"A REVIEW PAPER ON ANALYSIS AND OPTIMIZATION OF ALUMINIUM CASTING PARAMETERS"

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Abstract - *Casting is a process of solidification of liquid molten metal into a mold to solidify and then gently push the part away from the mold & or die. It is the one of the oldest manufacturing process new inventions has been done by the time and made the process somewhat modern. The sub-merged gate filling can improve the mold filling conditions, which may reduce the occurrence of inclusion defects during casting production. Casting helps to get a low wear resistance, good surface finish and that too having a uniform microstructure which can leads to get a good hardness which can help for cost reduction with less required material. In this present review paper we are going to make an attempt to produce HPDC components with accuracy and wear resistance. The HPDC wear rate, blow holes, excess material over a part, this all depends on various parameters some of them are pressure applied, duration of pressure applied, various temperatures such as die temp., molten temp., and various forces also that acts on them while application of pressure i.e. locking force, injection force, hydraulic ejection force. In this work the study of results and the optimization of them will be carried out by using*

Key Words*: *Casting, HPDC, RSM, Taguchi, FEM

1. INTRODUCTION

Casting is a manufacturing process in which a liquid material is usually poured within a mold that contains a hollow cavity of the desired shape, and then allows to solidify. This solidified part is also known as a casting, which is removed or broken out of the mold to complete the process. Casting done materials are usually metals or a various cold setting materials that are cured after mixing two or more components together.

Casting is one of the oldest metal shaping techniques known to humans. It means pouring molten metal within a refractory mold cavity and allows it to solidify. The solidified object is open out from the mold by breaking the mold apart. The casting process was discovered most probably around 3400 BC in Mesopotamia. In many parts of world during that period, copper axes (wood cutting tools) and other flat objects were made in open molds using clay. Those molds were essentially made in single piece. More refinement brought by the Bronze age into the casting process. Indus valley civilization was well known for their extensive use of castings from copper and bronze for ornaments, weapons, tools and utensils.

In metal casting, metal patterns are costly but are more dimensionally stable and durable. Metallic patterns are used when repetitive production of castings is required in large numbers. The modern casting process is subdivided into two main categories: Expendable casting and Non-expendable casting. It is further broken down by the mold material (i.e. sand or metal) and pouring method (i.e. gravity, vacuum, or low pressure).

Mold are made using a pattern or model of the final object. A mold is a hollow out block that is filled with a liquid or pliable material like plastic, glass, metal, or ceramic raw materials. The liquid hardens and sets inside the mold, adopting molds shape. A mold is the counterpart to a cast in casting.

The mold-maker is the manufacturer who makes the molds. A release agent is typically used to make removal of the hardened or set substance from the mold with ease and quick. Typical uses for molded plastics include are molded furniture, molded household goods, molded cases, and structural materials.

Die casting is type of casting process which was invented in around 1838 for the purpose of producing movable type for the printing industry. Applications increased rapidly, as die casting facilitating the growth in consumer goods and the appliances by making it affordable in the production of intricate parts in high volumes.

Basic steps of Casting: There are six steps in this process:

1. Placing a pattern into the sand to create a mold.
2. Incorporating the pattern and sand in a gating system.
3. Removal of the pattern.
4. Filling the mold cavity with molten metal.
5. Allowing the metal to cool.
6. Breaking away the sand mold and remove the casting.

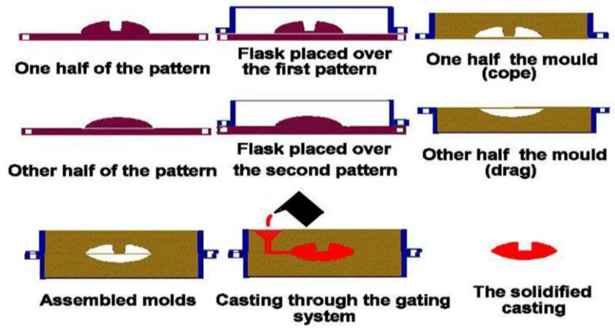

Fig.1.1. Basic casting process.

