MANUFACTURING SCIENCE-I

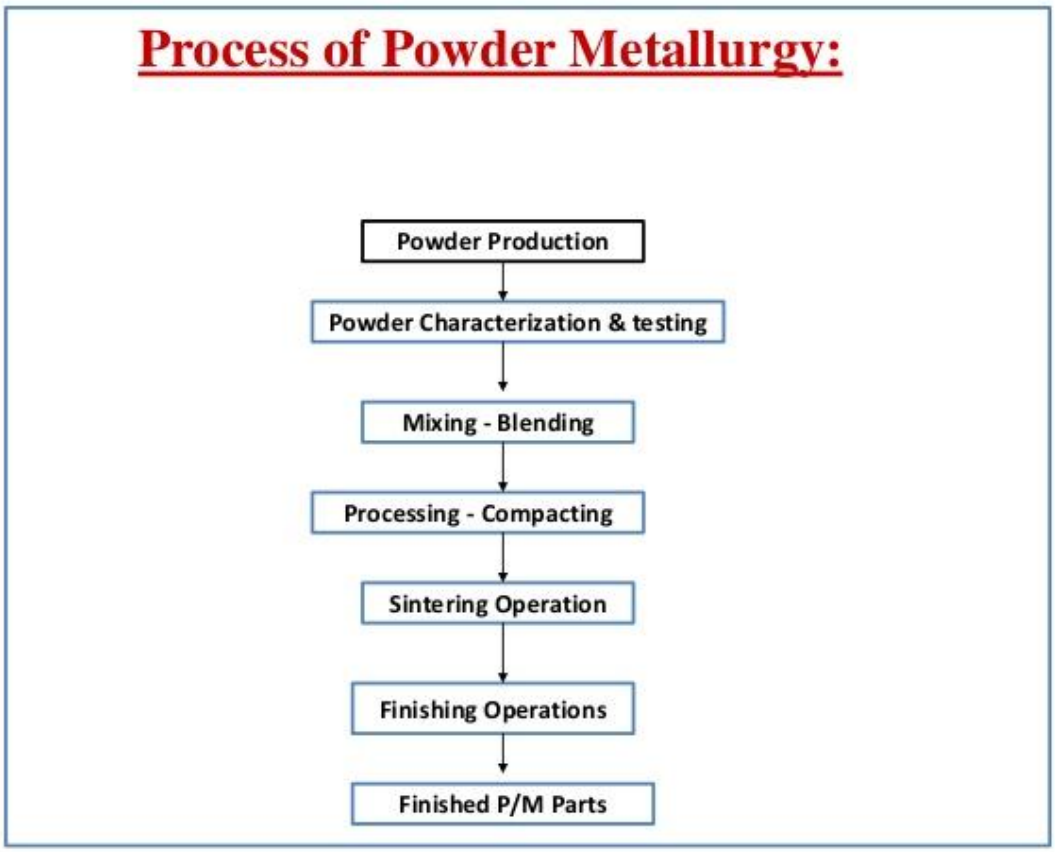
UNIT-5

POWDER METALLURGY

POWDER METALLURGY

The powder metallurgy process consists of mixing elemental or alloy powder, compacting the mixture in a die and then sintering or heating the resultant shape in a controlled atmosphere. Powder metallurgy is a highly developed method of manufacturing ferrous and nonferrous materials. It is a chip less working process. This process is cost effective in producing simple or complex part in manufacturing (Production) rates which can range from a few hundreds to several thousands parts per hour. Due to high cost of die and equipment this process is suitable for mass production only. The basic steps involved in the production process are given below.

• Preparation of powder or powders of desired composition.
• Mixing and blending – Powder are mixed thoroughly and blended to ensure desired property.
• Compacting the powders into desired shape and size and providing strength to the parts.
• Sintering – Green compacts are heated at elevated temperature to impart strength.



ADVANTAGE OF POWDER METALLURGY

• Parts with closed dimensional tolerance (nearest shape) and good surface finish can be produced.
• It eliminate or minimizes scrap losses by more than 97% of the raw material in the finished part, unlike other process.
• Process can be fully automated hence unskilled labour can be employed which reduces labour cost.
• It eliminate or minimizes machining.
• It facilitates manufacture of certain parts by mixing different metals, metals and non metals, metals and ceremics etc to obtain desired properties which is impossible with other working processes.
• High production rates from 500-1000 parts/hour can be achieved.
• It facilitates manufactures of small and unique shape part which cannot be produce by any other manufacturing process.
• Detect free component with uniform structure can produce.
• Non equilibrium composition possible e.g. cr. alloys.

