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Effect of Pouring Temperature on Mechanical Properties of Semisolid Cast A319 Aluminum Alloy

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Abstract: ***Semisolid metal (SSM) casting or thixoforming is a technique used to produce near net-shaped products. The process is used with non-ferrous metals, such as aluminium, copper and magnesium. Furthermore, it has advantage over conventional casting due to suppression of dendrite growth. In the present work, the semisolid casting of A319 aluminium alloy has been carried out by using an inclined plate with different melt pouring temperatures (620, 625, 630 and 635 °C). A319 alloy melt undergoes partial solidification when it flows down on an inclined plate. It results in continuous formation of columnar dendrites on plate wall. Due to forced convection, these dendrites are sheared off into equiaxed or fragmented grains and then washed away continuously to produce semisolid slurry at plate exit. The prepared castings were checked for their mechanical properties like tensile, hardness and impact strength. The results obtained were compared with that of alloy prepared from conventional sand casting. It was found that there is an enhancement in mechanical properties due to shearing off columnar dendrites.***

Keywords: ***casting, mechanical properties, pouring temperature, semisolid***

I. INTRODUCTION

Aluminium and its alloys are widely used in industries particularly automobile, aerospace and defense due to their light weight. Aluminium has a density one third the density of steel. It is easy to produce aluminium due to its good thermal and electrical conductivity and it does not exhibit a transition from ductile to brittle phase at low temperatures. The aluminium castings are extensively used in automobile industries for making piston, cylinder liners, wheels, brackets, brake parts, control arm, cylinder heads and instrument panels [1]. The solidification process of the liquid metal plays a crucial role in determining the physical and mechanical properties of the alloy. The conventional casting may have casting defects and low strength due to dendritic microstructure of the alloys. Several techniques have been developed to produce alloy of non-dendritic microstructure, out of which stir casting is noteworthy [2]. The effect of steering on solidification pattern and alloy distribution during semisolid metal casting has also been studied [3]. Flemings [4] investigated the effect of convection that occurs due to mechanical or electromagnetic stirring technique during solidification of liquid metal. Cooling slope casting is alternative technique used in semisolid metal processing which is simple and cost effective [5]. In this process, molten metal is poured on the top of an inclined cooling plate. Due to forced convection, the columnar dendrites formed during solidification are broken into refined and globular microstructure [6]. The semisolid slurry is then solidified in mould cavity. This technology promises some advantages such as prolonged die life due to less thermal shock and also provides more laminar cavity fill which could lead to reduced gas entrapment. The components formed in semisolid metal casting process have superior mechanical and properties because of globular or thixotropic microstructure [7-9]. Application of vibration is another method in semisolid metal (SSM) processing to produce thixotropic microstructure of cast components. It has also been reported that applying mechanical and ultrasonic vibration in the semisolid metal processing can lead to formation of fine, non-dendritic and globular microstructure. However these techniques are time consuming and not cost effective [10]. Therefore a process using minimal equipment is required to reduce the cost of the semisolid metal processing (SSM) [11]. This process is mainly used to cast complex products with near net shapes and excellent dimensional accuracy. Several works of semisolid metal processing on aluminium alloy A356, A357, A390, A319 have been carried out using cooling slope technique [12]. The effect of cooling slope parameters such as plate length, plate inclination, pouring temperature of liquid metal and flow rate of water on microstructure of alloy is critically studied [13]. However substantial investigation on mechanical properties of semisolid cast alloy has not been reported. In the present work, billets of aluminium alloy A319 were prepared using cooling slope technique and effect of pouring temperature on mechanical properties is analyzed by comparing with the conventional cast sample.

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