GOVERNMENT POLYTECHNIC, SONEPUR

Lecture Note on

Production technology (3rd Sem)

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The mother Powder metallurgy

→ Define powder metallurgy process.

Ans:- powder metallurgy is the name given to a process in which metallic powders are heated below their melting temp. to achieve bonding.

→ The powder metallurgy process enables to produce parts in their final shape, thus eliminating the need for any additional machining.

→ Raw material is not wasted during the processing while unusual materials or mixtures can be utilized.

→ most of the powder metallurgy parts are in the size range of less than 2kg, though parts as large as 20kg are made too.

Steps used in powder metallurgy:-

1. powder production
2. compaction
3. Sintering
4. secondary operation.

process used in PM

There are a number of process used for the manufacture of metal / alloy powders:-

- Solid state reduction
- electrolysis
- Atomization
- chemical

1. Solid state Reduction:-

The process is generally used for producing iron powder.

→ in this process, the selected metal / alloy is crushed, mixed with carbon and passed through furnance where a reaction takes place, which leaves a cake of sponge metal.

→ this sponge metal is then crushed after separating from all non-metallic material

→ The purity of the powder is dependent on the purity of the raw materials.

→ The powder particles are irregular and sponge like which can be readily compressed to give good green strength. (it available at low compact density

Atomization:- Atomization breaks molten metal into contact with each other or with a solid surface.

→ The atomization is achieved by bringing the thin molten metal stream in contact with the impact of high-energy jets of gas or liquid.

→ Air, nitrogen and argon are commonly used gases and water is the most widely used liquid.

→ in Atomization, the particle shape is determined largely by the rate of Solidification and varies from spherical.

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Solidification:- both liquid and solid have equal energy at melting point and therefore both are equally stable at melting point -) Some under cooling essential for solidification.

Electrolysis:- The desired metal is made as anode in an electrolytic cell, such that it is dissolved by the electrolyte in the cell and then transported and deposited on the cathode in a spongy or powdery form.

-) The deposit is removed, washed, and dried to get the metal powder.

-) Copper is the primary metal produced by electrolysis but iron, chromium, and magnesium powders are also produced using this process.

Basic steps of the process:- The production of a component by P/M involves the following basic steps-

1. preparation of powder / powders of the desired composition.

2. Mixing and Blending :- in this step, more than one powders are mixed thoroughly and blended to ensure their even distribution, or a powder is mixed with lubricants additives or binders that might be used.

3. Compacting :- in this step, the blended mixture is compacted to bring the finely divided particles or powder into close proximity while imparting the desired part configuration and providing green strength to the part.

4. Sintering :- in this step, the compacts obtained after step 3 are heated at elevated temp. to establish permanent strong bonds between adjacent particles and thereby to impart strength to the compact.

(b) State advantages of powder metallurgy techniques.

Ans :- Following are some of the advantages found in powder metallurgy than conventional manufacturing processes :

1. Elimination or minimization of scraps losses and machining (cutting) like casting, forming etc other processes.

2. The processes of powder metallurgy are quiet and clean.

3. cleaner and quiter operation.
4. Do not require highly skilled labours.
5. ~~Do not require~~ can produce components from such metals or alloys having poor castability. (it refers to a past design or material property)
6. provide controlled porosity for self-lubrication or filteration. (it measure the void spaces in material)
7. effective control over the uniform structure and size of grain which eliminates some defects like, voids, blow holes etc. in metal components. (not void)
8. Maintain close dimensional tolerances and high surface finish.
9. The components produced by powder metallurgy process bears longer life.
10. High purity of metal components can be achieved.
11. produces materials of high strength or wear resistance. (loss of material from a surface by means of some mechanical action)
12. Much better uniformity of chemical composition.
13. Suited to low to high volume production requirements
14. Bimetallic and laminated special purpose parts can be manufactured.
15. Hig

15. Highly cost effective in producing certain parts as compared to other manufacturing processes.

16. 'cermets' (ceramics + metal) is manufactured in this process which is being increasingly used as tool material. used in machining (harder than the material of the workpiece)

17. The use of diamond in industry has been made possible mainly through powder metallurgy..

Q) Explain different process of powder metallurgy.

