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Internal Assessment - II

Additive Manufacturing

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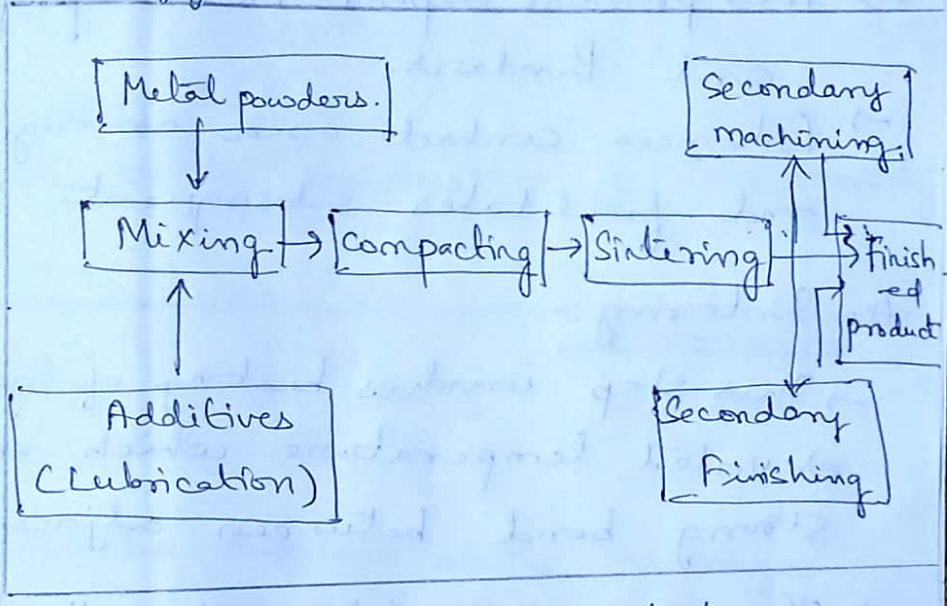
① Powder metallurgy can be defined as the process of preparation and process the powdered iron or non-ferrous metals or materials.

The steps in powder metallurgy are:-

1. Powder preparation
2. Mixing and Blending
3. Compacting.
4. Sintering.
5. Secondary operations.



Diagrammatic representation.

1. Powder preparation:-

→ First and Basic step in powder metallurgy. Any material can be converted into powder

→ There are various process of producing powder such as atomization, grinding, chemical reaction, ball milling, Electrolysis etc...

2. Mixing and Blending:-

→ Blending imparts uniformity in the shapes of the powder particles

→ Process ensures even distribution of powder with additives binders etc

→ Lubricants are added to improve flow characteristic of powder.

3. Compacting:-

→ Compacting means compressing the prepared powder mixture into predefined dies

→ This step ensures to reduce the voids and increase the density of the product.

→ It involves pressure range from 80 to 1600 MPa

→ This pressure depends on the properties of metal powder and Binders.

→ Enhances contact area among the powder particles and facilitates subsequent sintering process.

4. Sintering:-

→ This step involves heating of green compact at an elevated temperature which ensures a permanent strong bond between adjacent particles.

→ This process provides strength to green compact & converts to final product

→ The Sintering temperature is about 70-90% of melting temperature of metal powder

5. Secondary operations.

→ Sintered object is more porous compared to full dense material.

→ Some finishing operation such as reprocessing, sizing, hot forging, infiltration is done to further improve the quality of the product.

→ Most common secondary operation are sizing, coining impregnation, hot forging etc.

