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NUMERICAL SIMULATION OF FLUID FLOW AND HEAT TRANSFER DURING THE INITIAL PHASE LEADING TO STEADY STATE SOLIDIFICATION IN D. C. CAST ALUMINUM ALLOYS

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In this paper, two dimensional unsteady flow and energy equations are employed for simulating the fluid flow, heat transfer and solidification during direct chill continuous casting of Al-Mg alloy billet. In these processes, the formation of some macro defects such as thermal cracking, hot tearing, surface cracking, etc, has been found to initiate during the starting phase of the operation. In this paper, a numerical study of these developing fluid flow and thermal phenomena from the beginning of casting operation to a steady-state is presented. The computations are based on an iterative deforming finite volume method and a single-domain enthalpy formulation to solve the growth of metal being solidified and the accompanying dynamic fluid flow and thermal behavior. The effect of phase change on convection is accounted for using a Darcy's law-type porous media treatment. The results indicate that the fluid flow and temperature fields change drastically at the initial stage but evolve slowly afterwards.

Keywords: Fluid flow; heat transfer; finite volume; solidification; continuous casting; direct chill casting.

1. Introduction

In recent years, the continuous casting process in which molten metal is constantly cast into semi-finished shapes has been widely adopted in the steel and nonferrous metal producing industry, mainly due to its economic advantages associated with increased yields and the elimination of intermediate processing steps.

Direct chill (DC) casting (Fig. 1) is a semi-continuous process for the production of metal ingots or slabs for extrusion and rolling processes. To start a cast, the mold bottom is sealed by a dummy bottom block to prevent liquid metal from flowing out of the mold. The Liquid metal is introduced into the cavity through a nozzle, until the cavity is filled. The mould is chilled from the inside with running water