Ans:- powder metallurgy process:- The powder metallurgy process consists of the following steps:-

(i) Formation of metallic powders.

(ii) Mixing or blending of the metallic powders in required proportions.

(iii) compressing and compacting the powders into desired shapes and sizes in form of articles.

(iv) Sintering the compacted articles in a controlled furnance atmosphere

(v) Subjecting the sintered articles to secondary processing if needed so.

Manufacture of metal powders:- There are many methods available for the production of powders, depending upon the type and nature of the metal. Some of the common methods:

(i) Atomization:- In this method, molten metal is broken up into small droplets by spraying it against an oncoming stream of compressed air, inert gas or water jets. With air and water atomization the powder always gets oxidised. The particle shape and size can be readily varied by controlling the process parameters, that is, metal flow rate or the pressure and temp. of the stream of air or gas.

(ii) Machining:- This method produces coarse powder particles and is used mainly for producing magnesium powder.

(iii) Reduction:- pure metal is obtained by reducing its oxide with a suitable reducing gas at an elevated temp. This pure metal is then crushed and milled to a powder.

(iv) Crushing and Milling:- These methods are mainly used for brittle metals and utilize various types of crushers, rotary mills and stamping mills to break down the metals.

(v) Electrolytic deposition:- The process is similar to electroplating. For producing iron, impure steel plates act as anodes in tanks containing an electrolyte. Sheets of stainless steel are also placed in the tank and act as electrodes. When D.C. current is passed through the electrolyte pure iron gets deposited on cathode.

(vi) Shotting:- In this method, the molten metal is poured through a sieve or orifice and is cooled by droping into water. Most metals can be shotted. The droplets are transformed into small particles as they are agitated and coole

(viii) Granulation:- In this method, the molten metal is converted into small particles by rapidly stirring the metal while it is cooling.

(viii) Condensation of Metal powders:-

The powders of some metal like magnesium, zinc and cadmium can be produced by boiling them and then condensing the vapours.

(ix) Thermal Decomposition:-

in this method, metals are made to combine with carbon monoxide to form volatile carbonyls. At suitable temp and pressure, these carbonyls decompose to get pure metal.

Mixing or Blending of Metallic powders

After the formation of metallic powders, proper mixing or blending of powders is the ~~1st~~ first step in the forming of powder metal parts. The mixing is being carried out either wet or dry using an efficeint mixer to produce a homogeneous mixture.

Compacting of powder:- compacting is the technique of converting loose powder into compact accurately defined shape and size. This is carried out at room temp. in a die on press machine. The press used for compacting may be either may be either mechanically hydraulically operated. The die consists of a cavity of the shape of the desired part.

-) Metal powder is poured in the die cavity and pressure is applied using poured in the die cavity and pressure is applied using punches, which usually work from the top and bottom of the die.

Ans:- in the powder metallurgy, the green compact as obtained after compacting operation is not very strong and is very brittle and cannot be used (break easily) it is. in orders that it become a usable powder metal product, it must undergo the sintering operation (a device used for high temp heating). (compact - shape and size of the finish product)

In this process the green compact is placed in a furnace to below the melting point of at least one of the major constituents under a controlled atmosphere. (The model is called green compact as comes out of the die).

So sintering can be defined as the bonding of adjacent surfaces of particles in a mass of metal powder, by heating.

The time of exposure, the sintering temp and the rate of cooling are vary with the following factors:- (The state of having no protection from something harmful)

a) Type of metal powder
b) compressive local applied.
c) strength requirements of the finish parts etc.

~~This major type of furnace. it can be used batch type~~

The major type of furnace used for sintering is the electric resistance furnace (furnace - it can be used batch type or continuous type.

The following structural properties change during sintering.

