Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Engineering
4(1), 2016, 14-18

ISSN 2347 – 7393

Original Research Article

OPTIMIZATION OF PRESSURE DIE CASTING PROCESS PARAMETERS BY TOPSIS METHOD

Mukesh Kumar Upadhyay, Mihir Kumar Pandey

Jawaherlal Nehru College of Technology, Rewa (M.P)

Abstract: TOPSIS has developed a methodology for the application of designed experiments, including a practitioner's handbook. This procedure has taken the design of experiments from the exclusive world of the statistician and brought it more fully into the world of manufacturing. Experiment carried out on design of experiment characterized by different survey on the basis of Temperature, Force exerted with Type of casting process on aluminum alloy that solidify and investigation the defects of shrinkage and porosity due to gases passed in casting process. In this work defects initiation and progression have been analyzed in order to identify the factors causing these very high residual stresses that often produce shrinkage and porosity spread throughout the casting.The defects were found on every square centimeter by microscope and then take their ordinary. The best productivities were obtained on the basis of results of confirmation experiments reveal that TOPSIS method can efficientlyoptimize an optimal combination of the process parameters.

Key Words:- Casting process, TOPSIS, Alloy.

Introduction: Aluminum Alloy is comparably easy to cast and recyclable, therefore, aluminum is still the most broadly processed metal in the field of die casting for engineering components such as aeronautic space, defence and motorized applications etc. It is therefore essential that the optimum casting technique with minimum defects be approved to reduce the manufacturing cost of die casting component during mass production. Pressure die casting is mostly affected by the process parameters such as solidification time, molten temperature, filling time and injection pressure and plunger velocity. Die casting uses the Die forces generated by revolving the mold to propel the metal and to facilitate filling.[1] Vacuum curve skull furnaces discharge titanium alloy at a

For Correspondence:
mukeshmech21@rediffmail.com
Received on: January 2016
Accepted after revision: January 2016

temperature just above its melting point, and the Die casting is usually needed to ensure good filling. The Die technique is used mostly for the production of hollow components, but Die casting is used to create solid parts The Die casting process is generally preferred for manufacturing a superior-quality hollow or cylindrical casting, because the process is economical with regard to casting yield, cleaning room expenses, and mold cost. The Die force causes high pressures to develop in the metal, and it contributes to the suckling of the metal, with separation from non-metallic inclusions and evolved gases. In Die casting of hollow sections, non-metallic enclosures and evolved gases tend toward the inner surface of the hollow casting. By using the outstanding advantage created by the Die force of spinning molds, castings of high quality and integrity can be produced because of their great density and freedom from oxides, gases, and other non-metallic inclusions.[3]

The Die force imparted to molten metal allows it to be picked up and held in contact with the rotating mould. The mould is allowed to rotate till the casting is completely solidified. Therefore the outer form of casting takes the shape of the inside of the mould and the bore of casting is truly rectangular and concentric with alignment of rotation. In case of Die casting, there is no need of runners and risers. The aging heat behaviour programs were systematically performed in the as-established alloy after long-term use. The acquired samples after various aging conditions were investigated and analyzed. A variety of occupied rolls according to the dimensions, design and factual properties could be chosen for different types of rolling positions. When studying thermo mechanical loads of rolls during one revolution, two types of stress and strain field might be considered in the contact.[2] Stresses in the area amongst working and back up roll could describe the Hertzian contact philosophy between two elastic circle bodies and in the area between working roll and rolled metal, which are extensive through the larger contact field. The Die casting method was developed after the turn of the 20th period to meet the need for higher standards. The process of Die casting differs from static casting in that the mold itself is spinning during the time, casting is solidifying. Die castings are usually poured while the mold is spinning; though, for certain applications, particularly in the case of a vertical casting, it is occasionally preferable that the mold be stationary when pouring begins. The machine then quickens the speed of the rotating mold either during the filling of the mold or after completion of pouring. Researches about the Die casting primarily focus on the as-cast defects. In the process of the Die casting, the molten metal flow has a great influence on the quality and the presentation of the roll. Since the Die casting is under the complicated force situation and under high temperature, force exerted and the cooling environment, it is difficult to know the defects develop in casting.[5]

