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MANUFACTURINGPROCESS OF METAL POWDERS

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Abstract: – This report included a brief mention on the production of metal powders. This essay also discusses the benefits, uses, and restrictions of powder metallurgy. A straightforward figure was used to present the powder metallurgy design rule. Nowadays, powder metallurgy is used to produce a wide range of components, including tantalum, molybdenum, refractory materials, carbide cutting tools, etc. The mechanical engineer could learn the fundamentals of processing metal particles from this essay.

Keywords: - Automation, powder, grinding, finishing

1. INTRODUCTION

Broadly speaking, casting, hot working, and cold working methods are used to make components to the appropriate size and shape. Certain metals are difficult to form by machining. Certain metals cannot be easily melted and cast because they have high melting points. The aforesaid drawbacks are overcame using a unique technique known as powder metallurgy.

Various definition of Powder Metallurgy

i. Broadly speaking, casting, hot working, and cold working methods are used to make components to the appropriate size and shape. Certain metals are difficult to form by machining. Certain metals cannot be easily melted and cast because they have high melting points. The aforesaid drawbacks are overcame using a unique technique known as powder metallurgy.
ii. Powder metallurgy refers to the production and processing of iron and nonferrous metal in powder form. Basic shaped items can be precisely sized to a tolerance of 0.1 mm.
iii. . Powder metallurgy is a technique used to combine metal and non-metal powders to create components

The following figure 1 shows the several particle shapes in Powder Metallurgy.

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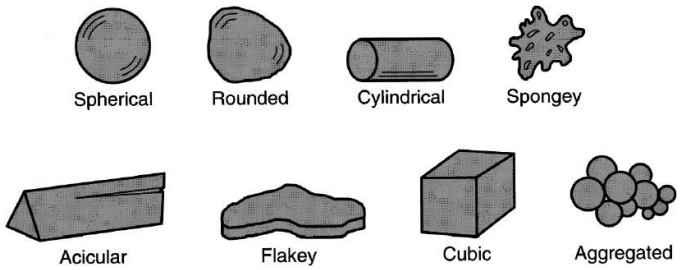

Figure 1 several particle shapes in Powder Metallurgy

Sequence of Steps involved in manufacturing process

The following figure 2 shows the various Steps involved in manufacturing process

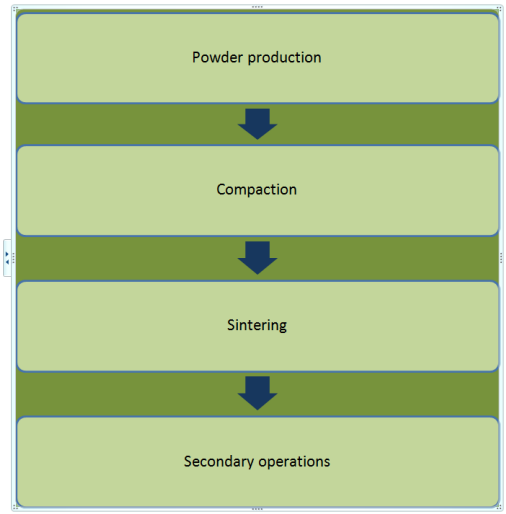

Figure 2 Sequence of Steps involved in manufacturing process

Mechanical Properties of Parts Made By Powder Metallurgy

1.2.1 Strength

The structure was not fibrous as the powder grains are only bonded together. So the products have low tensilestrength.

Hardness

The hardness of the powder metal component was less due to the pores present in it. The hardness will not beuniform as the density varies at different locations.

Ductility

The powder metal component has low ductility as the structure was porous. The ductility can be increased bythe hot pressing and sintering.

Dampness

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Powder metal components have good damping properties. So they can absorb vibrations.

