness. The associated disadvantage with rubber bond is, these are lesser heat resistant. A rubber wheel bonded wheel is denoted by the letter 'R'.

Oxychloride Bond

These bonds are processed by mixing abrasives with oxides and chlorides of magnesium. The mixture is moulded and baked in a furnace to give shape of a grinding wheel. These grinding wheels are used for disc grinding operations. Anoxychloride bonded wheel is specified the letter 'O'.

3.10 SURFACE GRINDING OPERATIONS

- Rough grinding
- Precision grinding

- Surface grinding
- Cylindrical grinding
- Centreless grinding
- Form grinding & Profile grinding
- Plunge cut grinding

3.11 GENERAL SAFETY

- Keep the floor and gangways clean and clear.
- Don’t touch or handle any equipment/machine unless authorized to do so.
- Don’t walk under suspended .
- Use the correct tools for the job.
- Keep the tools at their proper palace.
- Wipe out split oil immediately.
- Ensure adequate light in the workshop.

3.12 Grinding Wheel Operating Procedures

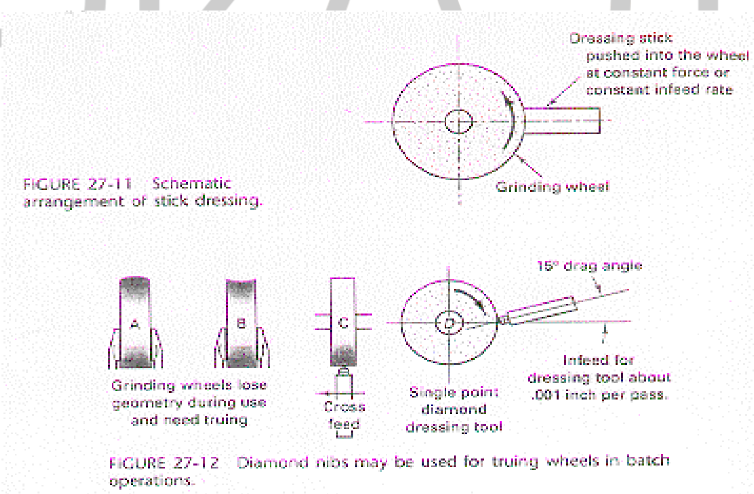


FIGURE 27-11 Schematic arrangement of stick dressing.
FIGURE 27-12 Diamond nibs may be used for truing wheels in batch operations.

3.13 Wheel Classification,

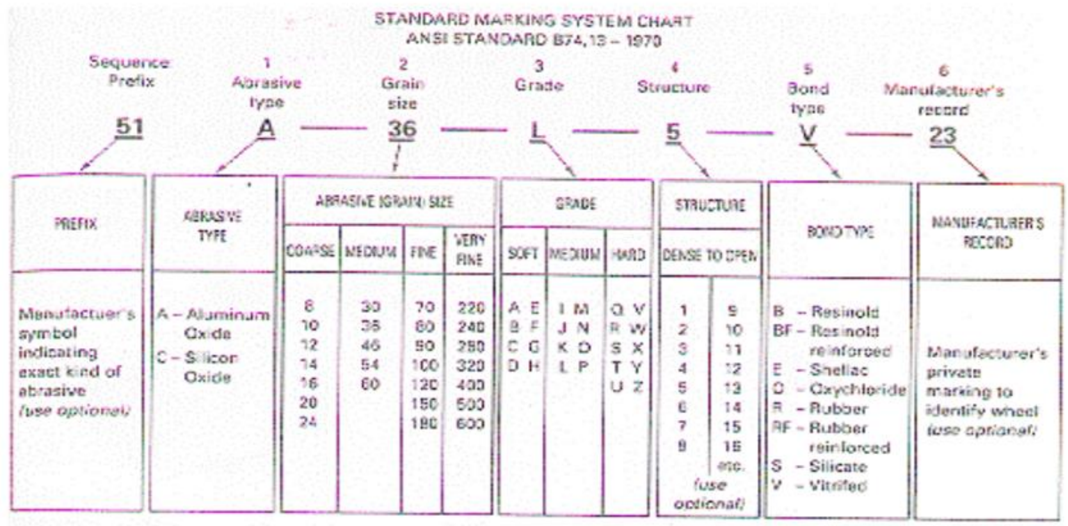


FIGURE 27-13 Standard marking system for grinding wheels (ANSI standard B74. 13-1970).

