The Effects of Different Cooling Rate Conditions on the Thermal Profile and Microstructure of Al-Si Alloy with Magnesium Addition

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Abstract. Thermal analysis is a technique that has played an important role in the characterization and development of the material. The aim of this study is to investigate the effect of magnesium addition on the cooling rate of an Al-Si alloy with magnesium addition using the method CCA-CA. In this work, a graphite crucible containing Al-Si alloy with an addition of 1% magnesium and up to the temperature of 800 °C was heated using induction furnace. The cooling curve was determined by K-type thermocouples. One K-type thermocouple was placed in the centre of the crucible and the other near the wall of the crucible. Both K-type thermocouples were submerged to 20 mm in the melt. The crucible was left in a chamber with a Kaowool insulator and in an open environment with additional minimal ventilation to achieve the slow and rapid cooling rate condition. The slow and fast cooling rates were calculated at 0.17 °C/s and 1.578 °C/s respectively. The temperature of liquids and solidus of the slow cooling rate condition was found at 579 °C and 464 °C respectively. Meanwhile, the liquidus and solidus temperature of fast cooling rate was at 577 °C and 477 °C. Furthermore, the microstructure formation of different cooling rate conditions were observed. The results show that the increased cooling rate condition refined the grain structure, enhance the grain globularity and reduced the aspect ratio.

INTRODUCTION

Metal casting is used extensively in the manufacturing industry to create a variety of components on a large scale. The primary problem facing today's casting industry is achieving good material quality. The material mechanical characteristics is one of the most significant fundamental elements in designing well-designed components utilized in a broad array of industries. The material's qualities have an impact on the level selection for structural engineering applications. Aluminium alloys play a significant role in the proportion of materials used in mechanical design and automotive sectors [1]. Since then, aluminium alloy has been an important material in metal casting activity, especially in oil and gas (drill pipe, drill collars, risers and line pipe) [1], automotive parts (engine block, piston, intake manifolds and cylinder head) [2– 4] and chassis application (instruments panel, brake components and wheels) [5], where these components were produced by the conventional casting process. Nonetheless, hot tearing, development of shrinkage porosity and gas entrapment are all drawbacks of the traditional casting method [6– 8]. On the other hand, some of

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