UNIT IV

METAL FINISHING PROCESSES

SURFACE FINISHING PROCESSES

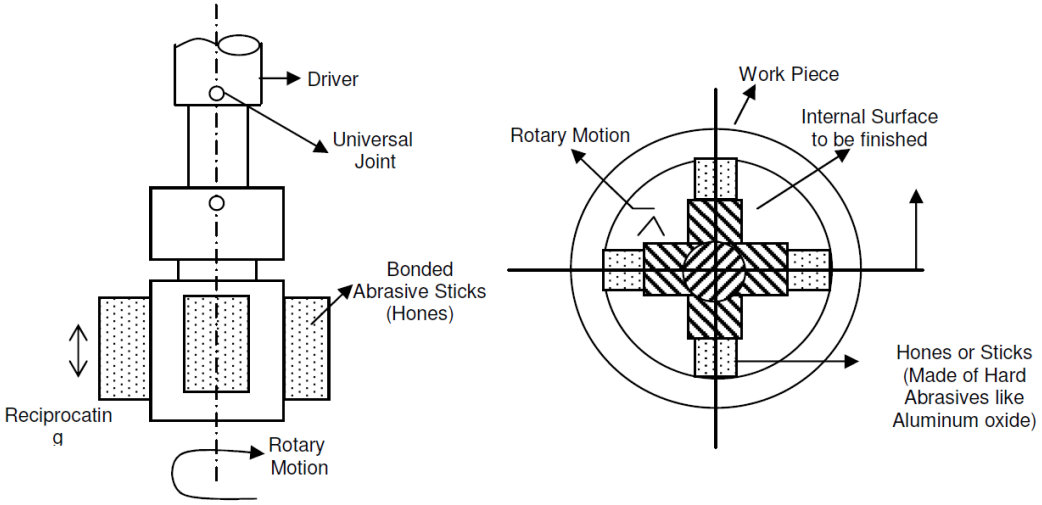
Manufacturing process employed determines surface finish level. Some processes areinherently capable of producing better surfaces than others. The processes recognized forgood surface finish are honing, lapping, polishing and surface finishing. Tolerance andrange of surface roughness produced by different processes are given below.

Process	Tolerance (mm)	Roughness (µm)
Grinding	± 0.008	5 to 75
Lapping	± 0.005	2 to 15
Honing	± 0.005	4 to 30
Super Finishing	± 0.003	1 to 10

Different surface finishing processes are described below.

HONING

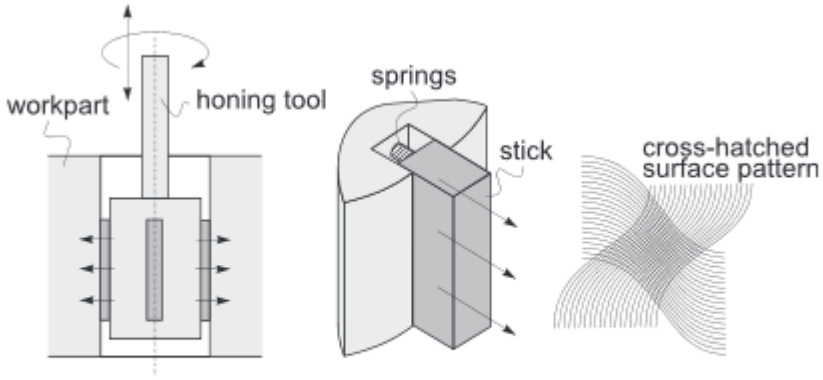
Honing is a surface finishing operation based on abrasive action performed by aset of bonded abrasive sticks. It is generally used to finish bores of cylinders of ICengine, hydraulic cylinders, gas barrels, bearings, etc. It can reduce the level ofsurface roughness below 32 µm. It produces a characteristics surface pattern ascross hatched which is a fit case to retain lubrication layer to facilitate motion tomoving parts, their best example is IC engine.