Important characteristics of the metal powders

The following are the important characteristics of the metal powders

1. Purity
2. Chemical composition
3. Particle size
4. Size distribution
5. Density
6. Compression ratio
7. Particle shape
8. Particle microstructure
9. Flow factor
10. Ability to be sintered

2. METHODS OF PRODUCING METAL POWDERS

Metal Powder of various metals are prepared by the following methods

i. Atomization
ii. Electrolytic deposition
iii. Chemical reduction
iv. Machining
v. Shotting
vi. Milling
vii. Grinding

Atomization

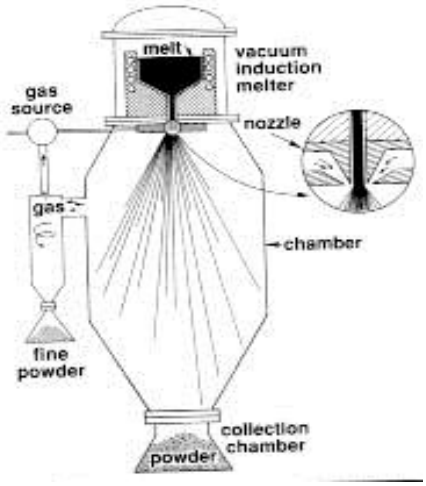
Atomization of molten metal can be done in different ways depending upon the factors like economy andrequired powder characteristics.

Types of Atomization process

i. Water atomization
ii. Gas atomization
iii. Vacuum atomization
iv. Centrifugal atomization
v. Rotating disk atomization
vi. Ultra rapid solidification processes

Gas atomization working principle

Figure 3 Atomization proess



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i. In this process, the molten metal is poured into the atomizing chamber.
ii. The molten metal comes out through an orifice provided at the bottom of the chamber.
iii. Heating coils are provided around the chamber to maintain the temperature of molten metal.
iv. A steam of high pressure water or air or inert gas is passed through a nozzle against the molten metalcoming out of orifice.
v. This makes the metal into finely divided particles (powder) and solidity. The metal powder is collectedwhen falls down.
vi. This method is used for producing powder of metals having low melting point such as aluminum, leadand zinc.
vii. In this process the size of the particle depends upon the temperature of molten metal, Pressure andtemperature of atomizing water or air or gas and Design or orifice and nozzle.

Advantages of Atomization process

1. Particles with any required size can be obtained.
2. The sizes of all particles are uniform.
3. The production rate is high.

Electrolytic deposition

i. It is similar to electroplating process.
ii. In this method, the metal to be powdered acts as anode (positive) and the metal on which the powder isto be deposited acts as cathode (negative).
iii. The two metals are dipped into an electrolyte. When D.C. supply is given, the metal from the anodegets deposited on the cathode like sponge. Then the metal powder is separated.
iv. Electrode is a salt solution of metal to be powdered. Copper sulphate solution is used as electrolyte toproduce copper powder. Here, copper plate acts and aluminum plate acts as cathode.

Advantages Electrolytic deposition Process

1. Pure powder can be obtained.
2. The powder will have good moulding properties.

Disadvantages Electrolytic deposition Process

1. It is a slow process.
2. The operating cost is high.

Applications of Electrolytic deposition Process

Metals powders of copper, iron, silver and zinc can be produced by this method.

Chemical reduction or reduction of oxides

i. In this method, metal powders can be produced by reducing the metal oxides.
ii. This powder is heated to a temperature below its melting point in hydrogen atmosphere.
iii. Tungsten oxide is reduced to tungsten by hydrogen in the form of spongy mass.

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iv. Hydrogen or carbon monoxide is used as reducing agent.

Advantages of chemical reduction process

1. The metal powder is soft.
2. Compacting can be done easily.
3. Production rate is high.

Disadvantages of chemical reduction process

1. It is suitable only for metals which can be reduced easily.
2. The metal oxides should be pure.

2.3.2 Applications of chemical reduction process

This method is suitable is suitable for producing powder of metals having high melting point such as tungsten and molybdenum.

3. PROCESS OF POWDER METALLURGY

The process of powder metallurgy involves different steps for the production and finishing components by this technique. The processes of powder metallurgy are divided into following stages. Steps involved in process of powder metallurgy are shown the following figure 4.