Nomenclature of grinding wheel

- Manufacturer symbol
- Types of abrasive
- Grain size
- Grade
- Structure
- Types of bonds
- Manufacturer Marko

3. Details Description of IDP

3.1 Analysis of grinding wheel with different speed

PERIPHERICAL SPEED OF GRINDING WHEEL

When the rotation speed decreases, the grinding wheel behaves as if it were softer, thus improving its grinding capacity. As a general guide, with every 5-8 mt/sec reduction in peripheral speed the grinding wheel loses approximately 1 degree of hardness. In contrast, if we need the grinding wheel to retain its profile or to produce a better finish (i.e. behave as if it were harder) the peripheral speed should be increased. Within reason, however: a grinding wheel that turns too slowly tends to lose its grains before the abrasive granules have the chance to work. Conversely, when increasing the speed, the limit is the maximum allowable speed indicated on the label of the grinding wheel, which absolutely must not be exceeded to avoid the risk of the tool exploding. Normally the recommended peripheral speed is slightly lower than the maximum indicated on the grinding wheel.

SPEED OF WORKPIECE

When the speed of the workpiece is reduced, each granule has to remove a larger quantity of material and is therefore subjected to greater pressure, meaning that the grinding wheel self-dresses more easily, and so behaving as if it were softer. The desired effect is not always achieved, however. Often on grinding wheels of medium-to-high hardness the greater stress to which they are subjected cancels out the self-dressing action of this expedient. As a rule, the speed of the workpiece can range between 10 and 20 metres per minute. For surfaces grinding this value corresponds to the table speed.

3.2 PARAMETERS OF GRINDING OPERATION

Normal parameters used in grinding operation are cutting speed, feed rate and depth of cut. These parameters are described below.

Cutting Speed

Cutting speed is grinding wheel is the relative peripheral speed of the wheel with respect to the workpiece. It is expressed in meter per minute (mpm) or meter per second (mps).The cutting speed of grinding wheel can be calculated as mpm

$$V = \frac{\pi D N}{1000} \text{ mpm (meter per minute)}$$

where, *D* is diameter of grinding wheel in mm. *N* are the number of revolution of grinding wheel if *N* is expressed in number of revolutions per minute, *V* will be in mpm,if *N* is expressed in number of revolution per second, *V* will be in mps.

Feed Rate

Feed rate is a significant parameter in case of cylindrical grinding and surface grinding. Feed rate is defined as longitudinal movement of the workpiece relative to axis of grinding wheel per revolution of grinding wheel. Maximum feed rate should be upto 0.9 time of face width of grinding wheel for rough grinding and upto 0.6 times of face width of grinding wheel for finish grinding. Feed cannot be equal to or more than the width of grinding wheel. Feed is used to calculate the total grinding time as given below.

$$T = \frac{L \times i}{S \times N} \times K$$

where *T* is the grinding time (min) *L* is the required longitudinal travel in mm. *i* is the number of passes required to cover whole width *S* is the longitudinal feed rate (mm/rev.).*N* is the rpm and *K* is the coefficient depending on the specified grade of accuracy and class of surface finish for rough grinding *K* = 1 to 1.2 and for finish grinding *K* = 1.3 to 1.5.

Depth of Cut

Depth of cut is the thickness of the layer of the metal removal in one pass. It is measured in mm. normally depth of cut is kept ranging 0.005 to 0.04 mm. Smaller depth of cuts are set for finish and precision grinding. The table given below shows recommended bonds and cutting speed for type of a workpiece.

TYPE OF WORKPICE	**BOND**	**CUTTING SPEED**	
Tool Steel	Vitrified	15 TO 25	PRECISION GRINDING
High Speed Steel	Vitrified	15 TO 25	
Cemented Carbide	Resin or Rubber	15 TO 25	
CAST IRON	Resin or Rubber or Vitrified	UP TO 30	ROUGH GRINDING
STEEL		UP TO 25	
Bronze		UP TO 20	
Soft Iron		UP TO 20	

3.3 GRINDING FLUIDS

Application of grinding fluids has been found to be effective in reducing the adverse thermal effects and high work surface temperature. All cutting fluids can be used as coolant in grinding operations and so these can also be named as grinding fluids.