Experimental Procedure

The molten metal was casted directly into the Die mould. In this work several samples manufactured to find the defects in variable temperature, Force exerted and type of process were studied and analysed. There are numerous ways to reduce these defects like increasing the dislocation density, alloying and making composite in such a way that the newly reinforcing phase acts like a barrier against movement of these dislocations. The design of experiment and their responses are shown in table 1.

Table 1 Average Defect with their parameters

S No.	Temperature in °C	Force Exerted F (KN)	Type of Process (Co)	Ts	P
1	400	55	Vertical	1.5	5
2	400	60	Horizontal	1.5	3
3	400	65	Hot chamber	1.6	4
4	500	55	Horizontal	1.3	4
5	500	60	Hot chamber	1.5	5
6	500	65	Vertical	1.6	4
7	600	55	Hot chamber	1.7	4
8	600	60	Vertical	1.5	5
9	600	65	Horizontal	1.4	3

The present experiments Microstructure has been shown in Fig. 1 were obtain to apply the randomly to establish the effects of casting parameters on the mechanical properties of aluminum alloy during casting. The common principle of the variation of parameter is to develop an understanding of the individual and combined effects of a variety of design parameters from a minimum number of experiments. In horizontal Die casting machine, the Die force is generated by a rotating cylindrical mould to throw the metal against the mould wall and form the tubular shape. The front end of the machine is fixed with a ring cover so that the molten metal is being prevented from splashing.

The pouring temperature there is increase in the time of solidification which results in columnar structure that is; there is a grain-coarsening effect, which reduces the ultimate tensile strength. The appropriate boundary conditions and initial conditions are imposed on the model, and the transient effect of the model has been obtained.