1.1 Types of casting process:

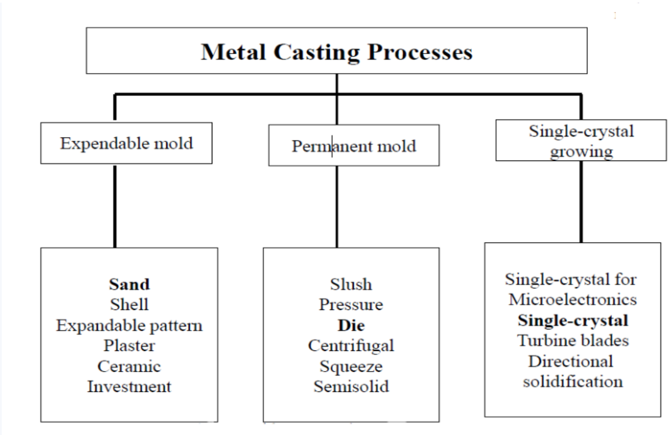

Fig.1.4. Metal Casting process types.

2. Literature review

Achamyeleh A. Kassie, Samuel B. Assfaw, Minimization of Casting Defects, IOSR Journal of Engineering (IOSRJEN), Vol. 3, Issue 5, PP 31-38 (May. 2013). According to them input parameters were variable parameters and output parameters variable on the defect scenario and the technique used for the minimization of cast defects were Taguchi's DOE and the results found for the system is that the shrinkage defect was precluded starting the first experiment since it can usually be corrected by proper design of the gating systems.

Manjunath Patel G Ca, Arun Kumar Shettigarb, Mahesh B. Parappagoudarc., A systematic approach to model and optimize wear behaviour of castings produced by squeeze casting process., 199–212, (2018). According to them squeeze pressure, die temperature and pouring temperature were the input parameters and minimized wear rate is the output parameter for the paper in the squeeze casting and The wear rate of casting parts is modelled in squeeze casting process by using the statistical design of experiments and soft computing based approaches.

Eva Angladaa, Antton Meléndeza, Iban Vicarioa, Jon Kepa Idoiagab, Aitz Mugarzab, Ernesto Arratibelc, Prediction and validation of shape distortions in the simulation of high pressure die casting, The use of the thermomechanical simulation is very infrequent in the metal casting industry although the associated results are really useful for the manufacturing process due to complexity, the long calculation times and the difficulties to interpret the results. The parts manufactured by metal casting processes cool from its filling temperature to ambient, which causes a certain stress-strain state, the main worry of the foundry men is the shape distortion. This work presents the prediction obtained using the thermo mechanical simulation for the final dimensions of a component manufactured in aluminium alloy by high pressure die casting (HPDC) and its validation with the final dimensions of the manufactured component.

Haibin Liu, Dingfa Fu, Zhaoyu Dong, Shaoxiong Huang, Hui Zhang, Bonding interfacial characterization of SiCp/8009Al composite and A356 aluminum alloy using compound casting, Compound casting was performed to investigate the bonding of the molten A356 aluminum alloy cast onto the SiCp/8009Al composite that was preheated at 395–450 °C. The bonding strength was measured by carrying out a tensile test. The interfacial microstructures were characterized by scanning electron microscopy, energy dispersive spectroscope, X-ray diffraction and electron backscattered diffraction. The results showed that the bonding strength increased by 37% when the preheating temperature increased from 395 °C to 420 °C, and decreased by 6.8% as the preheating temperature further increased to 450 °C. The transition zone widened, the interface formation mechanism and its effect on the fracture mechanism were also discussed.