* Advantages:-

1. High production rate can be achieved
2. Machining operation is eliminated
3. Reduced production time

* Disadvantages:-

1. High initial cost of metal powder
2. High tooling cost
3. Equipments used are costly. and poor plastic properties

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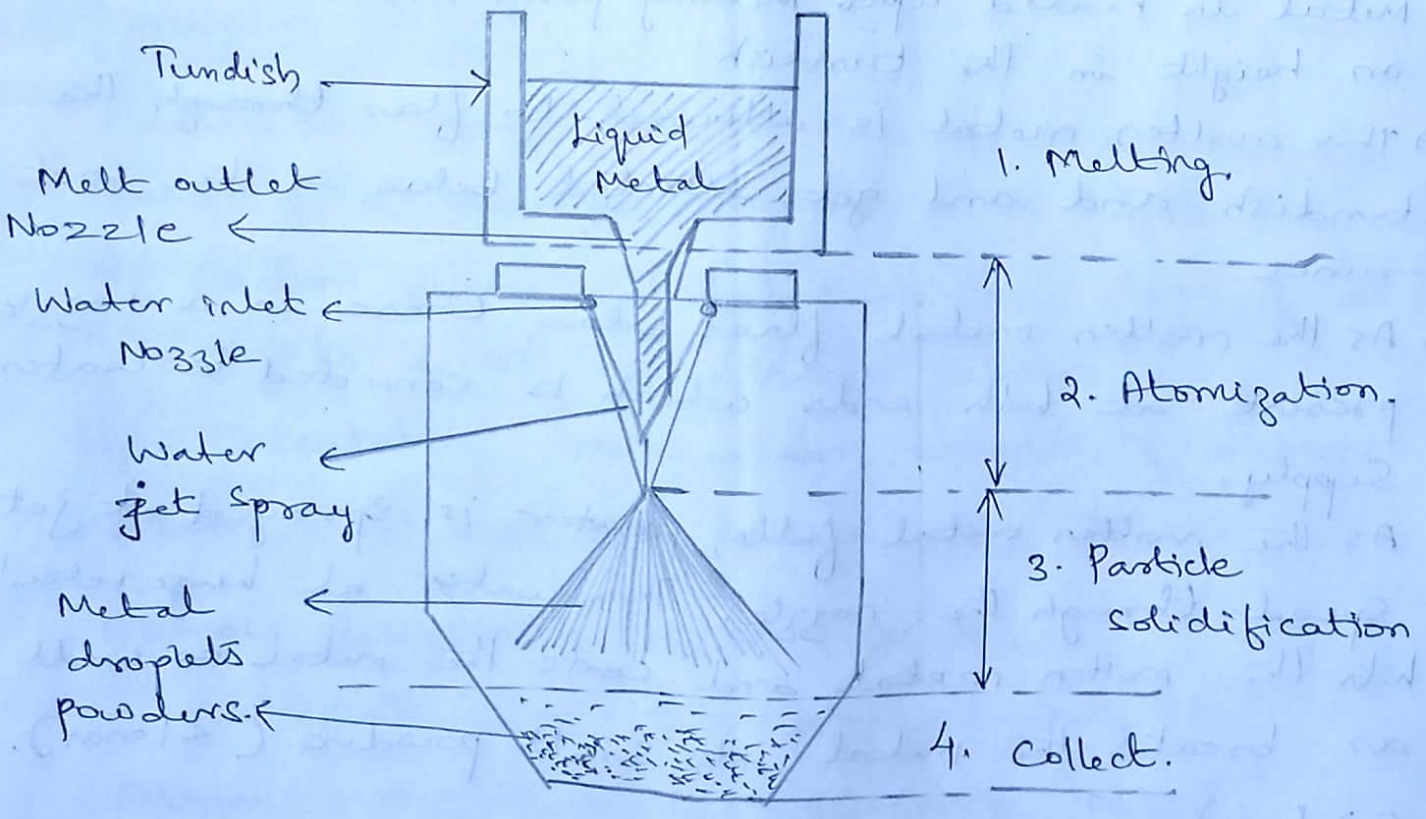
② Water Atomization process.



Schematic diagram.

* Water atomization of metals is process done inorder to achieve fine particle distribution for a range of materials.

→ Construction :-

a) Metal powder is heating upto its melting point and molten metal is placed inside the tundish.
b) There are water jet Sprayers inorder to facilitate atomization
c) It consists of a collecting dish below inorder to collect the fine powder particles of the metal

→ Working :-

→ Metal is heated upto melting point and stored at an height in the tundish.
→ This molten metal is allowed to flow through the tundish and and get collected below in the container
→ As the molten metal flows below, there is a nozzle present at both ends which is connected to water Supply.
→ As the molten metal falls, water is Sprayed at jet Speed through the nozzle. This water at huge velocity hits the molten metal and cools the metal as well as breaks the metal into small powders ($< 1mm$). ($> 1mm$).
→ As the metal becomes granules, it gets collected and cooled at the bottom of the setup and later is collected.

