PRE-READING

Unit-IV **Topic- Powder Metallurgy**
Subject - Manufacturing Process **Name of Faculty-**

Powder Metallurgy

Powder metallurgy is the art and science of producing fine metal powders and then making objects from individual, mixed or alloyed metal powders with or without the inclusion of non- metallic constituents.
(Or) Powder metallurgy is a branch of metallurgy which deals with the production of metal and non metal powders and subsequently manufacture of components by using these powders.

Powder Metallurgy Processes

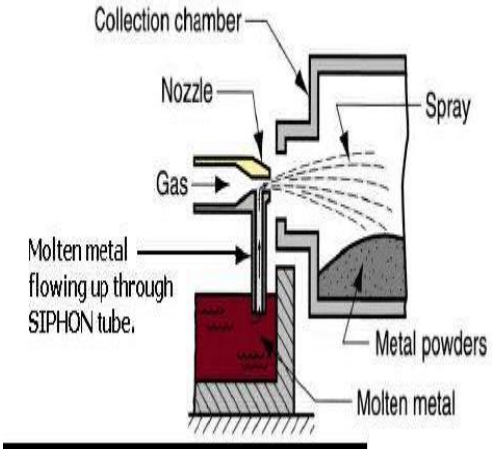
> Primary Operations

1. Producing metal powders

Various methods for manufacturing powders are

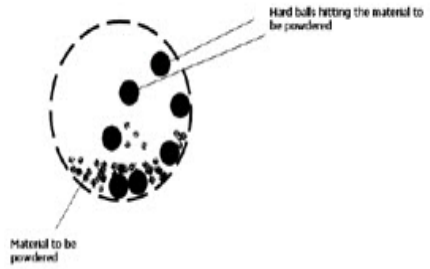
i. Atomization

The process of metal spraying against a stream of compressed air or inert gas is atomization. It is an excellent means of producing metal powders from many of the low temperature metals such as lead, aluminum, zinc and tin.



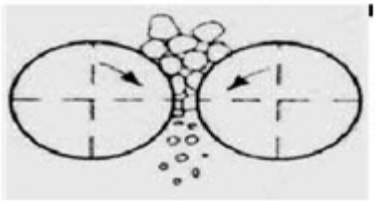
ii. Reduction

Reduction process is carried out in an atmosphere controlled furnace.In reduction process, the compounds of metals usually oxides like iron oxides are reduced with CO/H at temperature below melting point of metal. Tungsten, molybdenum, iron, cobalt, nickel powders are commercially produced by this process.



iii. Crushing

Process of passing the metal powders against two rollers so that the metal powders are crushed to required size. Crushing requires equipments such as stamp, hammers, and jaw crushers.



iv. Milling

Milling is carried out by using equipments such as ball mill, rod mill, impact mill, disk mill etc. In ball milling, material to be powdered is collected in a container with a large number of hard steel balls. These balls hit the material and break it in powder form.

v. Shotting

The process of pouring molten metal through a sieve or orifice and cooling by dropping into water is known as shotting. This process gives spherical or pear shaped powder particles.

vi. Electrolysis.

In this method, an electrolytic cell is set up as shown in figure. The desired metal is made to act as anode. Anode slowly dissolves and gets deposited on the cathode from where the deposit is removed, washed and dried.

2.Mixing / blending of metal powders

Blending : Mixing powder of the same chemical composition but different sizes

Mixing : Combining powders of different chemistries

Blending and mixing is necessary for-
- Addition of lubricants coats the powders and reduces die wear and lowers pressure required for pressing of powders.
- Mixing powders of different materials

- Obtaining uniform distribution of particle sizes.

3. Compacting / Pressing of metal powders

- Pressing the powders into desired part shape as closely as possible to final dimensions

- Powders are compacted using high pressure.

Degree of pressure required depends upon-
1- Required density of final product

2- Ease with which powder particles will weld together.

Compacting processes are-
i. Die pressing

ii. Roll pressing

iii. Extrusion

4. Presintering

- Powder metallurgy is used to make parts from materials that are very difficult to machine.

- When some machining is required on such parts, Presintering is done before actual sintering operation.

- Compact is heated for a short time at a temperature below sintering temperature

- Presintering removes lubricants and binders added to powders during blending operation.

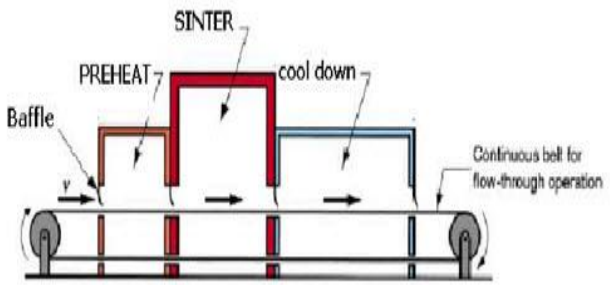
- After presintering, the part acquires sufficient strength to be handled and machined without difficulty

5. Sintering

- Sintering is the heat treatment process, to bond the metallic particles, thereby increasing strength and hardness

- Sintering consists of heating pressed metal compacts in batch or continuous furnaces to a temperature below the melting point of material.

- Most metals are sintered at 70 % to 80 % of melting temperature.



PRE-READING

Unit-IV **Topic- Powder Metallurgy**
Subject - Manufacturing Process **Name of Faculty-**

Secondary /Finishing Operations

A number of secondary and finishing operations can be applied after sintering, some of them are:

1- Sizing : cold pressing the sintered part to improve dimensional accuracy.

2- Coining : cold pressing to press details into its surface.

3- Impregnation : oil fills the pores of the part

4- Infiltration : pores are filled with a molten metal

5- Heat treating : annealing can be done for stress relief in powder metallurgy part.