Gerrit Dumstorffa, Christoph Pille b, Rico Tiedemanna, Matthias Busseb, Walter Langa. Smart aluminum components: Printed sensors for integration into aluminum during high-pressure casting, present a new and innovative approach for the direct integration of sensors into aluminum during casting to obtain strain and temperature data for the aluminum. This technology will enable a variety of new applications in sensing technology such as sensing car parts in the automotive industries (e.g. a suspension arm). Furthermore, these sensors can result in more efficient quality assurance, are fully encapsulated against environmental influence, provide an ideal connection between sensor and metal matrix. To reach the goal of integrating sensors in aluminum, they first focused on silicon-based sensors and analyzed by evaluating sensor data during casting. Due to the high difference in co-efficiency of thermal expansion between aluminum and silicon, high thermal-induced compressive stress is generated in the silicon and is destroyed in the casting process during solidification cooling. A sensor and its electrical connections are printed on aluminum sheets and integrated in aluminum in an industrial high-pressure casting process. As a result of these pre-tests, more than three-quarters of the devices survived the process of integration. Finally, they showed that they obtained the strain and temperature data from the cast part to develop smart components out of cast aluminum and to enable new sensing technologies.

3. Research Gap:

From thorough study of the research papers we can enlist some of the research gaps are as follows:

1. No work was found in the fields of multi objective optimization specifically by doing it for low cost and minimum investment, depending upon parameters of HPDC [41].
2. Very few work was found for High Pressure Die Casting method optimized for the MSME scale industries.
3. Only few work was found for the higher accuracy and most precise in the field of implementation of the optimized design in the industries.

4. Problem statement:

To Study the selected model in depth both analytically and experimentally and solve the problem for ease of production facilities and compare these techniques on the basis of design optimization and evaluating the accuracy in between these techniques and selection of best design with required optimization of part with the consideration of all the constrains and to evaluate parameters from hardness, stress, strain, surface roughness, porosity along with study of microstructure.

Objectives:

1. To obtain smooth surface finish of the casting experimentally and validated it by comparing with theoretical values for the same grade of material.
2. To decrease the porosity in the casting experimentally
3. To reduce the induced stress and strain by parameters change.

Possible outcomes

In this work the study of realize for the optimization of the parameters study can be carried out by using Stress – strain optimization and proving by three methods as, comparing with research paper value for the same material, another analytical and practically to conclude. Surface finish by optimize and validating the same by comparing with old technique, analytically, and by RSM (response surface method). Porosity by two parameters comparing and by using Electron microscope, hardness by Brinell's hardness number, and comparison.

Factors chosen

TABLE 1: Input and Output parameters

Input parameters	Output parameters
Die temp.	Wear rate
Ingot temp.	Surface finish
Locking force	Microstructure / porosity
Applied Pressure duration	Stress – Strain
Designer changes (Dimension, shape, system)	Hardness

Methods

- Stress – strain :
  Optimization and proving by 3 methods as, comparing with research paper value for the same material, another analytical and practically to conclude.
- Surface finish :
  Optimize and validate the same by comparing with old technique, analytically, and by RSM (response surface method).
- Porosity:- Two parameters comparing and by microscope.
- Hardness:- Brinell's hardness number and comparing with old technique and old design within an acceptable range.

Flow chart of procedure:

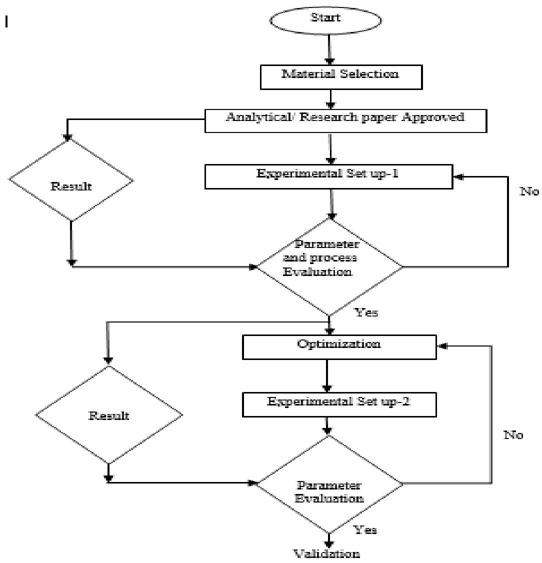

Fig.3.1. flow chart for the plan of action

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