* Advantages:-

1. It is a short process with high production efficiency
2. Suitable for large scale production
3. Cheap raw materials can be used to produce high value and high quality powder

* Disadvantages:-

1. Initial investment is very high.
2. It is not conducive to the production of low density iron powder.

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(4) Explain the following:-

(a) Molecular Weight.

Molecular weight can be defined as the average mass of a molecule compared to 1/12th the mass of Carbon 12 and calculated as the sum of atomic weights of the constituent atoms.

Eg:- Calculating molecular weight of water.

Atom :- H and O, molecule (H_2O).

Atomic weight of H. ⇒ 1.00794.

Total mass = $2 \times 1.00974 = 2.01588$.

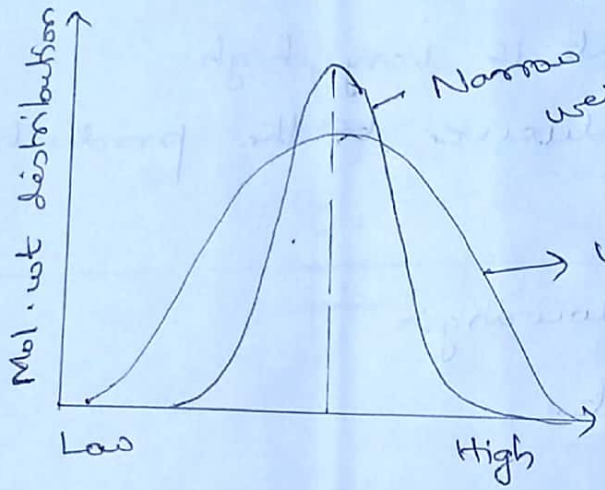
Atomic weight of O ⇒ 15.9994. ≈ 16.

Total weight = 18.0153 ≈ 18.

Therefore molecular weight of water = 18.0153 g/mol

(b) Weight molecular distribution.

The molecular weight distribution describes the relationship b/w number of moles of each polymer species (N_i) and molar mass (M_i) of that species. The molar mass distribution of polymer may be modified by polymer fractionation.



(c) Particle size:- Particle size is a term used to compare solid, liquid and gas dimensions. This can be applied to ecology particles, granular material particles and colloidal particles

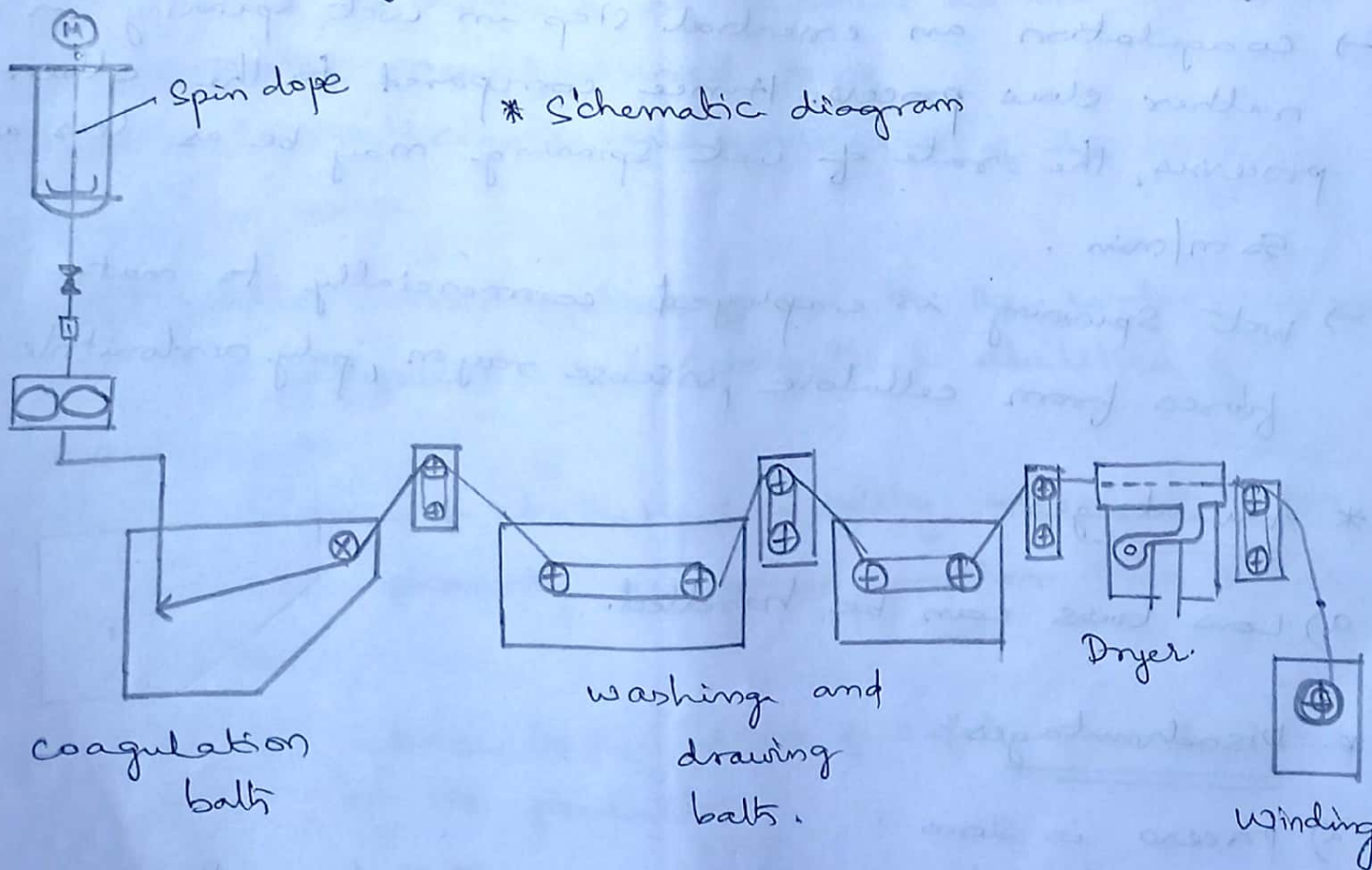
An object with spherical size can be defined through its diameter. However a common non-spherical object particle size can be based on volume, area and weight.