(i) crain growth across the original interparticle boundary.

(ii) voids tend to become closed.

(iii) Trapped angles tend to spheroidize.

iv) Residual stresses within the particles are relaxed allowing the particles to deform plastically

→ the ratio of the current density in the material to the electric field which causes the flow of current.

v) improved density, electrical conductivity and ductility of the powder metal parts.

The rate at which heat passes through a specified material.

characteristics accomplished by sintering are:-

→ able to be drawn out into a thin wire.

1) Residual stresses within the particles, caused by the compacting operation, are relaxed allowing the particles to deform plasticcally.

-) voids tend to become closed and this causes some shrinkage during sintering. Therefore, the green compact should be oversized.

-) individual crystals may be recrystalised within the compact if the sintering temp is high enough to have an effect on the crystalline structure. co

(c) Describe the various methods of powder metallurgy technique to produce a compone

Ans:- Methods of components by powder metall
gy technique:- powder metallurgy is a manufacturing process in which metals are first powdered and then placing these powders in moulds and are compacted in the desired final shape by using heavy compressive load.

The entire powder metallurgy process mainly consists of the following steps:-

(i) production of metallic powders.

(ii) Mixing and blending of metallic powders

(iii) compressing and compacting the powders into desired shapes and sizes.

(iv) sintering the compacted components at elevated temp. to establish permanent strong band between the particles.

(v) subjecting the sintered particles to secondary processing if required.

(i) production of Metal powders:- Now-a-day almost all metals and of a large variety of alloys generally copper base and iron base materials are used to manufactu

metal powders. The common process used to manufacture metallic powders are :-

- Atomization :- in this process the metal is 1st melted and then it is directed through an orifice and it emerges a high pressure stream of gas or liquid under impinges on it causing it to atomize into fine aparticles. This method is mainly used for low melting point metal and alloys like aluminium, brass, bronze, tin etc.

chemical reduction process :- in this process pure metal is obtained by reducing its oxide with a suitable reducing gas at an elevated temp. but below melting point. This pure metal is then crushed and milled to powder form.

Electrolytic process :- This process utilises the principle of electrolysis for production metal powders. in this process the deposited material at cathode is ground for fineness, pulverised for desired grain size. The powders produced through this process are the purest but high cost. it is used for iron, copper, silver, tantalum and various other metals.

crushing and milling process :- These process are commonly used for brittle metals and utilized various types of crushers,

ball mill, rotary mills and stamping mill to break down the metal by crushing and impact

Shooting:- In this method the molten metal is poured through an orifice or a and is cooled by dropping into water and the droplets are transformed into small particles as they are agitated and cooled in water

- condensation of metal powders:- This techniques is applied to some metals like magnesium, zinc and cadmium which can be boiled and the vapours are condensed in a powder form

(ii) Mixing and Blending:- After the formation of metallic powders proper mixing or blending of powders is required for the following reasons:-

- To obtain uniform distribution of particle sizes.
- To add lubricants to reduce die wall during the pressing operations.
- To mix powders of different materials like metallic and non-metallic powders.
- To ensure filling up of the interstices betn large particles.
- To add volatile agents to give a desired amount of porosity

Mixing and blending is done thoroughly either in dry, in a ball mill for wet mixing water or a solvent is added to the dry powder to reduce the possibility of explosion and dust hazard.

Compacting - ✓

sintering and pre-sintering :- The metal parts obtained after compacting are not strong and dense and cannot be used as it is. To improve these properties, the parts should be sintered.

-) pre-sintering means heating the green compact to a temp. below the sintering temp. it is done to increase strength of green compact and remove the lubricants and binders added during blendi

-) After pre-sintering, the compacted part acquires sufficient strength to be handled and machine o without difficulty.

-) pre-sintering is necessary when holes are to b drilled in hard to machine parts.

v) secondary operations :- in many cases, the metal parts may be used after sintering conditio but in some cases it requires some of the certa additional operations as given below :-