Honing Tool and its Operation

The honing tool used to finishinternal surface is shown in Figure. The honing tool consists of a set of bondedabrasive sticks. The number of sticks mounted on a tool depends on itscircumferential area. Number of sticks may be more than a dozen.

The motion of a honing tool a combination of rotation and reciprocation (linear).The motion is managed in such a way that *a given point on the abrasive stick doesnot trace the same path repeatedly*. The honing speed may be kept up to 10 cmsper sec. Lower speeds are recommended for better surface finish.



Schematics of honing process showing the honing tool, how the abrasive sticks are pressed against the work surface by springs, and the resulting surface pattern.

Manufacturingdefects like slight eccentricity a way surface, light tapper, less of circulating canalso be corrected by honing process.The process of honing is always supported by flow of coolants. It flashes away thesmall chips and maintains a low and uniform temperature of tool and work.

Honing Machines

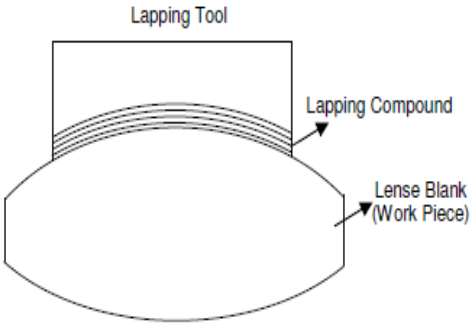
Honing machines resembles with vertical drilling machines in theirconstruction. Reciprocating motion of spindle is obtained by hydraulicmeans. The rotary motion may be by hydraulic motor or by a gear train. Depending upon the movement of spindle or hones a machine may bevertical honing machine or horizontal honing machine. Generally honingvertical honing machines are used. Horizontal honing machines arerecommended for finishing internal of long gun barrels.

LAPPING

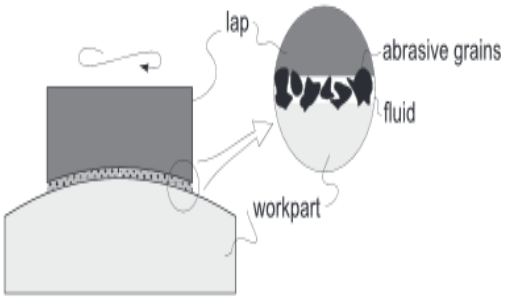
Lapping is also one of the abrasive processes used to produce finished (smoothlyaccurate) surfaces. It gives a very high degree of accuracy and smoothness so it isused in production of optical lenses, metallic bearing surfaces, measuring gauges,surface plates and other measuring instruments.

All the metal parts that aresubjected to fatigue loading or those surfaces that must be used to establish a sealwith a mating part are often lapped. The process of lapping uses a

bonded abrasivetool and a fluid suspension having very small sized abrasive particles vibratingbetween the work piece and the lapping tool. The process of lapping is shown. The fluid with abrasive particles is referred as lapping compound. Itappears as a chalky paste. Normally the fluid used in lapping compound is oil orkerosene.



Lapping Process



Schematics of lapping process showing the lap and the cutting action of suspended abrasive particles.

The fluid should have slightly lubricating properties to make the actionof abrasive mild in nature. Abrasives used in lapping compound are aluminiumoxide and silicon carbide. Their girt size is kept 300 to 600 μm. It is hypothesizedthat two alternative cutting mechanisms are working in the process of lapping.

In first mechanism the abrasive particles roll and slide between the lapping tooland work piece. These particles produce small cuts on both surfaces. Anothermechanism supposed to work in lapping is that the abrasives become imbedded inthe lap surface to give cutting action like in case of grinding.

Machine Lapping

Machine lapping is recognized as fast lapping process. Gudgeon pins with25 mm diameter and 75 mm long can be lapped at the rate of 500 units perhour. Mechanical lapping machines have vertical construction with thework holder mounted on the lower table which is given oscillatory motion.