Normally grinding fluids remove heat from grinding zone and wash the clips away. Generally two types of grinding fluids are used :

(a) Water based fluids, and

(b) Oils based fluids.

Water based fluids remove heat from grinding zone but these do not provide any lubrication to the grinding zone. However, oil based fluids provides lubrication properties also. Heat removing capability of oil base fluid is more due to their high specific heat. Examples of water based fluids are dissolved chemicals into water like sulfur chlorine, phosphorus, etc. Examples of oil based fluids are oils originated from petroleum, animals and vegetables. They can be emulsified oils suspended in water in the form of droplets. Cutting fluids can be recycled in flow after filtering them by separating out chips and dirt.

3.4 DEFECTS AND REMEDIES IN GRINDING

Major and inevitable defects in grinding are glazing of grinding wheels. Its remedy will be discussed later. After the continuous use grinding wheel becomes dull or glazed. Glazing of the wheel is a condition in which the face or cutting edge acquires a glass like appearance. That is, the cutting points of the abrasives have become dull and worn down to bond. Glazing makes the grinding face of the wheel smoother and that stops the process of grinding. Sometimes grinding wheel is left 'loaded'. In this situation its cutting face is found being adhering with chips of metal. The opening and pores of the wheel face are found filled with workpiece material particles, preventing the grinding action. Loading takes place while grinding workpiece of softer material.

Dressing

The remedies of glazing and loading are dressing of grinding wheels. Dressing removes the loading and breaks away the glazed surface so that sharp abrasive particles can be formed again ready for grinding. Different type of dressing operations are done on a grinding wheel. One of them is the dressing with the help of star dresser. It consists of a number of hardened steel wheels with sharp points on their periphery. The total is held against the face of revolving wheel and moved across the face to dress the whole surface. Another type of wheel dresser consists of a steel tube filled with a bonded abrasive. The end of the tube is held against the wheel and moved across the face.

Truing

Truing is the process of restoring the shape of grinding wheel when it becomes worn and break away at different points. Truing makes the wheel true and concentric with the bore.

4.4 BALANCING OF GRINDING WHEEL

Due to continuous use, a grinding wheel may become out of balance. It can be balanced either by truing or dressing. Here it is important to explain the meaning of a balanced wheel. It is the coincidence of centre of mass of wheel with it axis of rotation. Wheels which are out of balance produce poor quality of surface and put undue strains on the grinding machine. Balancing of wheel is normally done at the time of its mounting on the grinding machine with the help of moving weights around a recessed flange.

3.5 SURFACE CONTACT AREA

The surface contact area between grinding wheel and workpiece is very important. The smaller it is, the more the grinding wheel cuts and does not become clogged. If greater grinding capacity is required, reducing the surface contact area is strongly recommended, especially when grinding using vertical-axis wheels, for example cup or segmented wheels. In this case simply executing a chamfer on the edge of the cup wheel of reducing the number of segments fitted on the head of the grinding machine solves a lot of problems. The following table summarizes the effect of changing operating parameters on the behavior of the grinding wheel.

3.6 INFLUENCE OF OPERATING PARAMETERS ON GRINDING WHEEL BEHAVIOUR

PARAMETERS		HARDNESS	CAP.ASP.	FINISH
peripheral speed of wheel	> <	> <	< >	> <
feed rate	> <	< >	> <	< >
depth of cut per pass	> <	< <	> <	< >

It is clear that by varying the operating parameters appropriately it is possible to use the same grinding wheel for more than one kind of machining process. Of course, when large numbers of pieces need to be produced it is always advisable to use a dedicated grinding wheel.

4. Conclusions

As discussion of various parameter in previous chapter- 3 surface finishing is always affected on schronimazation of parameters like, Speed, Feed, Depth of cut, Material. It is recommended to schronimaze said parameter to achieve better surface finishing.

Websites

1 – www.google.com

- Photo of grinding operation

2-www.grindingwheel.com

3-www.wikipedia.com

- Detail of grinding

Book

1-material tool and technology

2-working principal of grinding

3-process planning