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A REVIEW ON INFLUENCE OF PROCESS PARAMETERS IN POWDER METALLURGY TECHNIQUE

Mylamala S S Prabhakar, P.G.Scholar, Department of Mechanical Engineering, JNTUA CE Pulivendula, Affiliated College to JNTU Anantapur, Ananthapuram, A.P, India.
R. Vishnu Vardhan Reddy, Assistant Professor, Department of Mechanical Engineering, JNTUA CE Pulivendula, Affiliated College to JNTU Anantapur, Ananthapuram, A.P, India.
K. Pavan Kumar Reddy, Assistant Professor, Department of Mechanical Engineering, JNTUA CE Pulivendula, Affiliated College to JNTU Anantapur, Ananthapuram, A.P, India.
[1]*prabha.steve001@gmail.com*, [2]*vishnuvardhan.me@jntua.ac.in*, [3]*pavankumar.me@jntua.ac.in*

Abstract
Powder metallurgy (P/M) technique is one of the frequently used metal-forming processes, which has more advantages when comparing with other metal work technologies. In this overview the processing parameters that are influencing P/M technique has been discussed. This review mainly focuses on parameters like compaction pressure, sintering temperature, sintering time, powder particle size and how these parameters effects the mechanical properties of the P/M processed components. From this study the optimal conditions of processing parameters are explained.

Key words: Powder Metallurgy, Compaction pressure, Sintering temperature, Sintering time, particle size.

I. INTRODUCTION

Powder metallurgy (P/M) is a manufacturing method that creates precise and very accurate products by applying intense pressure to powdered metals and alloys in rigid dies. Among the other metal forming processes like casting forging, bending & extrusion. P/M provides better advantages in product quality, shape and cost effectiveness. Both ferrous and non ferrous materials can be processed by using P/M. The main advantage of P/M technique was the wastage or scrap is very low, which is one of the major economical factors considered by manufacturing industries [1-2].

Stainless Steel is the commonly used base metal for powdered metal processes. It offers numerous properties for producing powdered miniature components. Powdered stainless steel are available in multiple grades of 300 & 400 series. P/M limits in expensive metal powders as compared to the price of the raw materials required to make the casting and forging components [3-4].

Principle of powder metallurgy:

P/M involves mixing powdered metal or alloy, compacting the mixture in a die, and then sintering or heating the resulting shape in a controlled environment [5]. The flow chart of powder metallurgy technique is shown in Fig. 1. Schematic diagram of P/M is shown in Fig. 2.

Recent studies stated that processing parameters play an key role in the components mechanical and physical properties.

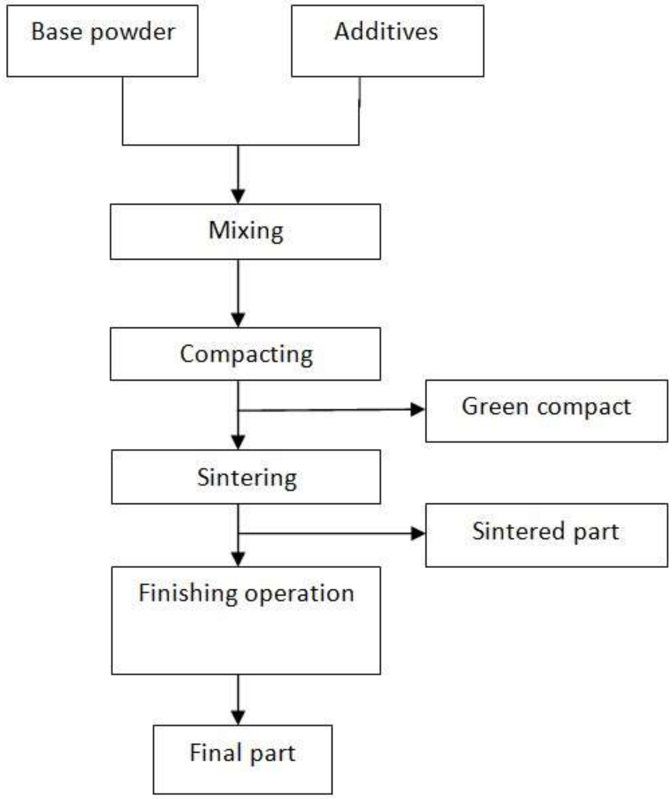

Fig. 1. Sequence of operations in powder metallurgy

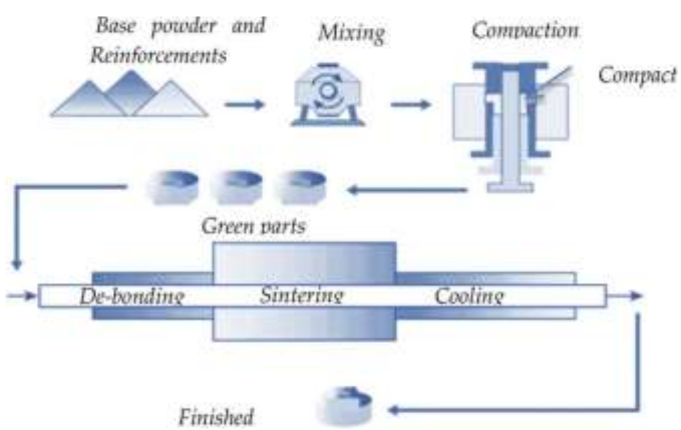

Fig. 2. Schematic diagram of P/M technique

Processing parameters in P/M, which highly influence the components characteristics, are [6-7].