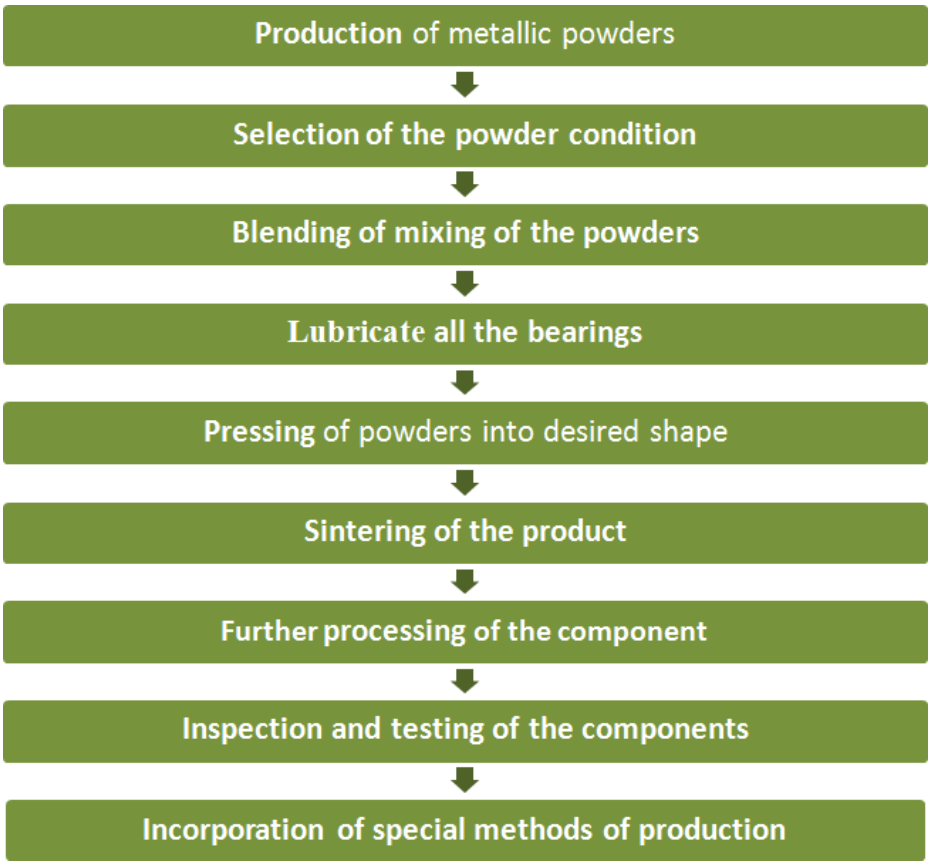

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Figure 4 Steps involved in process of powder metallurgy

Blending or mixing

i. Blending or mixing is the process of combining metal and non-metal powders with correct proportions to get required properties.
ii. The particles are uniformly distributed during mixing by using machine. Mixing should be done only for correct duration.
iii. The friction between die and component during pressing can be reduced by adding lubricants like graphite powder.

Pressing or compacting

i. Pressing or compacting is the process of pressing the mixed metal powder into a dieto get to get required size and shape.
ii. It is also called briquetting.
iii. Two types of pressing are available they are Cold pressing and Hot pressing

Cold pressing

i. Mechanical or hydraulic press is used for cold pressing
ii. In this method, the mixed powder was filled in the die cavity and pressed between upper and lower punch
iii. Thus required shape is obtained
iv. This process was also called as green compact

Hot pressing

i. Hard materials like diamond and tungsten carbide metal powders can be pressed by using hot pressing to make the component.
ii. The mixed metal powder is filled in the die cavity.
iii. When temperature is below 1000^{o}C Steel dies are used and when the temperature is above 1000^{o}C graphite dies are used.
iv. The metal powder is heated by the heating coils provided around the die. At the same time, the metal powder is pressed by the upper and lower punch.
v. Hot pressing is done in vacuum or in an inert gas atmosphere.
vi. In hot pressing, heating and pressing take place at the same time.

Advantages of Hot pressing

1. Components having high strength and hardness can be obtained.
2. Low compacting pressure is sufficient.
3. No lubricant is required.
4. Components with high density can be obtained.
5. Production rate is high as heating and pressing take place at the same time.

Disadvantages of Hot pressing

1. The cost of the die is high.
2. The life of die is less as it wears out quickly.

Sintering

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i. Sintering is the process of heating the green compact just below the melting point ofits base metal in a controlled atmosphere.
ii. Sintering process is affected by the temperature, time and atmosphere.
iii. During sintering, the particles of green compact are fused together.
iv. This gives required strength, hardness and properties to the component.
v. Sintering is done in vacuum or inert gas atmosphere.