6- Machining : creates geometric features that cannot be achieved by pressing, such as threads, side holes, and other details

Applications

1. **Filters:** Powder metallurgy filters have greater strength and shock resistance than ceramic filters. Fiber metal filters, ***having porosity up to 95%*** and more, are used for filtering air and fluids.

2. **Cutting Tools and Dies:** Cemented carbide cutting tool inserts are produced from ***tungsten carbide*** powder mixed with a ***cobalt binder.***

3. **Machinery Parts:** Gears, bushes, and bearings, sprockets, rotors are made from metal powders mixed with ***sufficient graphite*** to give the product desired ***carbon content***.

4. **Bearing and Bushes:** Bearing and bushes to be used with rotating parts are made from ***copper powder*** mixed with ***graphite.***

5. **Magnets:** Small magnets produced from different compositions of ***powders of iron, aluminum, nickel, and cobalt*** have shown excellent performance, far superior to that cast.

PRE-READING

Unit-IV **Topic- Powder Metallurgy**
Subject - Manufacturing Process **Name of Faculty-**

Advantages

- A combination of metals and non metals powdered parts can be manufactured.

- High dimensional accuracy is achieved.

- Fine surface finish is achieved.

- No material is wasted as scrap. This process makes use of 100 % raw material unlike casting, press forming etc.

- Porous parts can be produced which is not possible by any other method.

- Highly qualified or skilled person is not required for handling powder metallurgy method.

- Large scale production of small parts with this process gives efficient results.

- Production of cemented carbide tools is possible only by this process.

- It eliminates numerous machining operations.

- Powder metallurgy parts can be easily brazed, welded, soldered.

- Process is economical as mass production process

Limitations

There are limitations and disadvantages associated with P/M processing. These include:

- High tooling costs.

- Expensive raw materials (powders).

- Relatively long parts are difficult to manufacture.

- Difficult storing and handling of powders

- Powder metallurgy is not economical for small scale production.

- Articles produced by powder metallurgy process possess poor ductility.

- Difficult to produce high purity powder.

- Due to porosity, specified mechanical properties are difficult to be obtained.

- P/M parts show poor plastic properties.

- Punches, dies, rolls etc are very costly and also very bulky to transfer from one place to another

PRE-READING

Unit-IV **Topic- Sheet Metal Operations**
Subject - Manufacturing Process **Name of Faculty-**

Spinning

Metal spinning, also known as **spin** forming or **spinning** or **metal** turning most commonly, is a metal working **process** by which a disc or tube of **metal** is rotated at high speed and formed into an axially symmetric part. **Spinning** can be performed by hand or by a CNC lathe.

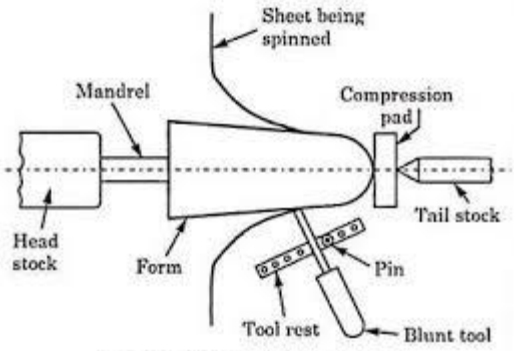


Fig. 6.14. (a) Spinning operation.

Forming

- In forming operation, sheet metal is stressed beyond its yield point so that it takes a permanent set and retains the new shape
- In this process, the shape of punch and die surface is directly reproduced without any metal flow
- The operation is used in the manufacturing of door panels, steel furniture, air-craft bodies, etc.

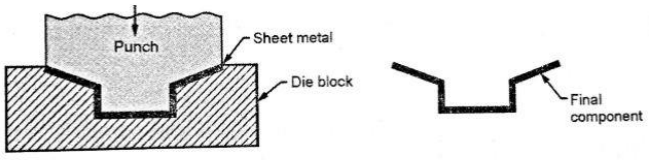


Fig. 2.21 : Forming

Embossing

- With the help of operation, specific shapes of the figures are produced on the sheet metal
- It is used for decorative purposes or giving details like names, trademarks, etc on the sheet metal

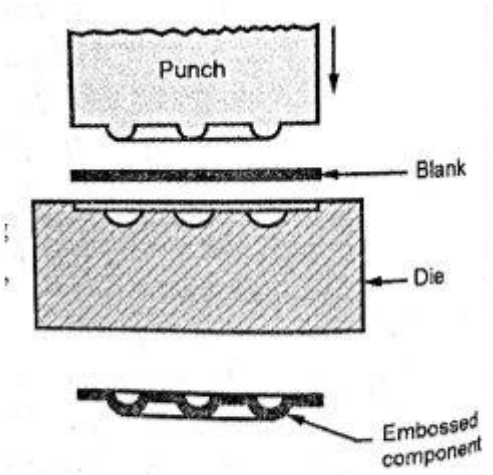


Fig. 2.20 : Embossing

Coining (squeezing)

- In coining operation, the metal having good plasticity and proper size is placed within the punch and die and a tremendous pressure is applied on the blank from both ends
- Under severe compressive loads, the metal flows in the cold state and fills up the cavity of the punch and die
- The operation is used in the manufacturing of coins, ornamental parts etc.

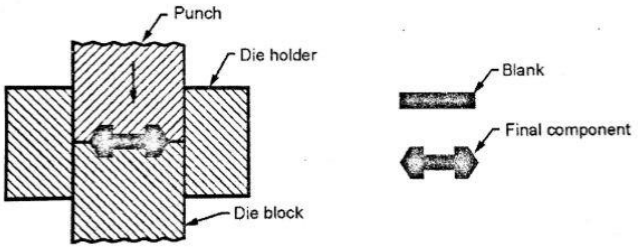


Fig. 2.22 : Coining