1) Compaction pressure
2) Sintering temperature
3) Sintering time
4) Powder particle size

II. IMPACT OF COMPACTION PRESSURE IN P/M:

Basically the metal powders are compacted in a die through the application of high pressure. These compacted samples before proceeding to sintering are called green compacts, This process in shown in

Fig. 3. The density of green compacts is called as green density. It increases with increase in compaction pressure [8-9].
The density and porosity are controlled productively by controlling the compaction pressure. Porosity can be enhanced or diminished by increasing or decreasing the compaction pressure. Out of all other parameters compaction pressure is major influencing factor on the components mechanical and physical properties [10-12].

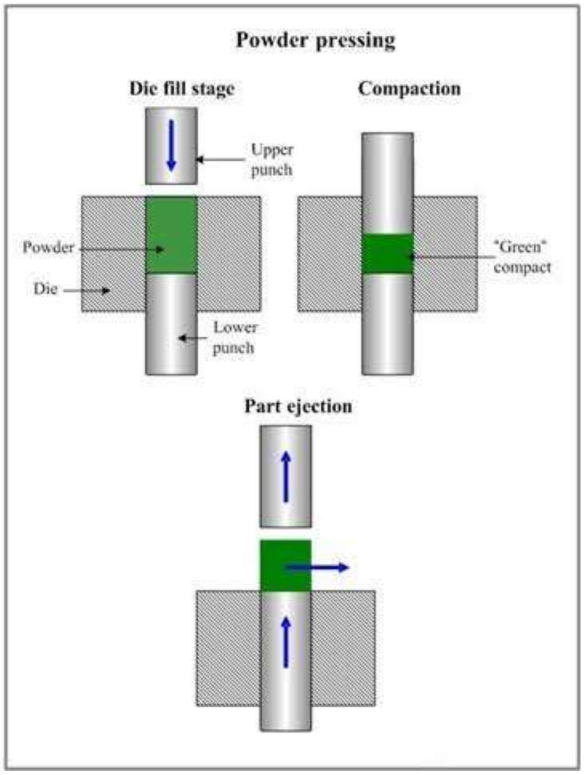

Fig. 3. Die compaction process

III. IMPACT OF SINTERING TEMPERATURE AND TIME IN P/M:

1) Sintering temperature:

In the process of sintering, the material is heated to a temperature slightly below its melting point. The metals desirable qualities can be preserved by tightly fusing the particles together at an optimal sintering temperature. [13-14]. As shown in Fig. 4.
Increasing the sintering temperature decreases the voids in the sample which leads to decrease in the porosity. The density of the sintered samples is high when compared to green compacts [15-16].
After sintering there is a expansion or shrinkage of material due to temperature changes, which is considered as coefficient of thermal expansion (CTE). Lower CTE describes for lower propensity for change in size. Sintering has significant effect on CTE when comparison to compaction pressure [17]. Generally sintering process is carried out in box furnace. For better sintering and to avoid oxidation sintering process can be done in vaccum furnace, this helps in achieving better mechanical properties due to absence of air and other gases. From earlier studies it was suggested that for stainless steel 1300^0c is considered as optimal sintering temperature [18].

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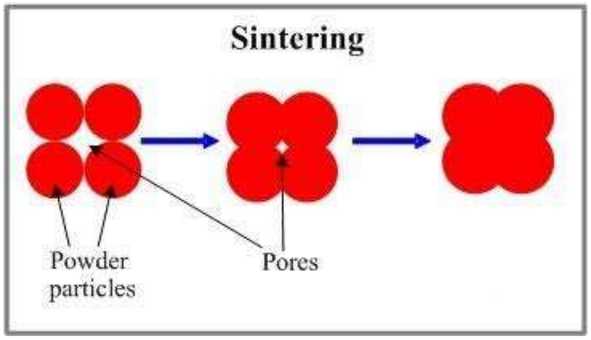

Fig. 4. Sintering of powder particle

2) Sintering time:

Along with the sintering temperature, sintering time is also one of the predominant factors. It is nothing but the holding time of the samples during heat treatment. Previous researchers observed that longer holding time gives higher density and smaller porosity content [19-20]. The micro hardness and density of the samples are increased. Loss of wear is reduced in the samples which are heat treated for optimal holding time. An optimal holding time of 90 minutes is better suggested for P/M materials due to strong inter facial bonding & less defects in the samples. Upon increasing the holding time interface defects gets increased and bond strength gets decreased [21].

IV. POWDER PARTICLE SIZE:

Powder particle size has a key role in density of the powder. The morphology of the powder particles can be changed significantly by milling the powder particles. Oxidation behavior is influenced by powder shape. The amount of oxides formation depends on the pores present on the sample. Higher corrosion resistance and low CTE values are observed in the samples produced from milled powders [17].

Ball milling is commonly used method for milling metal powders. In it steel balls are used to collide with powder particles to get fine size particles. Ball milling is shown in Fig. 5.

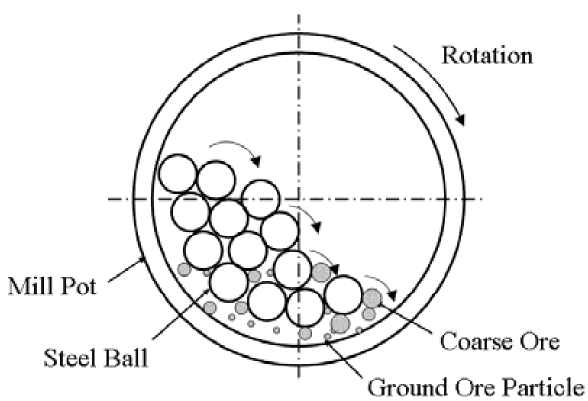

Fig. 5. Ball milling process

CONCLUSION:

The influence of processing parameters in P/M technique has been reviewed in the present study. The detailed explanation regarding optimal conditions of processing parameters haven’t expressed clearly. With the recent advancements in the production process of P/M there is a future scope of researches can be done in this field.

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