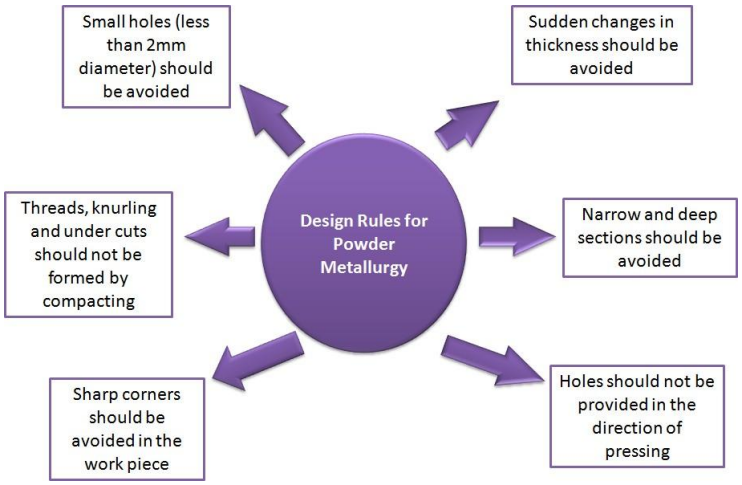
Secondary operations or finishing operations

The powder metal products can be used directly after sintering. The following finishing operations are done if more surface finish and accuracy are required. These operations are known as secondary operations.

1. Sizing or coining
2. Infiltration
3. Impregnation
4. Machining
5. Heat treatment
6. Plating
7. Joining

4. DESIGN RULES FOR POWDER METALLURGY

The following figure shows the design rules for powder metallurgy



5. APPLICATIONS OF POWDER METALLURGY

The following are the applications of powder metallurgy

1. Porous metal sheets
2. Porous bearings
3. Babbitt bearings for automobiles
4. Cemented carbides
5. Ductile tungsten

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6. Cores and electrodes
7. Magnets
8. Glass metal seals
9. Metallic coating
10. Pump rotor gears
11. Motor brushes
12. Refractory material composite
13. Metallic fillers
14. Diamond tools
15. Paints and pigments
16. Metal powder also added to plastic
17. Oil well drills
18. Grinding wheel dressers
19. Diamond cutting process
20. Brake bonds
21. Welding electrodes
22. Graphite electrodes used in arc furnace
23. Cathode, anode and control grids.
24. Heavy duty electrical contacts.
25. Automobile clutch plate, brake lining and motor brushes.
26. Small gears, cam, lever, piston ring and magnets.
27. Nozzles used in rockets and missiles.

6. ADVANTAGES OF POWDER METALLURGY

The following are the advantages of powder metallurgy

1. High dimensional accuracy, shape and surface finish can be obtained
2. No material wastage. This process makes use of 100% of the material
3. The product with required density and porosity can be obtained
4. Components with required properties can be produced by combining metal and non-metal
5. The rate of production is high
6. Cleaner an quicker operation and longer life of the component
7. Super hard cutting tool bits of tungsten carbide are also made by this process
8. Relatively more uniform structure free from defects is obtained
9. Parts with wide variations in material composition can be produced
10. Production of diamond impregnated tool is possible only by this method
11. Electrical and magnetic contacts materials are produced by this method
12. Highly skilled and qualified labour is not required
13. Components with complicated shapes can be produced easily.
14. The life of the products is high.
15. Components with high hardness can be made easily.

7. LIMITATIONS OF POWDER METALLURGY

1. It is not economical for small scale production.
2. The cost of equipments and die are high.

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3. Large components cannot be produced.
4. The density is not uniform throughout the component.
5. When powder is stored, it may be wasted by oxidation.
6. The broken parts cannot be rejoined.
7. Explosion may occur while handling some metal powders.
8. The health of operator may be affected.
9. Good physical properties of components cannot be obtained.
10. The time for producing metal powder is more.

Conclusion

This publication included a brief comment on the steps required in the production process for metal powders. This essay also discusses powder metallurgy's benefits, uses, and restrictions. This study provided the powder metallurgy design guideline and the steps required in the process. The mechanical engineer could learn more about powder metallurgy by reading this paper.

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