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Problems in Aluminium DC Casting Process Associated with Melt Treatment Operations

Abstract

The quality of DC cast Al alloys is highly dependent on melt batch composition and impurity level in the molten alloy. The chemical composition and cleanliness of a melt is controlled through the melt treatment operations, carried out while the melt is still in the furnace before casting starts. The present work has studied some of these operations and associated problems such as slow dissolution of alloying elements, non-reproducibility in chemical composition analysis and inclusions.

The results of the dissolution of the alloy elements Mn and Fe showed different behaviors. For Mn three intermediate phases were involved, all of which exhibited a smooth interface between Mn and the liquid. These three phases were identified as the γ2, Al11Mn4, and μ phases, which grow slowly towards the dissolving Mn particles. The results from the Fe dissolution revealed that only one phase dominates the process, Al5Fe2, which penetrates the Fe particles with an irregular interface.
The interaction between Mn and Ti additions to AA3003 alloys and consequences for the solidification and precipitation behavior was investigated. The study could map the limits for formation of an earlier unknown AlMnTi phase, which formed large particles, detrimental for subsequent rolling operations.

Different sampling procedures for chemical composition analysis were studied, and a novel approach was proposed. A mould with an insulated periphery provided one-dimensional solidification, which gave compositions close to nominal.

Inclusion distributions along as-cast billets were studied as a function of different holding times, and thus different grades of sedimentation. Holding times longer than 30 minutes did not show any improvements. It was also shown that if melt remaining in the furnace at end of casting is less than about 3000 kg, the sedimented inclusions are stirred into the bulk again, and can enter into the end of the billet.

The impact on hot tearing susceptibility of different Cu and Fe contents for AA3000 alloys was studied. Cu contents in a range from 0.3 to 1.2 wt% significantly increase the hot tearing tendency, which was attributed to bad feeding at end of solidification. Decreasing of the Fe content below 0.2 wt%, gives a strong cracking tendency, owing to decreased precipitations of the

Al6(Mn,Fe) phase, which contributes to early bridging and thus reinforcement between grains.