LIMITATIONS OF POWDER METALLURGY

• The cost of material in powder form is quite high this cost is offset for Large volume production by absence of scrap and low labour cost.
• Products with intricate design are difficult to produce as there is little flow of metal powder during compaction.
• The residual porosity left in sintered parts makes then rough.
• This process is economically feasible for Large volume production due to high cost of dies and equipments.
• Producing parts of Large size and weight is quite expensive due to costly dies.
• It is difficult to compress some metal powders and also difficult to procure some metal powders.
• The density of compact is not uniform throughout.
• Some e.g. zr present explosion hazard.
• Parts produce by powder metallurgy have low impact and fatigue strength as compared to other method.
• Healt problems from atmospheric contamination of the work place.

APPLICATION OF POWDER METALLURGY

The application of powder metallurgy components fall in two main groups-

 First are component that are difficult to manufacture by other method such as those made from tungsten, Molybdenum and tungsten carbide.

 The second group consists of components that offer a cost effective alternatives to machined components, casting and forging.

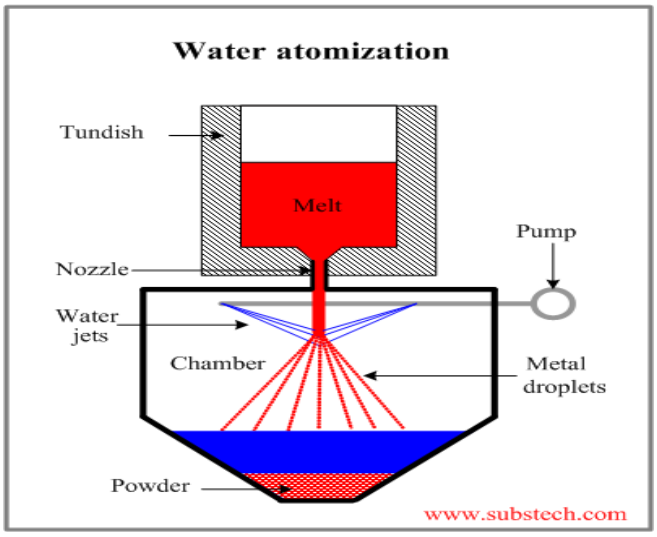
Some applications are as follows-

• Used to produce porous parts e.g filters.
• Some components of tungsten employed in jet engines are made by powder metallurgy.
• Auto mobile components such as clutch plates, connecting rods, cam shafts and piston rings etc.
• Many types of hard and soft magnetic components.
• Grinding wheels are manufactured by using steel and diamond powder.
• Nozzle for rockets and missiles are made using silver infiltrated tungsten.
• It is used to produce complex shaped parts which require machining when produced by other methods e.g. gears.
• Electrical bushes for motors are made by combining metallic and non metallic material.
• Some parts used in clocks, type writers, calculators, permanent magnet etc. are made by powder metallurgy