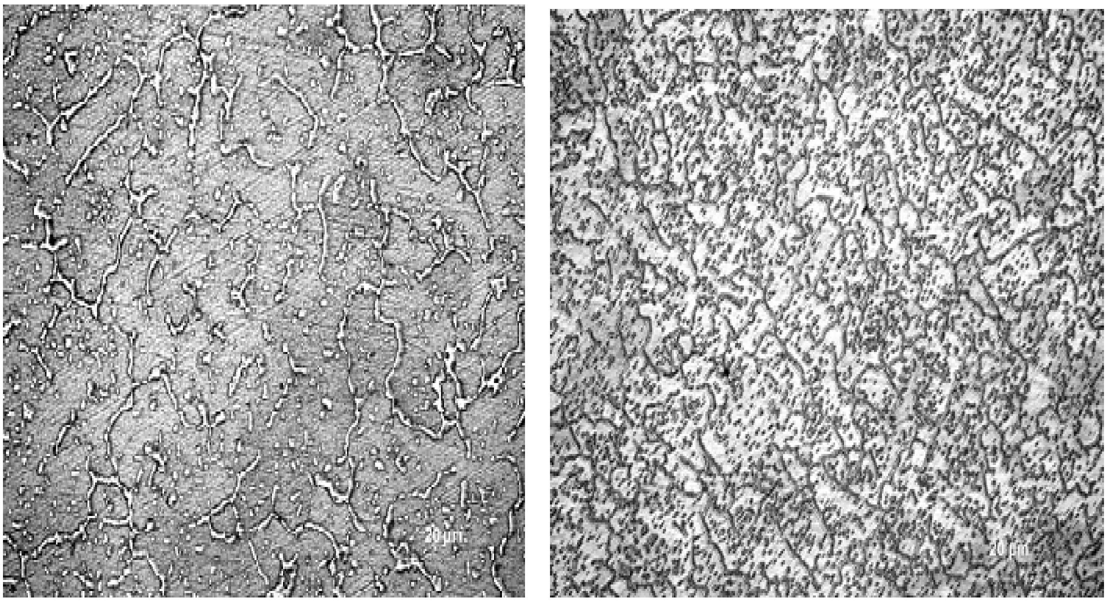

Fig 1 Microstructure of casting materials

Concrete is not the only material which suffers from adverse effects of shrinkage, but almost all brittle materials are affected similarly. As an example, flutes made of bamboo can undergo cracking when they are subjected to drying. Apparently, the flutes are not restrained and free to contract without any tensile stresses developed. So normally no cracking is expected due to shrinkage; however, if the outside and inside surfaces of the flute lose different amounts of moisture, then these surfaces would have uneven shrinkage strains.Defects in castings are the occurrence difficult in diagnosis. Cold cracks are one of the commonly occurring defects. The occurrence of these defects exposes foundries to the risk of incurring serious expenses, and this is the main reason why their elimination accurate in the casting process is extremely important.

TOPSIS Methods: TOPSIS (technique for order preference by similarity to an ideal solution) method is presented. TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives. The basic standard is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution.[3] The procedure of TOPSIS can be expressed in a series of steps:

1. All Experimental Data are converted S/N ratio.
2. The experimental design matrix along with normalized response (R_{ij}) is shown in Table X. R_{ij} is the normalized value and this normalized matrix can be calculated by the equation 2.

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{30} x_{ij}^2}} \qquad (2)$$

- Where x_{ij} is the experimental value of the i^{th} attribute of the j^{th} experimental run.

All attributes of normalized matrix (Rij's) are multiplied by S. D. weights. Resultant matrix is called weighted performance matrix which is denoted by S_{ij} (for i^{th} experimental run and j^{th} response).

Where d(x,y) is the distance between two fuzzy numbers. This distance of twovalue of d+ and d− are shown in Table X. After calculating the distance between the positive and negative ideal solution, the final step is to determine closeness coefficient (CC_i), which is calculated by equation 3. This CC_i value indicates the closeness of each the experimental value to the ideal solution that is shown in the same table.

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \qquad (3)$$

Result of Responses: Results of casting defects are presented in terms of CCI (closeness coefficient value) which shows the variation of different parameter with different temperature, speed and cooling for the specimen. For the temperature 500 rpm and 65 KN Force in Horizontal direction of mould value is unityshows the optimum parameter for the overall best rank which shows in same Fig. 1.

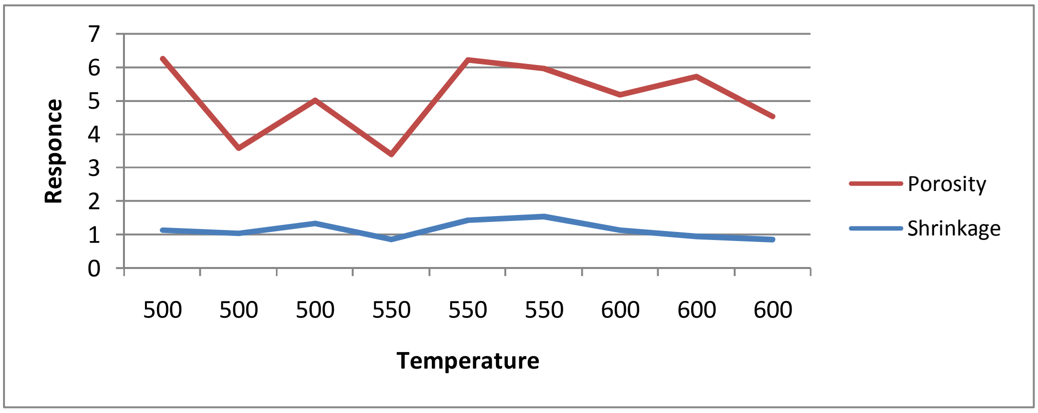

Fig. 1 Response Graph

It have better output in all over combination. At higher temperature and higher speed casing will produce pin average holes and low shrinkage. From Fig. 1 it is confirmed that 50^{o}C temperature and 550 rpm is the best combination for Die casting. Cooling of specimen is also a factor to improve the quality of Die casting, in such case sand cooling gives low defects. Figure 2 shows the graphical representation of the CCI Vs experimental runs. This graph showing the graphically which experiment setting is best of our results for multi-objective to Single objective optimization.

