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Fabrication and Development of Die for Powder Compaction Press

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Abstract: *Development of die is one of the cumbersome tasks in the powder metallurgy process. In this research, some important points were discussed for the development of die and after that it is fabricated by the use of manufacturing processes. Mostly utilized manufacturing process is electric discharge machining and its variant like CNC wire cut electric discharge machine. Rough and trim cutting operations were utilized for the fabrication of die.*

Keywords: *Die development, Design, Fabrication, Powder compaction Press.*

I. Introduction

Powder metallurgy is the process of fabrication of net shaped objects by the use of compacting force and temperature. Some time force was of one side and sometimes of both sides as shown in Fig. 1. There are of four steps viz. powder preparation, blending (mixing), compacting and sintering. Sometimes impregnation (i.e. oil insertion) was also provided for self-lubricating bearings durring blending process [1]. For the fabrication of different parts die has to be fabricated for each part, sothat the outcome of die will be a net-shaped or near net-shaped object eliminating the need of further machining [2]. Applications of powder metallurgy was found in the aerospace, self-lubricated bearings, porous components, gears, implants, actuators, electronic and automotive industries etc.

Cracks in powder metallurgy (P/M) components primarily originate from the compaction prior to the sintering. Although the cracks may not become evident until the sintering has occurred, the root cause is most likely the poor interparticle bonding obtained prior to the sintering [3-6]. Uni-axial compaction is the simplest type for powder compaction. One limitation of this type was the variation in the pressed density. The main cause of this limitation is the die-wall particle and particle–particle friction, which ultimately cause the micro-crack on the surface of green compact [6].

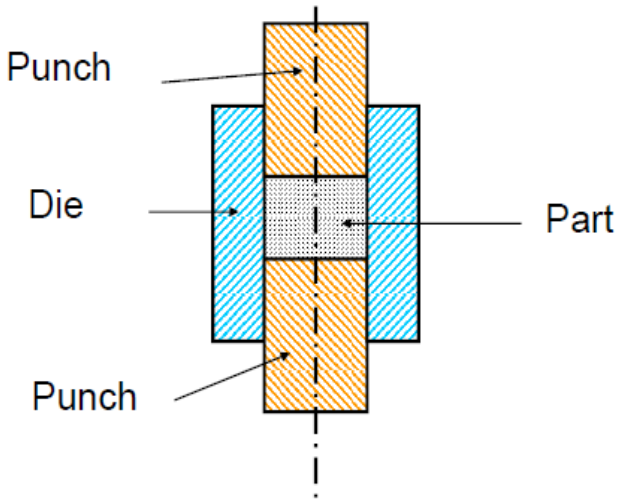

Fig 1: Schematic of P/M Process

II. EXPERIMENTAL WORK

Depending upon the work-structure the die design has been carried out considering all the work-conditions. Die has to be developed for powder compacting press as shown in Fig. 2. The details of the powder compacting press are given by Table 1.

Table 1: Details of powder Compacting Press

Sr. No.	Part Name	Specification
1	Maximum Force	15KN
2	Working Force	7.5 KN
3	Working Table Radius	60mm diameter
4	Working Table space Height	125mm
5	Force Action	Single side

Considering the above details of the compacting press, the design of die is carried out. The various steps are described in this section.

A. Design and development

The design portion basically consists of the formulation of plan to satisfy the conditions for the given need. The plan results a product which is usable, safe, marketable, reliable and competitive. The design includes the following steps [7-8]:

- Create alternate solution.
- After analysis and test, reproduce and calculate the performance of each substitute, retain satisfactory alternative, and remove unacceptable ones.
- Choose the best alternative discovered as an approximation to optimality.
- Implement the design.

