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REVIEW ON PARAMETER OPTIMIZATION OF SELF LUBRICATING BEARING

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ABSTRACT

The Self Lubricating Bearing is used in Electronic Motors, Fuel Pumps, Actuators, Household Appliances etc. Self Lubricating Bearings are manufactured only by Powder Metallurgy, since Porosity needed for Oil Content can be achieved only by Powder Metallurgy. High Oil Content is desired for better operation of bearing. Oil Content depends on parameters like Powder Weight, Density of Component, Sintering Temperature and Sintering Speed etc. The Bearing manufactured by GKN Sinter Metals has Weight around 22-25 gm and Density around 5.8-6.0 gm/cc with Oil content about 18-20%. The main objective of the project is to optimize the parameter values to achieve

The parameters can be optimized based on Mixture Growth of Powder, Dimensions of Bearing and Minimum Breaking Load required. Design of Experiments are planned by Orthogonal Array decided by Taguchi Method. Effect of each parameter on amount of Oil Content in Bearing is analysed by ANOVA Method in SPSS software. A comparative analysis can be carried out on basis of existing parameter values and optimized values.

KEY WORDS - Oil Content, Powder Weight, Component Density, Sintering Temperature, Sintering Speed, Taguchi, ANOVA, SPSS.

INTRODUCTION

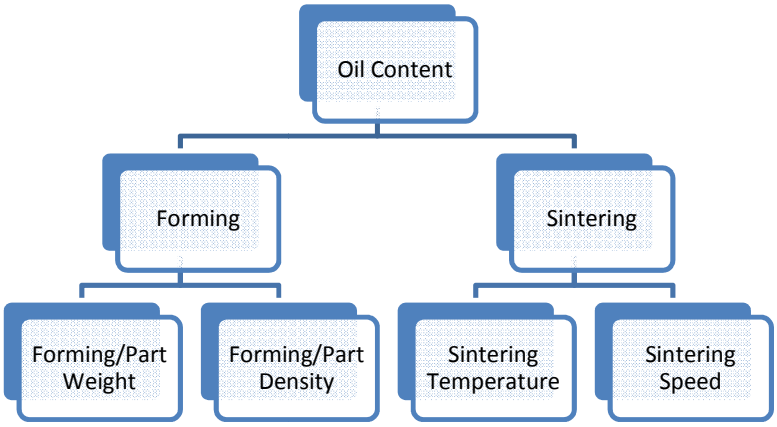
With the growing demand for metallic components in the metalworking industry, powder metallurgy can be used to produce components with complex geometries, reduce machining costs and compete with other forming processes for large-scale production. Powder metallurgy can be used to form multiple compositions by blending pre-alloyed or elemental powders. In the powder metallurgy process, the industrial pieces are produced through compacting powder in the frame and sintering within a controlled setting. Powder Metallurgy (PM) deals with products and processes which use raw material in the form of powders that are compacted into the required shape and size using suitable moulds. These compacted powders are called "Green Compacts". The Mechanical properties of the component produced by PM processes are influenced by powder characteristics such as composition, morphology, particle size, distribution, and method of compaction. In the usual Powder Metallurgy production sequence, the powders are compressed (pressed) into the desired shape then heated (sintered) to bond the particles into a hard, rigid mass and finally Sized in desired Dimensions.

-Forming or Pressing is accomplished in a press-type machine using punch-and-die tooling designed specifically for the part to be manufactured.
-Sintering is performed at a temperature below the melting point of the metal.
-Sizing is performed on press-type Sizing machine.

However Porosity is important disadvantage of Powder Metallurgy for Mechanical properties of manufactured part, but this disadvantage is helpful for manufacturing Filters, Self Lubricating Bearing etc. Hence Self Lubricating Bearings can be manufactured by only Powder Metallurgy. Self Lubricating Bearing have wide Industrial Application. In Self Lubrication Oil content in Bearing is desirable characteristic. In this Dissertation Parameters affecting Oil Content are tried to Optimize.