The upper lap is stationery and floating while lower one revolves at 60 rpm.Some special purpose lapping machines are available for lapping of smallparts such as piston pins ball bearing races, etc. in machine lapping apressure upto 0.02 N/mm2 for soft material and 0.5 N/mm2 for hard materialis applied.

Lapping Applications

Materials processed by lapping range from steel, cast iron to non-ferrousmetal like copper, brass and lead. Wooden parts, made of hard wood, canalso be finished using wood laps. Lapping removes material at a very slowrate. So lapping is generally followed by accurate machining of work pieces.

Lapping is a costlier process so its applications are justified only when veryLapping ToolLapping CompoundLense Blank(Work Piece)high grade of surface finishing is required.

Lapped surfaces are wellresistant to corrosion and wear, used in manufacturing of high precisionparts.

POLISHING AND BUFFING

Polishing and buffering are similar surface finishing operations. Polishing is usedto remove scratches and burrs from a machined surface. It develops a very smoothsurface by means of abrasive grains embedded to a polishing wheel rotating athigh rpm.

Rotating speed is equivalent to 2300 meter per minutes. The rotatingwheels are made of softer materials like canvas, leather or paper. Thus, the wheelsare enough flexible to finish the cavities and internal of intricate shapes.

POLISHING

Polishing is carried out with the help of above mentioned polishing wheels.Abrasive grains are bonded by gluing to the outside periphery of the wheel.After the abrasives have been worn down and used up, the wheel isreplenished with new girts. Depending on the girt size polishing is dividedinto three categories.

(a) **Rough Polishing:**Girt size is maintained 20 to 80.
(b) **Finish Polishing:**Girt size is kept 80 to 120.
(c) **Fine Finish :**For polishing to give very fine finishing abrasivegirt size is maintained to above 120. In case of fine finishingprocess oil, tallow or beeswax is used as lubricating agent.

There is a limitation of polishing process that the parts with irregularshapes, sharp corners, deep recesses and sharp projections are difficult topolish.

Polishing Tool

Polishing can be done by hand, but for mass production work,specially designed semi-automatic and automatic polishing machinesare available. Abrasive particles are Al2O3 or diamond. Carrier ofabrasive particles has already been discussed. Polished surfaces maybe buffed to obtain an even finer surface. Polishing does not improvedimensionless accuracy as done by lapping.

Different between Lapping and Polishing

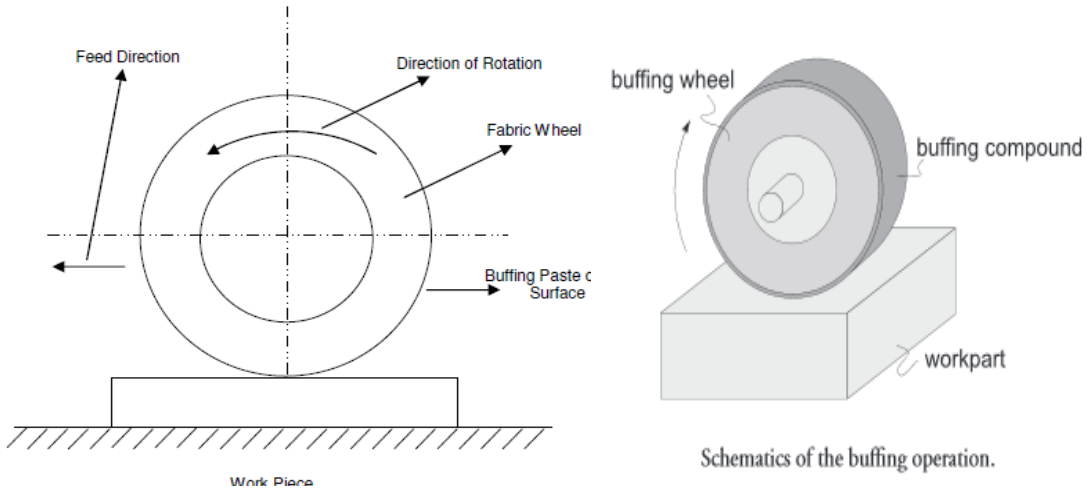
- Lapping and polishing differ in the following manner, polishing produce a shiny surface but lapping does not produce bright shiny surface.
- Lapping removes metal from the surface to be finished, however, polishing removes negligible amount of metal.
- Lapping involves cutting action but polishing consists of producing a kind of plastic flow of the surface crystals so that the high spots are made to fill the low spots.

