Fluid control of molten steel in continuous casting mould with magnetic field

Engang Wang*, Zefeng Han, Wangzi Dong

Key Laboratory of Electromagnetic Processing of Materials (Ministry of Education)
Northeastern University, Shenyang, P. R. China
*corresponding author: egwang@mail.neu.edu.cn

Abstract In this paper, a new type EMBr that called vertical combination electromagnetic brake (VC-EMBr) is proposed. The fluid control of molten steel in continuous casting mould with VC-EMBr is investigated by numerical simulation method to consider the position of vertical magnetic poles in the mould, the casting speed and the different type of EMBr, and the position of vertical magnetic polar. The numerical simulation of turbulent kinetic energy near the narrow surface of the mold under the different casting speed show that the turbulent kinetic energy is apparently reduced as applied EMBr, and turbulent kinetic energy is minimum as the vertical magnetic polar is in C position, which mean that the VC-EMBr with the type of C position have the most effective braking.

Keywords: electromagnetic brake, continuous casting, steel

1 Introduction

In the continuous casting of steel in metallurgical process, the molten steel flows into a mould through a submerged entry nozzle (SEN) at a certain jet angle, and then impact the narrow side of the rectangular mould in a certain velocity, so as to form an upward fluid and a downward fluid in the mould. The upward fluid is easy to cause level fluctuation in the molten steel surface in the mould, and especially the level fluctuation of the molten steel near the meniscus can be aggravated to cause slag entrapment easily. The downward fluid has great penetration depth and can bring some inclusions and bubbles in the molten steel to cause defects in continuous casting slabs.

In order to solve the problems, a steady magnetic field is set up in the mould so as to control the level fluctuations and impact depth of molten steel in the mould, which called the technique of Electromagnetic Brake (EMBr) with two magnetic polar on the width of the mould in horizontal direction. The generally patterns are Ruler-EMBr and the FC (Flow Control) Mold. However, the horizontal two magnetic polar on the width of the mould could not effectively to control the impact of molten steel flows on the narrow side of the rectangular mould and cause some subsurface defects in slabs.

2 Proposal of Vertical Combination EMBr

In this paper, a new type EMBr that called Vertical Combination Electromagnetic Brake (VC-EMBr) is proposed based on the advantage of Ruler-EMBr and V-EMBr[1,2], which applied to the thin slab or slab continuous casting process. The fluid control of molten steel in continuous casting mould with VC-EMBr is investigated by numerical simulation method to consider the position of vertical magnetic poles in the mould, the casting speed and the different type of EMBr.

3 Numerical Simulation of VC-EMBr

The vertical magnet poles are set in three different positions as shown in Fig. 1a. The numerical simulation magnetic fields of VC-EMBr with B, C, D magnetic poles are shown in Fig.1b, c, d.

The numerical simulation results show that the maximum turbulent kinetic energy are 0.009 m²/s², 0.0081 m²/s² and 0.0097 m²/s² corresponding the vertical magnetic poles of B, C and D position. The contour plot of the turbulent kinetic energy near the narrow surface of the mold are shown in Fig.2, which mean that the best comprehensive braking effect is got when the vertical magnetic poles is in C position.
The numerical simulation results of turbulent kinetic energy near the narrow surface of the mold under the different casting speed show that the turbulent kinetic energy is apparently reduced as applied EMBr [Fig. 3], which mean that the VC-EMBr with the type of C position have the most effective braking.

![Fig. 1 Magnetic flux density of VC-EMBr with B, C and D magnetic pole](image1)

![Fig. 2 Turbulent kinetic energy with three magnetic poles of B, C; D](image2)

Fig. 2 Turbulent kinetic energy with three magnetic poles of B, C; D

![Fig. 3 The turbulent kinetic energy of three type of EMBr](image3)

**Fig. 3 The turbulent kinetic energy of three type of EMBr**

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**References**