PRODUCTION OF METAL POWDER

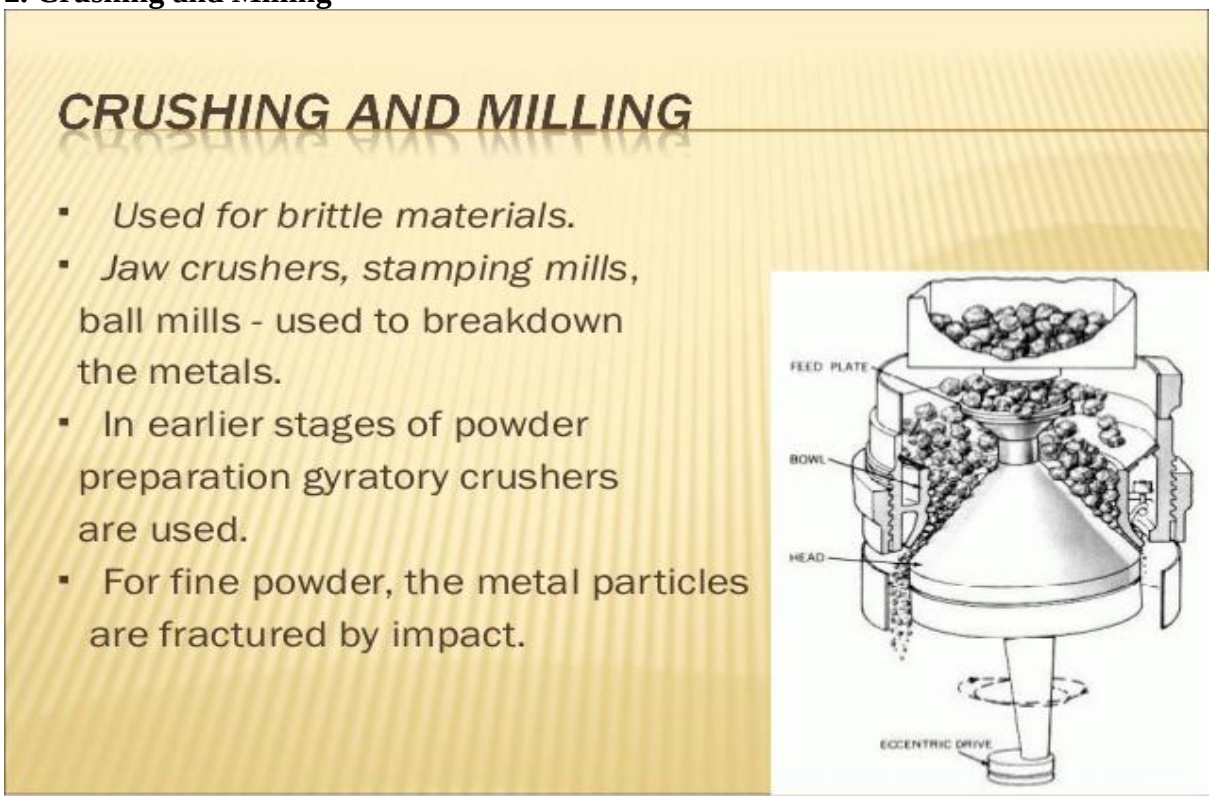
Some common methods used in powder production depending on type and nature of metals are as follows.

1. **Atomization**



In this process molten metal is broken up into small droplets by spraying it on the streme of inest gas or air jets and rapidly frozen before the drops come into contact with each other or with the solid surface this technique is applicable to all metals that can be melted and is used commercially for the production of iron, copper, brass, bronze, lead, zinc etc.

2. Crushing and Milling



Crushing and milling operations are perform on brittle or less ductile materials (metals). Metal particles are crushed in crushing m/c for final powder.

3. Electrolysis Process

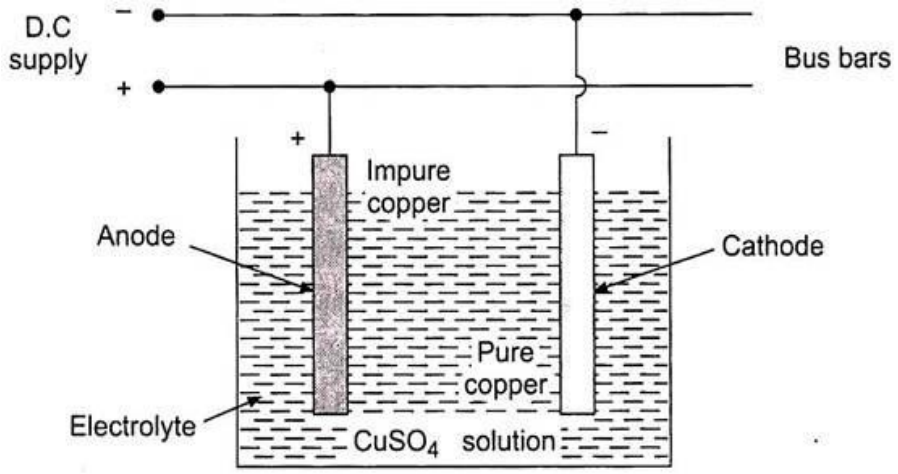


Fig. 5.2 *Refining of Copper*

By choosing suitable conditions such as electrolytic composition and concentration temp and current density many metals can be deposited in a spungy or powdered state further processing is required which yields high purity and high density powders. Cu is the primary mental produced.

4. Chemical Process

The most common chemical powder treatments involve oxide reduction precipitate form solution and thermal decomposition. The powder produced can have a great variation in properties and yet have closely controlled particle size and shape.

CHARACTERISTICS OF METAL POWDERS

Some characteristics on which behaviour of metal powder depends are described below-

1. Particle shape & size distribution

The shape of particles depends mainly on the method of production of powders, spheroidal shaped particles have excellent sintering property and irregular shaped particles are good for moulding. Mostly 100□μ size powders are used.