BUFFING

Buffing is similar to polishing in appearance, but its function is different. Buffing is used to provide attractive surfaces with high luster. Buffing is like a polishing operation in which the work piece is brought in contact witha revolving cloth buffing wheel that usually has been charged with a veryfind abrasive as shown in Figure. Buffing status is somewhere inbetween polishing and lapping. A minor cutting action with microchip isdone in case of buffing.

Buffing wheels are made of discs of liners, cotton, broad cloth and canvas.These are made more or less firm by the amount of stitching used to fastenthe layers of the cloth together. Buffing tools are enough flexible to polish up to interior of intricate cavities. The buffing tools arenamed as BUFFING ROUGES.

There are semi-automatic buffing machines available consisting of a series of individually drivers buffing wheel which can be adjusted to the desired position so as to buff different positions of the work piece. The work pieces are held in fixtures on a suitable rotating worktable so as tomove the buffing wheels.



Schematics of the buffing operation.

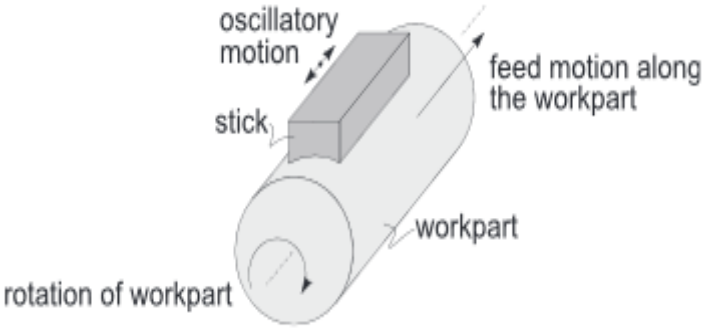
Application of buffing produces mirror like finish. It is used for finishing ofautomobile parts, boats, bicycles, sport items, tools, furniture, fixtures,commercial and residential hardware, house hold utensils and homeappliances, etc.

SUPER FINISHING

Super finishing is an alternative process similar to honing. This also uses bondedabrasive stick moved with a reciprocating motion and pressed against the surfaceto be finished. The relative motion between the abrasive stick and the workpiece isvaried so that individual grains do not retrace the same path.

Cutting fluid is usedin the process for cooling of tool workpiece interface. Coolant also washes awaythe tiny chips produced in the process. The time needed for super finishing

is verysmall. Workpiece may be super finished to a roughness of the order of 0.075 μmwithin 50 seconds.



Schematics of the superfinishig process.

Sometimes the process of super finishing can be continuedupto 3 minutes for very fine quality of finish. Super finishing can be differentiatedfrom honing in the following ways

(a) Super finishing stroke length is comparatively shorter but frequencyis larger. It is upto 1500 stokes/minute.
b) It requires low pressure application as compared to honing process.
(c) During the process fed is given to workpiece, the fed rate in case ofsuper finishing operation is smaller than honing.
(d) Grit size of abrasive used in case of super finishing is smaller thanthat is used with hones.

