FINISHING/SECONDARY OPERATIONS ON P/M PART:

Finishing operations are carried out to improve the quality/characteristics of the final products like improving the dimensional accuracy & shape, improving the strength, impregnating of the heated oil in the bearings, and control of the porosity. Number of secondary operations are carried after sintering to sintered products. These are:

1. Sizing
2. Coining
3. Repressing and Re-sintering
4. Impregnation
5. Heat treatment
6. Steam treatment
7. Machining
8. Infiltration
9. Joining
10. Plating
11. Coating

1. **Sizing:**

   In this process, the sintered products are pressed to correct size, warping, distortion, improve surface finish, wear properties of the surface, and other dimensional defects present.
Sizing is performed by forcing the sintered product into a die of slightly smaller dimensions by applying force of less magnitude so that small deformation takes place resulting smoothening of the surfaces. The improvement in density is meager.

2. Coining:

It is similar to sizing process except the force applied is of larger magnitude. This significantly improves the density, hardness and strength. Due to high pressure, elongation of parts also takes place. Hot coining is also performed, in which, hot porous sintered product is compressed with high
energy causing deformation, producing sound and highly sound product. This technique is used for cermets.

3. Repressing and Re-sintering:
In repressing, the force applied is of higher magnitude resulting significant improvement in physical and mechanical properties along with dimensional control due to more plastic deformation. This process reduces the dimensional scattering and closes the surface pores with adjustment of final dimensions without large shape changes. However, if this process is adopted, the sintering temperature
is kept low so that sinter compact is weak. The repressing process leads to sealing of surface pores but internal pores are unaffected. This process improves the strength with reduction in ductility & toughness and fatigue strength increases. After repressing (room temperature), the repressed mass is again sintered.

4. Impregnation:
This process is used in porous bearings, where lubricant is impregnated in the pores of product after sizing to minimize friction among the moving body. Viscosity of lubricant and its corrosion resistance properties are important.
5. Heat treatment:

Heat treatment to sintered products is done to improve the various physical and mechanical properties such as to improve strength, hardness, wear resistance, surface hardness, and machinability. Quenching & Tempering, case hardening & annealing are mostly done. Salt bath and cyanide bath are not used for quenching to avoid trapping of salt in pores of sinter mass. Mostly water and oil are used. Austenizing is done with slightly higher temperatures and longer times (up to 50% higher) because of limited homogeneity of the sinter mass.
6. Steam treatment:

Steam treatment to sintered products is done to improve the various physical and mechanical properties such as to improve corrosion resistance, compressive strength, surface hardness & wear resistance, and surface finish. In case of steel, high pressure steam is passed over the sinter mass kept at a temperature of around 500 to 500°C. A magnetite (iron oxide) layer is formed on the exposed surfaces including open pores. Oxide layer increases the corrosion resistance, compressive strength, surface hardness & wear resistance.
7. Machining:

Machining is not necessary for sintered parts as it has specific dimensions. But, it can be done to produce specific shape (holes, threads, undercuts, & grooves) in the sintered mass. Mostly cemented carbide tools are employed for machining to increase life of tools. The machined surface is then treated to remove the cutting fluids. Electrical Discharge Machining (EDM) and laser cutting techniques are also used to obtain specific shape.
8. Infiltration:

This process is used to produce a sound, non-porous and improved mechanical strength of the sinter mass, in which, liquid metal or alloy is filled in the pores of sintered product. The sintered product must have significantly high melting point compare to infiltrating metal or alloy. The infiltrant must wet pores completely, have low surface tension to fill small pores and must not alloy or react with sintered parts. Infiltrants used are; copper & its alloys, silver and nickel. These infiltrants are injected in pores by capillary dip, contact infiltration, gravity feed, and pressure or vacuum infiltration.
9. Joining:

Joining of sintered parts are done with one another to give a particular shape or design of the component, which are not possible to make by powder metallurgy process. Porosity creates problem during joining process. Resistance projection welding, TIG, MIG, laser beam, electron beam and friction welding are used for satisfactory joining of parts. Brazing can be used in case of infiltered porous parts. Epoxy resins are also used for bonding of porous parts. Insert moulding, sinter bonding, press fitting are other secondary operations.
10. Plating:
Copper, nickel, cadmium, zinc and chromium can be electroplated on the sintered products to get specific properties. In case of porous parts, pores must be impregnated before plating, otherwise, plating solution will fill the pores, which will oozed out causing blistering of surface.

11. Coating:
Cutting tools are coated by wear-resistance layer of titanium carbide, titanium nitride, alumina or a combination of these materials using Chemical Vapour Deposition (CVD) or Physical Vapour Deposition (PVD) techniques.