2. Density

True density is mass per unit volume of the solid material apparent density is defined as the mass of loose powder per unit actual volume filled by the powder it depends on particle shape, size distribution powders with high apparent density require shorter compressive strike to produce a compact of given density and size.

3. Flow Rate

It is defined as the time required for a measured quantity of powder to flow out of a standard orifice flow rate should be high to obtain high production rate.

4. Compressibility and Compression Ratio

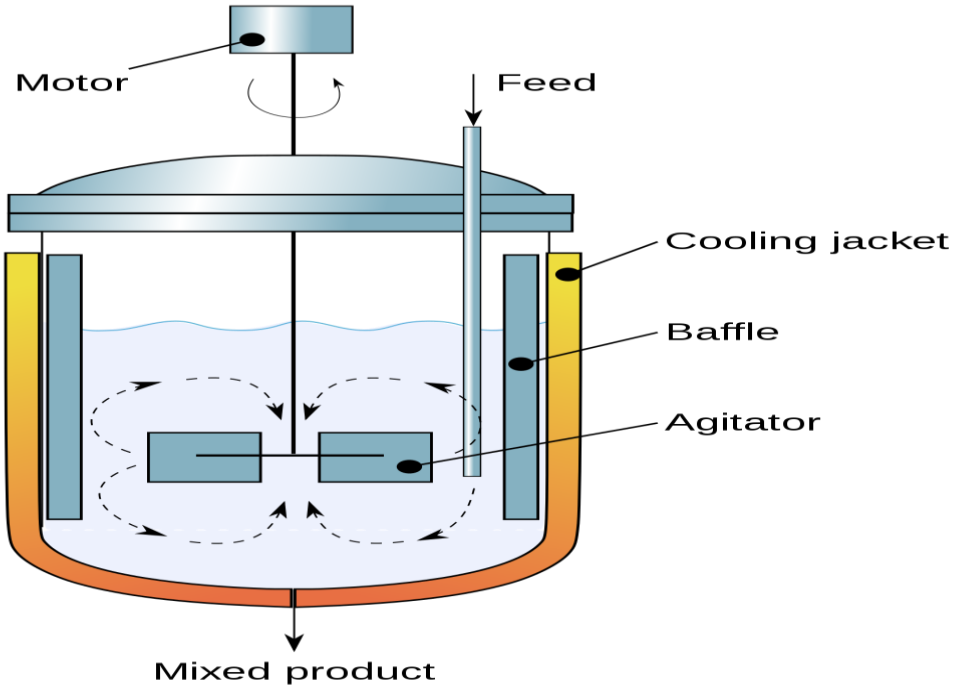
Both depends upon shape size and size distribution of particles compressibility is defined as the ratio of initial volume of the powder (Un pressed volume) to final volume green strength to powder also known as mechanical strength of compressed part.