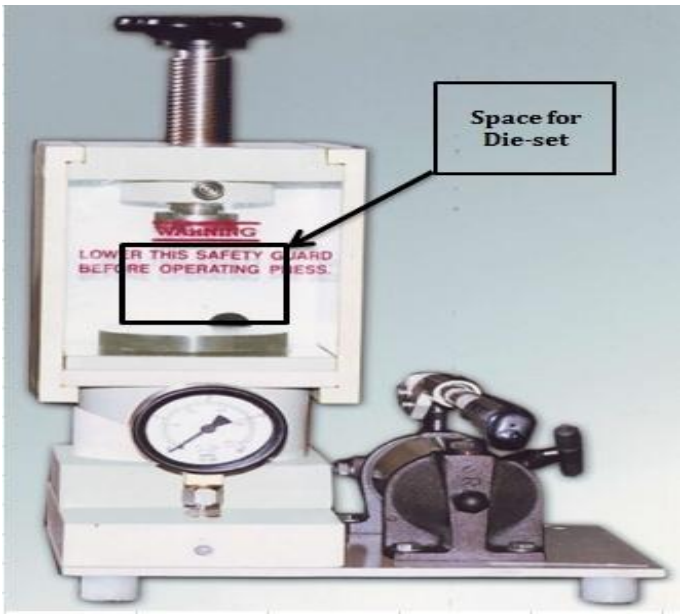

Fig 2: Powder Compacting Press

B. Design considerations

Sometimes the strength required of an element in a system is an important factor in determination of the geometry and the dimension of the element. In such a situation we say that strength is an important design consideration. When we use the expressions design consideration, we are referring to some characteristic which influence the design of the element or perhaps, the entire system. Usually quite a number of such characteristics are taken for consideration in a given design situation,

- Working space
- Green compact size
- Maximum working load
- Thickness of green compact

C. Procedure for material selection

The first step in any material selection problem is to define the needs of product. Without prior basis about material or method of fabrication, the engineer should develop a clear picture of all the characteristic necessary for this part to adequately perform its intended function. These requirements will fail into three major areas-

- Shape or geometry considerations
- Property requirement
- Manufacturing concerns

The material is processed with the help of EDM and WEDM due to surface characteristics of the material. The surface roughness of approximately 1-2µm can be easily achieved with these non-traditional machining processes.

III. CALCULATIONS

Working Load (F) =7.5 KN
Specimen size = 50mm×10mm×4mm
Working Pressure= Force/ Area of cross-section
Machining Process selected – Electric Discharge Machining (EDM) and CNC wire-cut electric discharge machining (WEDM)
Material selected for die – Cryogenically Treated D-2 Tool steel [9]
Density of Material- 7.7 x 1000 kg/m^3
Young's Modulus of Material – 190-210 GPa.

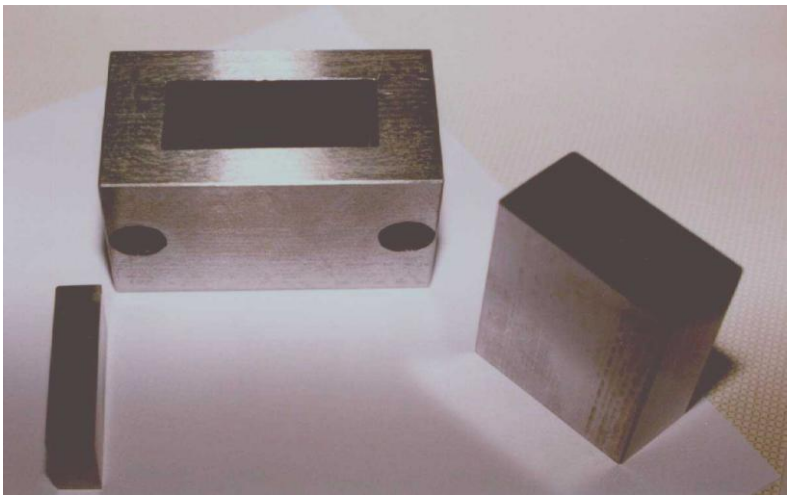

Fig 3: Powder compacting Die

The process parameters selected for the fabrication of die during WEDM Process are given in Table 2. These parameters are selected for the minimum value of surface roughness or maximum surface quality.

Table 2: Process Parameters Selected during WEDM [9]

Control Factors	Symbol	Value
Pulse on-Time	Ton (µs)	105
Pulse off-time	Toff (µs)	25
Spark Gap Voltage	SV (V)	30
Peak Current	IP (A)	188

IV. CONCLUSIONS

Die is designed and fabricated according to the working space of powder compaction press and their working load. Literature review helps in the selection of material and the parameters for the processing of the selected material. After the development and fabrication of die for powder compaction press the following concluding remarks comes into the picture:

1. The material selected for the fabrication of die is cryogenically treated D-2 tool steel as cryogenic treatment enhances the life of die.
2. Maximum working pressure investigated during the operation is 190MPa, this working pressure can be enhanced by changing the material of die.
3. Surface characters tics of die material also helps for easy ejection of green compact from the die.
4. The micro-cracks were eliminated on the green compact due to the selection of finishing parameters of WEDM for highest surface finish.

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