Powder Technology

Text books:

- Powder metallurgy technology, G. S. Upadhyaya.
- “Powder metallurgy and particulate materials processing”, Randall M. German.
- An introduction to Powder Metallurgy, F. Thummler and R. Oberacker.

Powder Technology

It involved all the techniques used to produce fine particles and final products of metallic, ceramic and cermet for different engineering applications.

Powder Metallurgy

Powder metallurgy has been defined as the art and science of producing fine metal powder and objects finished or semi-finished-shaped from individual, mixed or alloyed metal powders with or without the inclusion of non- metallic constituent.

It consists of preparing and mixing of metal powders, compacting and simultaneous or subsequent heating, (or sintering) at elevated temperature in a furnace under a protective atmosphere (non-oxidizing atmosphere or vacuum) with or without fusion of a low melting-point constituent only so as to develop metallic or metal-like bodies with satisfactory strength, density and without losing the essential shape imported during compacting. Figure 1 shows the flow chart of main steps of powder metallurgy.

The main steps for powder metallurgy are:-

- Powder producing
- Blending and mixing powders
- Compacting
- Sintering
- Secondary finishing treatments

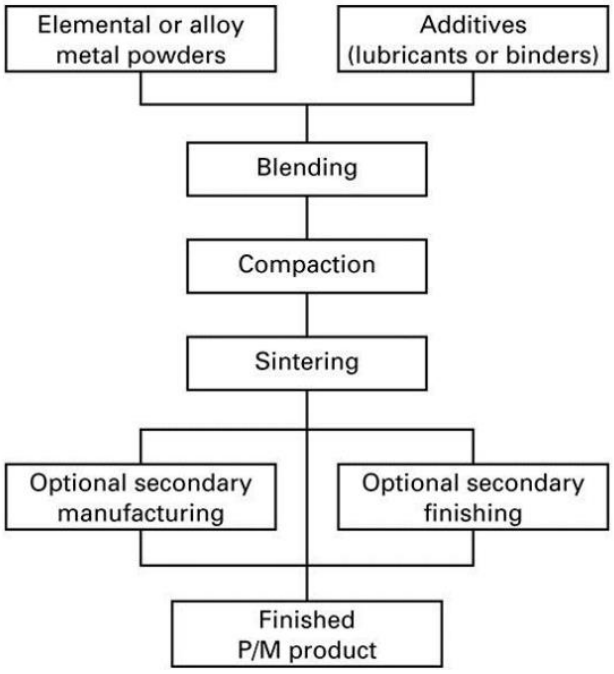

Figure 1: Flow chart of main steps of powder metallurgy.

The development of powder metallurgy is due to its great advantages over other methods in certain applications. The powder metallurgy process has provided a practical solution to the problem of producing refractory metals, which have now become the basis of making heat-resistant materials and cutting tools of extreme hardness. It is impossible on an industrial scale to melt such materials and produce articles from them by normal methods, because it is difficult to select a furnace lining which would not melt at high temperatures (for example, the melting point of tungsten is 3400°C) or which would not react with the fused metal or compound. Powder metallurgy alone enables alloys to be made from metals insoluble in each other, which because of liquation cannot be melted by ordinary methods. This is the case if the melting points of the metals constituting the alloy are very different, for example tungsten and copper (3400°C and 1083°C), iron and lead (1535°C and 327°C) etc.

Advantages of powder metallurgy

The powder metallurgy process has certain basic advantages over conventional melting and casting method of producing metals, alloys and finished articles.

- Powder Metallurgy parts can be mass produced to net shape or near net shape, eliminating or reducing the need for subsequent processing.
- The Powder Metallurgy process itself involves very little waste of material; about 97% of the starting powders are converted to product. This compares favorably with casting processes in which sprues, runners, and risers are wasted material in the production cycle.
- Owing to the nature of the starting material in PM, parts having a specified level of porosity can be made. This feature lends itself to the production of porous metal parts such as filters and oil-impregnated bearings and gears.
- Certain metals that are difficult to fabricate by other methods can be shaped by powder metallurgy. Tungsten is an example; tungsten filaments used in incandescent lamp bulbs are made using PM technology.
- Certain metal alloy combinations and cermets can be formed by PM that cannot be produced by other methods.
- PM compares favorably with most casting processes in terms of dimensional control of the product. Tolerances of ±0.13 mm (±0.005 in) are held routinely.
- PM production methods can be automated for economical production.

Limitations of powder metallurgy

There are limitations and disadvantages associated with PM processing. These include the following:

(1) tooling and equipment costs are high, (2) metallic powders are expensive, and (3) there are difficulties with storing and handling metal powders (such as degradation of the metal over time, and fire hazards with particular metals). Also, (4) there are limitations on part geometry because metal powders do not readily flow laterally in the die during pressing, and allowances must be provided for ejection of the part from the die after pressing. In addition, (5) variations in material density throughout the part may be a problem in PM, especially for complex part geometries. (6) articles made out of metal powders possess, as a result of their porosity, an increased tendency to oxidation, moreover oxidation may occur not only on the surface but also throughout the whole body of the article. (7) powder metallurgy products possess comparatively poor plastic properties (impact strength, elongation).