Oil Content in Self Lubricating Bearing is depend mainly on following parameters-

1- Forming Weight
2- Forming Density
3- Sintering Temperature
4- Sintering Speed



- Forming Weight is weight of Powder used for forming per part manufactured. For less Material Cost minimum possible Forming Weight is desirable.
- Forming Density is depending on Forming Weight and Compression Load. In case of Self Lubricating Bearing for maximum oil content, less density is desirable.
- Sintering Temperature is generally 70% - 75% of melting point of powder material. Change in Dimensions after Sintering mainly depends upon Sintering Temperature and Material Properties.
- Sintering Speed is speed of heating of part in furnace. Generally expressed in millimetres per second.

OBJECTIVE OF WORK

- To Optimize the parameters affecting amount of oil content in Self Lubricating Bearing to achieve maximum possible oil content.
- To maintain required Dimensions and Tolerances without affecting required Breaking Load.

LITERATURE REVIEW

After the study of Research Papers it is observed that Most of the previous studies have used Taguchi Method and ANOVA method for Optimization. Orthogonal Array for Experiment can be decided by Taguchi Method while the Effect of each Parameter on Results can be found out by ANOVA method. Forming Density and Forming Weight depends Powder size as well as amount of Lubricant. After Sintering Porosity increases due to vaporisation of Lubricant present in powder. Porosity increases with decrease in density and density increases with compression, temperature , keeping time / Soaking time and Sintering Speed. With increase in Density mechanical characteristics and particularly tensile strength improves.

METHODOLOGY

The Self Lubricating Bearing provides self lubrication effect and can be manufactured by limited number of materials, in GKN Sinter Metals it is manufacture by using Copper powder. Melting Point of Copper is 1084^0 C so Sintering Temperature is limited to 800^0 C - 840^0 C as the Sintering Temperature cannot be more than 75-80% of the Melting Point. For Optimization 3 values of Sintering Temperature are selected as 800^0 C, 820^0 C and 840^0 C.

The Sintering Speed affects the Keeping / Soaking Time which in turn varies the Density of Bearing. In GKN Sinter Metals Sintering Speed is kept between 260-300 millimetres per minute. For Optimization 3 values of Sintering Speed are selected as 260 mm/min, 280mm/min, 300mm/min.

The Powder Weight is nothing but Forming Weight and affects the Density as well as Strength of the Bearing. In GKN Sinter Metals Bearing with varying weight from 21 to 23 grams are manufactured. For Optimization 3 values of Forming Weight are selected as 21gm, 22gm, 23gm.

The Powder Density is approximately equal to Forming Density. Porosity for Oil Content totally depends on the Forming Density. In GKN Sinter Metals Bearing with density varying from 5.8 to 6.0 gram per cubic centimetre. For Optimization 3 values of Forming Density are selected as 5.8gm/cc, 5.9gm/cc, 6.0gm/cc.Design of Experiments is decided by Taguchi Method of Optimization. Since we selected Three values for each of the Four variables the Orthogonal Array of L_9 (3^4) is used. After the Experimentation effect of each parameter is studied by ANOVA (Analysis of Variance) method by using SPSS software.

EXPERIMENTAL VALIDATION

The experimental validation of finalized Optimum Parameter can done by replacing the old Bearing with the modified Bearing with optimized parameters. The validation includes effect on amount of Oil Content, Breaking Load and the required Bearing Dimensions should be studied.

RESULT AND DISCUSSION

The Experiments can be carried out according to orthogonal array decided by Taguchi Method. The Optimum value of each parameter affecting amount of Oil Content can be found after carrying out the Experiments. In order to find Effect of each parameter on amount of oil content in Self Lubricating Bearing the ANOVA method can be used. SPSS software is helpful tool to analyse the effect of one variable on the another. A comparative analysis can be carried out with the existing and optimized values of each parameter to know the effect on amount of Oil Content, Breaking Load and Bearing Dimensions. The earlier studies reveals that Oil Content totally depends upon Porosity and Porosity depends on Density. For high amount of oil content high porosity and minimum density is desired. But Density cannot be decreased beyond limit because it also affects Breaking Load and Strength of the Bearing. To Obtain Maximum Oil Content and required Breaking Load all the four parameters Forming Weight, Forming Density, Sintering Temperature and Sintering Speed should be varied within their acceptable range to find Optimum Value of each parameter.

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