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Optimization of degree of sphericity of primary phase during Cooling Slope casting of A356 Al alloy: Taguchi method and Regression analysis

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Abstract

The present work presents the results of experimental investigation of semi-solid rheocasting of A356 Al alloy using a cooling slope. The experiments have been carried out following Taguchi method of parameter design (orthogonal array of L_9 experiments). Four key process variables (slope angle, pouring temperature, wall temperature, and length of travel of the melt) at three different levels have been considered for the present experimentation. Regression analysis and analysis of variance (ANOVA) has also been performed to develop a mathematical model for degree of sphericity evolution of primary α-Al phase and to find the significance and percentage contribution of each process variable towards the final outcome of degree of sphericity, respectively. The best processing condition has been identified for optimum degree of sphericity (0.83) as A3,B3,C2,D1 i.e, slope angle of 60^o, pouring temperature of 650^oC, wall temperature 60^oC, and 500mm length of travel of the melt, based on mean response and signal to noise ratio (SNR). ANOVA results shows that the length of travel has maximum impact on degree of sphericity evolution. The predicted sphericity obtained from the developed regression model and the values obtained experimentally are found to be in good agreement with each other. The sphericity values obtained from confirmation experiment, performed at 95% confidence level, ensures that the optimum result is correct and also the confirmation experiment values are within permissible limits.

Keywords: Semi-solid; Cooling slope; Rheocasting; Degree of sphericity; Taguchi method; ANOVA.

1. Introduction

Semi-solid processing of metals (alloys) has emerged as a potential manufacturing technology for automobile, aviation, electronic and machine tool components. It enables