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 during blending process [1]. For the fabrication of different parts die has to be fabricated for each part, so that 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>
<thead>
<tr>
<th>Sr. No.</th>
<th>Part Name</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum Force</td>
<td>15KN</td>
</tr>
<tr>
<td>2</td>
<td>Working Force</td>
<td>7.5 KN</td>
</tr>
<tr>
<td>3</td>
<td>Working Table Radius</td>
<td>60mm diameter</td>
</tr>
<tr>
<td>4</td>
<td>Working Table space Height</td>
<td>125mm</td>
</tr>
<tr>
<td>5</td>
<td>Force Action</td>
<td>Single side</td>
</tr>
</tbody>
</table>

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.

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.
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 fall 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/m³

Young’s Modulus of Material – 190-210 GPa.

![Fig 3: Powder compacting Die](image)

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>
<thead>
<tr>
<th>Control Factors</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse on-Time</td>
<td>Ton (µs)</td>
<td>105</td>
</tr>
<tr>
<td>Pulse off-time</td>
<td>Toff (µs)</td>
<td>25</td>
</tr>
<tr>
<td>Spark Gap Voltage</td>
<td>SV (V)</td>
<td>30</td>
</tr>
<tr>
<td>Peak Current</td>
<td>IP (A)</td>
<td>188</td>
</tr>
</tbody>
</table>
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 characteristics 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.

REFERENCES