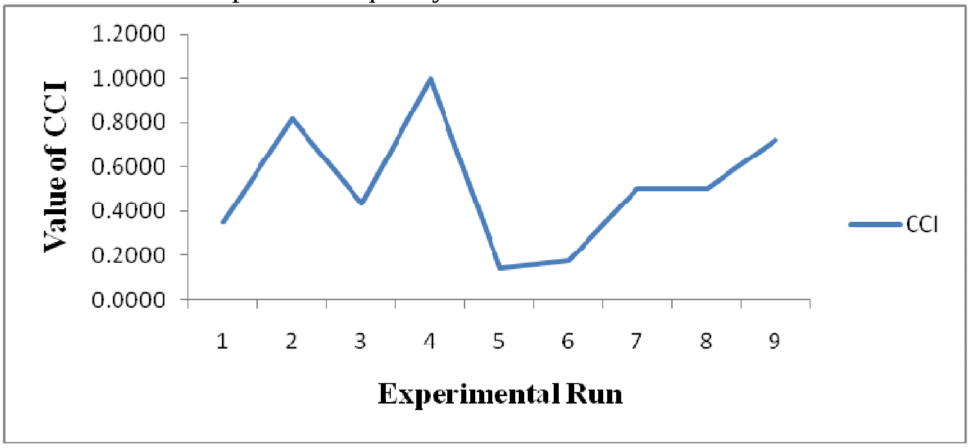

Fig 2 CCI graph

Conclusions: TOPSIS method was applied for optimizing the die casting process parameters, and the results obtained using this method was useful in eliminating the Srinkage and blow holes problem in casting process. At optimized parameters the casting quality was better than the previous casting that was cast under the non-optimized conditions. The Microscopic test results also revealed that samples cast under the optimized parameters has no significant defects. Similarly the results obtained using simulation at optimized condition shows no presence of defects in casting. Considering the contribution of the parameters, temperature 500^{0}C and 65 KN Force in Horizontal directionwas the factor showing more influence on the casting density compared to the other parameters.

References

[1]. K. Müller, W. Reif, Einfluß von Begleit- und Spurenelementen auf die Kornfeinung hochsilizium Al-Si-Guslegierungen auf Reinstbasis, Metall 51, 1-2, 1997, 25-32.

[2]. K.G. Basavakumar, P.G. Mukunda, M. Chakraborty, Influence of grain refinement and modification on microstructure and mechanical properties of Al-7Si and Al-7Si-2.5Cu cast alloys, Materials Characterization, 59, 2008, 283 – 289.

[3]. S.G. Shabestari, S. Ghodrat, Assessment of modification and formation of intermetallic compounds in aluminum alloy using thermal analysis, Materials Science and Engineering A 467, 2007, 150–158.

[4]. J. Pavlovic-Krstic, R. Bähr, G. Krstic, New Casting Technologies and prediction of casting properties using advanced computational simulation technology, International PhD Foundry Conference, June 1.-3. Brno, 2009, 117-125.

[5]. J. Pavlovic-Krstic, R. Bähr, G. Krstic, New Casting Technologies and prediction of casting properties using advanced computational simulation technology, International PhD Foundry Conference, June 1.-3. Brno, 2009, 117-125.

[6]. Gao, J. W. and Wang, C. Y., “Modeling the Solidification of Functionally Graded Materials by Die Casting”, Material Science and Engineering, A292, pp 207-215, 2000.