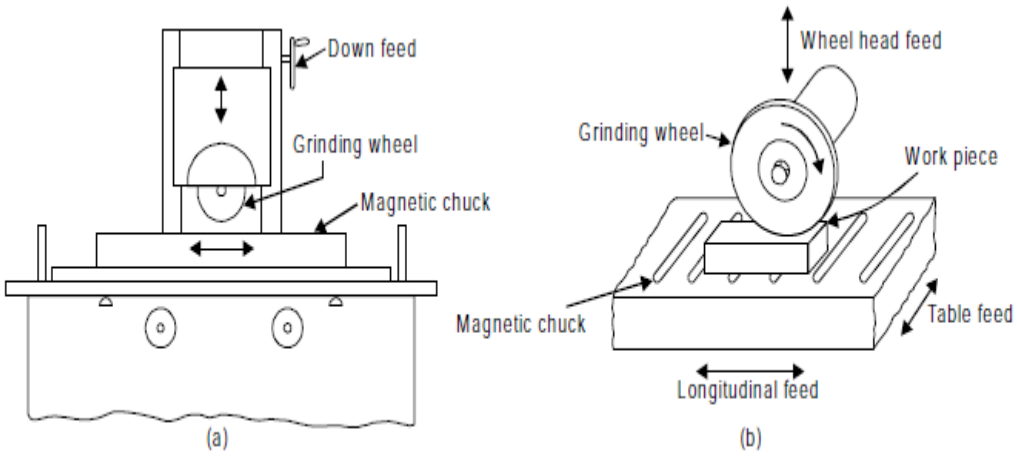
Major applications of super finishing are finishing of computer memory drums,sewing machine parts, automotive cylinders, brake drums, bearing components,pistons piston rods, pins, axles, shafts, clutch plates, guide pins, etc.

GRINDING

Grinding is generally called as fine machining or finishing operations of removing materials from surface usually 0.25-0.50 mm in most operations through the use of grinding wheel. Grinding wheel is highly useful in removing extra unwanted metal and sharpening cuttingtools such as chisels, drill, taps, and other cutting tools.

It may be used to finish almost allsurface, which has been previously roughly shaped by some other processes or to remove theextra material which is too hard to be removed by other machining processes.

The accuracyin fine grinding is in few microns or even less. In grinding, the work is held pressed againstthe high speed rotating grinding wheel and the metal gets reduced by abrasion. Grindingwheel is generally made from silicon carbide or aluminium oxide. It is generally made up ofparticles of hard substance called the abrasive and is embedded in a matrix called the bond.

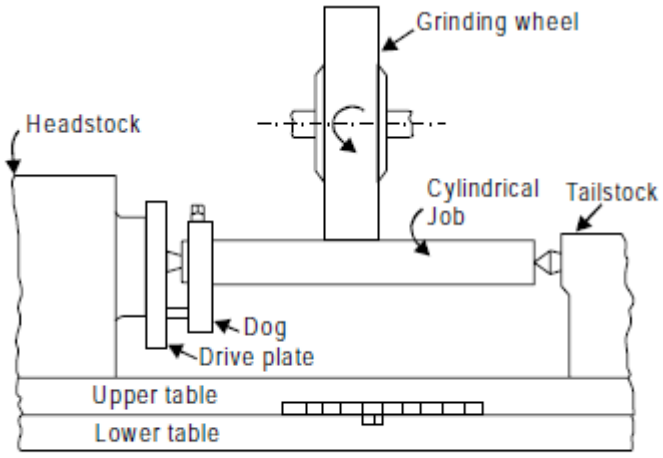


Surface grinding machine and its principle

These abrasives form the cutting points in a wheel and are termed as grains. The abrasivesare of generally two types namely natural and artificial. Emery and corundum are two naturalabrasives, while carborundum and aloxite are artificial abrasives.

POLISHING

Polishing is surfacing finishing process for producing a flat, scratch-free, mirror-likefinish. It consists of fine grinding, intermediate grinding, rough polishing, and fine polishing.Initially the surface to be polished is roughly ground to remove deep cut off marks. Then theintermediate grinding is done with fine emery or silicon carbide (Carborundum) papersdecreasing in grit size in three to four stages to remove grinding marks.



Principle of cylindrical grinding

Emery papers aregraded from fine to coarse. This polishing operation may be performed by hand or mechanicallyusing the rotating disks. The motion in polishing of work on polishing wheel should alwaysbe straight and the polishing strokes should cover the whole length of the surface beingpolished. Finer grade emery disc pr polishing wheel should be used for the fine finish work.Polishing is commonly performed on utensils.