(d) Particle shape:- Particle shape is defined by the relative dimensions of the long, intermediate, and short axes of a particle. It is the external appearance of a particle. Various different aspects of particle

Shape are of interest and range of descriptors has been ~~at~~ devised to allow particle shape to be described.

(c) Powder Structure :- A powder is a dry, bulk solid composed of many very fine particles that may flow freely when tilted or shaken. Powders are special sub class of granular materials. Powders are very fine and Homogenous in nature. Many powder behaviours are common to all granular materials. These include segregation, stratification, jamming and unjamming, shearing and fragility.

(3) Wet Spinning method.



* Schematic diagram

Wet spinning employs fairly concentrated polymer solution. The process details for wet spinning also converts a viscous polymer solution into fine jets through spinner.

→ These jets are led into coagulation baths containing large volume of non solvents which can precipitate the polymer from its solution.

→ When continous jets of polymer solution come in contact with a non-solvent, they precipitate in the fine elements.

→ Filaments are gathered on a spindle after undergoing washing, drying etc...

→ Coagulation an essential step in wet spinning is a rather slow process. Hence compared to the other processes, the rate of wet spinning may be as less as 50 m/min.

→ Wet Spinning is employed commercially to make fibres from cellulose, viscose rayon, polyacrylonitrile etc.

* Advantages:-

a) Low tows can be handled.

* Disadvantages:-

a) process is slow.

b) Washing is to be done to remove impurities

c) Solvent and chemical recovery.

(5) Defects analysis of Sintered components.

(a) Testing and inspection procedures which donot realistically reflect actual use situation, eg:- particle size yeild in floor screening by vibro screens. Vs the laboratory routine screening.

(b) Arbitrary material substitution by the purchasing or manufacturing departments, without adequate engineering evaluation.

(c) crash design to incorporate new features in existing designs with minimum tooling changes.

(d) Failure apply the same evaluation methods to purchased components or powders as are applied to internally manufactured ones

(e) Failure to anticipate misapplication of the product by the user

(f) Too little consideration given to the wide variation in the physical and intellectual abilities of customers

(g) Interpretation of statistical quality control function as absolute quantity assurance rather than basis for action

(h) Inadequate advice to the user of safety procedures related to the product

(i) The powder metallurgy allows considerable cost variation if Specific part requirements are not clear.