PROCESSING OF POWDERS

Processing of powder has been classified in two groups-

(A) PRIMARY PROCESS

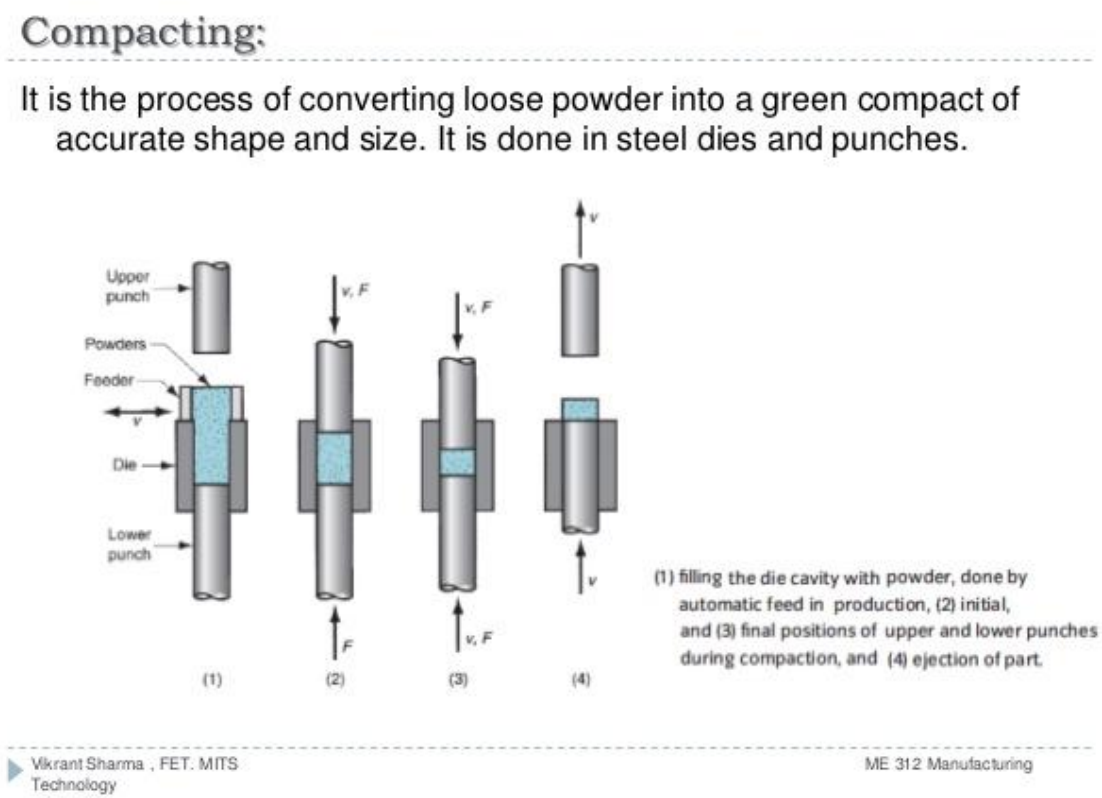
1. Mixing and Blending of Powder



Mixing means the intermixing of powders of two or more materials. Intermixing of a powder and binder or intermixing of a powder and lubricants. The mixing and blending of metal powder is done under controlled condition to avoid contamination and deterioration. It fulfil following purposes.

- It produces a uniform distribution of particle shape and size.
- It allows different metal to be mixed to obtain specific physical property.
- It improves metal powder interaction by addition of lubricants (e.g stearic acid, Zinc stearate in proportion of 0.25 to 0.5% by weight) to the powder improves the flow characteristics of the powder. Such blends result in reduced friction between the metal particles, improved flow of powder metal into dies and longer die life.
- Co-combine metallic and non metallic powder.

2. Compacting or Briquetting

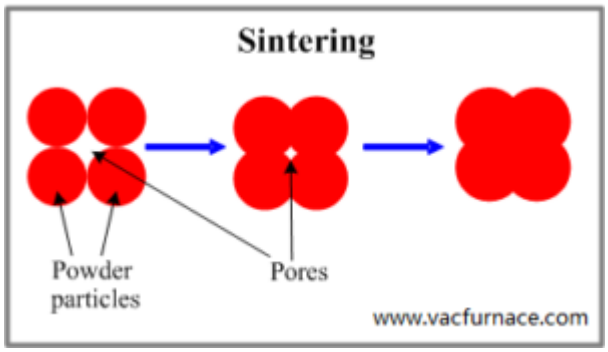


The mixed powders are compacted in die to form the size and shape of the desired part, parts fo produced are known as green compact. The density after compaction is called green density. Depends upon the compaction pressure, dimensions of the compacted parts and powder hardness. The compacting is carried out at room temp. in dies. The die cavity is filled with required amount of mixed powder for uniform distribution of pressure two punches are generally used one from top and other from bottom side of powder. The green compact expand slightly when taken out of die to elastic recovery this expansion depends of the pressure and extend of plastic deformation in powder particles.

3. Pre-Sintering (Not done when machining is not required)

It is defined as a process in which green compact is heated to temperature below final sintering temperature to increase the strength. It also removes the lubricant and binders added during blending. After this the final sintering operation is performed.

4. **Sintering**



Sintering is the process of heating the material to a temp. below the melting temp. but high enough to allow bonding or fusion of individual particles under protective atmosphere prevent oxidation. Continuous sintering furnace are used which have 3 chambers-

• A chamber to volatize (easily becoming goes or dangerous) the lubricants in the green compact in order to improve bond strength and prevent cracking it. It is called brunt off chamber. It slowly raises the temp. in a controlled manner.

• A high temperature chamber for sintering for bonding b/w the powder particles the time during the second stage must be sufficient to produce the desired density and final properties.

• A cooling chamber.

B) SECONDARY OPERATIONS

These operation are carried out to obtain desired dimensional tolerances, physical property improve its strength, hardness and wear resistance etc. finishing operations are often perform after sintering for better dimensional accuracy different machining operations are performed. Heat treating the sintered part will improve its hardness, strength and wear resistance. Finishing operation is perform to improve the surface characteristics of part.

THANK YOU

Question Session

?