(155) MODELLING OF SLAG RIM FORMATION AND PRESSURE IN MOLTEN FLUX NEAR THE MENISCUS

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I. Introduction

An important parameter which controls the formation of oscillation marks on CC materials is the local pressure in the molten flux around the meniscus. This problem has already been looked into by previous investigators (1). In the present work, we have studied the behavior of the slag rim oscillating with the mold and modelled the shape of the slag rim and the pressure generated in the molten flux by the motion of the rim, using numerical simulation.

II. Estimation of the shape of the slag rim

A schematic picture of the different phases in the region of initial solidification is shown in Fig.1. In order to estimate the shape of the slag rim, we made a two-dimensional heat transfer simulation model to calculate the temperature distribution in this region. An example of the results is shown in Fig.2.

The temperature distribution in the molten flux in this region mainly depends upon the heat extraction through the mold more than any other conditions.

III. Calculation of the pressure

Through the whole region shown in Fig.1, we assumed that the flow was two-dimensional, purely laminar and steady-state. Navier-Stokes equations are thus written as follows :

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=-\frac{1P}{\rho x}+X+\nu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right) \quad , \quad \frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}=-\frac{1P}{\rho y}+Y+\nu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right),$$

where u, v: flow velocities in the x and y-directions respectivery, ρ : density of the molten flux, ν : kinematic viscosity of the molten flux, X, Y: external forces in the x and y-directions respectivery, P: pressure and t: time.

Thus the pressure is given by:

$$P_{i+1}=P_i-6\mu\Delta x Q_x(h_i+h_{i+1})/(h_i h_{i+1})^2-6\mu\Delta x(W+Ve^{-i\omega t})\sin\alpha_i/h_i h_{i+1}-\rho(g+F)\Delta x\sin\alpha_i \quad ,$$

where Q_x:flow amount of molten flux in the x-direction, μ: viscosity and other signs are shown in Fig.1.

As an example, the results of the calculations which were carried out using the temperatures shown in Fig.2 are given in Fig.3.

In this case, the pressure at the point where the initial solidification starts, reaches around 800~1200 N/m² (8~12 g/cm²) and this leads to the possibility that the initial solidified shell will be bent inward as shown in Fig.1. This phenomenom makes oscillation marks deeper. When we decrease the size of slag rim in this model, the pressure decreased enough to prevent the bending of the shell.

IV. Conclusion

The theoretical model which we developed shows a possibility that the pressure in the molten flux increases enough to bend the initial solidified shell inward.

(1)S.ANZAI et al:Tetsu-to-Hagane,69(1983)12,S1038

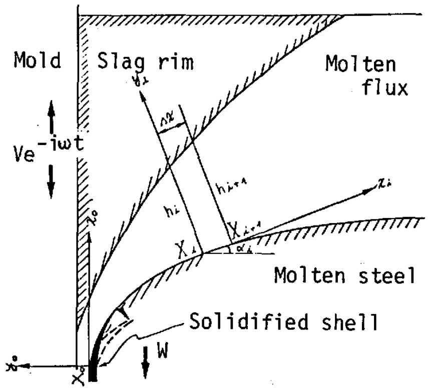

Fig.1 Schematic Picture of The Different Phases in The Regoin of Initial Solidification

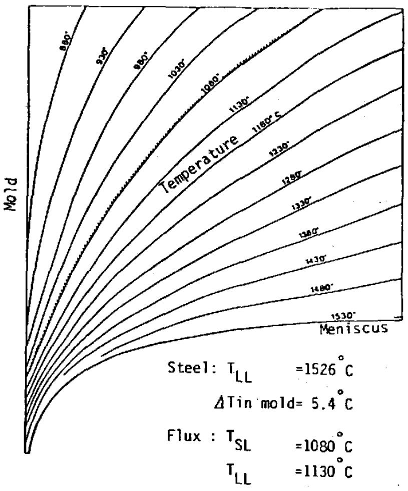

Fig.2 Temperature Distribution in The Molten Flux near The Meniscus

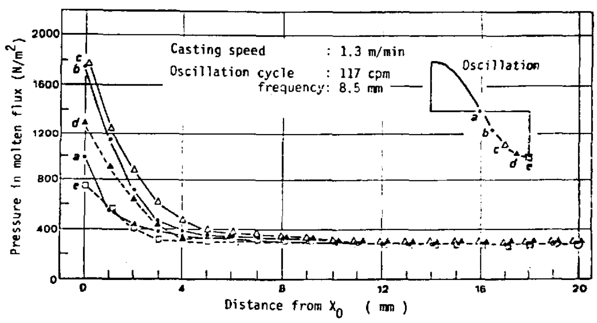

Fig.3 Pressure Distribution in The Molten Flux near The Meniscus