UNIT IV
METAL FINISHING PROCESSES

SURFACE FINISHING PROCESSES

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

<table>
<thead>
<tr>
<th>Process</th>
<th>Tolerance (mm)</th>
<th>Roughness (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grinding</td>
<td>± 0.008</td>
<td>5 to 75</td>
</tr>
<tr>
<td>Lapping</td>
<td>± 0.005</td>
<td>2 to 15</td>
</tr>
<tr>
<td>Honing</td>
<td>± 0.005</td>
<td>4 to 30</td>
</tr>
<tr>
<td>Super Finishing</td>
<td>± 0.003</td>
<td>1 to 10</td>
</tr>
</tbody>
</table>

Different surface finishing processes are described below.

HONING

Honing is a surface finishing operation based on abrasive action performed by a set of bonded abrasive sticks. It is generally used to finish bores of cylinders of IC engine, hydraulic cylinders, gas barrels, bearings, etc. It can reduce the level of surface roughness below 32 μm. It produces a characteristics surface pattern across hatched which is a fit case to retain lubrication layer to facilitate motion to moving parts, their best example is IC engine.
The honing tool used to finish internal surface is shown in Figure. The honing tool consists of a set of bonded abrasive sticks. The number of sticks mounted on a tool depends on its circumferential 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 does not trace the same path repeatedly. The honing speed may be kept up to 10 cms per sec. Lower speeds are recommended for better surface finish.

Manufacturing defects like slight eccentricity a way surface, light taper, less of circulating can also be corrected by honing process. The process of honing is always supported by flow of coolants. It flashes away the small chips and maintains a low and uniform temperature of tool and work.

**Honing Machines**

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

**LAPPING**

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

All the metal parts that are subjected to fatigue loading or those surfaces that must be used to establish a seal with 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. It appears as a chalky paste. Normally the fluid used in lapping compound is oil or kerosene.

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

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

**Machine Lapping**

Machine lapping is recognized as fast lapping process. Gudgeon pins with 25 mm diameter and 75 mm long can be lapped at the rate of 500 units per hour. Mechanical lapping machines have vertical construction with the work holder mounted on the lower table which is given oscillatory motion.

The upper lap is stationary and floating while lower one revolves at 60 rpm. Some special purpose lapping machines are available for lapping of small parts such as piston pins, ball bearing races, etc. in machine lapping. A pressure up to 0.02 N/mm² for soft material and 0.5 N/mm² for hard material is applied.

**Lapping Applications**

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

Lapping is a costlier process so its applications are justified only when very high grade of surface finishing is required.
Lapped surfaces are well resistant to corrosion and wear, used in manufacturing of high precision parts.

**POLISHING AND BUFFING**

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

Rotating speed is equivalent to 2300 meter per minutes. The rotating wheels are made of softer materials like canvas, leather or paper. Thus, the wheels are 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 is replenished with new girts. Depending on the girt size polishing is divided into 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 abrasive girt size is maintained to above 120. In case of fine finishing process oil, tallow or beeswax is used as lubricating agent.

There is a limitation of polishing process that the parts with irregular shapes, sharp corners, deep recesses and sharp projections are difficult to polish.

**Polishing Tool**

Polishing can be done by hand, but for mass production work, specially designed semi-automatic and automatic polishing machines are available. Abrasive particles are Al2O3 or diamond. Carrier of abrasive particles has already been discussed. Polished surfaces may be buffed to obtain an even finer surface. Polishing does not improve dimensionless 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 with a revolving cloth buffing wheel that usually has been charged with a very fine abrasive as shown in Figure. Buffing status is somewhere in between polishing and lapping. A minor cutting action with microchip is done 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 fasten the layers of the cloth together. Buffing tools are enough flexible to polish up to interior of intricate cavities. The buffing tools are named 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 to move the buffing wheels.

![Schematics of the buffing operation.](image)

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

**SUPER FINISHING**

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

Cutting fluid is used in the process for cooling of tool workpiece interface. Coolant also washes away the tiny chips produced in the process. The time needed for super finishing
is very small. Workpiece may be super finished to a roughness of the order of 0.075 μm within 50 seconds.

Sometimes the process of super finishing can be continued up to 3 minutes for very fine quality of finish. Super finishing can be differentiated from honing in the following ways:

(a) Super finishing stroke length is comparatively shorter but frequency is larger. It is up to 1500 strokes/minute.

b) It requires low pressure application as compared to honing process.

(c) During the process feed is given to workpiece, the feed rate in case of super finishing operation is smaller than honing.

d) Grit size of abrasive used in case of super finishing is smaller than that 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 cutting tools such as chisels, drills, taps, and other cutting tools.

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

The accuracy in fine grinding is in few microns or even less. In grinding, the work is held pressed against the high speed rotating grinding wheel and the metal gets reduced by abrasion. Grinding wheel is generally made from silicon carbide or aluminium oxide. It is generally made up of particles of hard substance called the abrasive and is embedded in a matrix called the bond.
These abrasives form the cutting points in a wheel and are termed as grains. The abrasives are of generally two types namely natural and artificial. Emery and corundum are two natural abrasives, while carborundum and aloxite are artificial abrasives.

**POLISHING**

Polishing is a finishing process for producing a flat, scratch-free, mirror-like finish. 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 the intermediate grinding is done with fine emery or silicon carbide (Carborundum) papers decreasing in grit size in three to four stages to remove grinding marks.

Emery papers are graded from fine to coarse. This polishing operation may be performed by hand or mechanically using the rotating disks. The motion in polishing of work on polishing wheel should always be straight and the polishing strokes should cover the whole length of the surface being polished. Finer grade emery disc or polishing wheel should be used for the fine finish work. Polishing is commonly performed on utensils.