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CAUSE ANALYSIS AND IMPROVEMENT MEASURES OF STEEL-HEAPING IN WIRE RODS PRODUCTION

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Based on the composition detection results of steel inclusions, it is found that the steel-heaping reason of cold heading wire is caused by the slag entrapment in steelmaking process. In view of the above reasons, by controlling the fluctuation of liquid level of tundish, controlling the fluctuation of continuous casting speed, optimizing the thickness of covering slag and tundish cover powder, the phenomenon of steel-heaping in the rolling process can be effectively reduced when producing Q195 and other cold heading steel. It is of great significance to guide process improvement.

Keywords: Q195 steel, billet continuous casting, wire rod, steel-heaping, X-ray research

INTRODUCTION

The annual output of cold heading steel in a steel mill is about 500 000 tons, and the production process is Bessemer smelting process. After casting 150 mm×150 mm billet, and then billets roll into specifications ϕ 6,5 ~ 22 mm cold heading rod. In the rolling process, steel-heaping accidents caused by steel-making inclusions occur frequently [1, 2]. There are many reasons, most of which are closely related to the quality of continuous casting billet [3]. Steel-heaping not only affects the smooth running of the rolling process, but also causes certain damage to the equipment [4, 5]. Therefore, it is particularly meaningful to explore the causes of high-line steel-heaping [6, 7].

PRESENT SITUATION OF STEEL-HEAPING

In general, the pass distribution of steel-heaping is as follows:

Rough-rolling of steel-heaping stage: It mainly focuses on steel-heaping before rolling-mill 6 enters no. 1 flying shear.

Intermediate rolling of steel-heaping stage: The main performance of steel-heaping in this area is mainly concentrated cracking.

Finish rolling of steel-heaping stage: The main reasons for steel-heaping are cracking, foreign matter pressing in, and material dropping at the end of the last billet, etc.

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Figure 1 Photo of rotten steel produced by steel-heaping

The steel-heaping of the paper is mainly produced in the finishing rolling stage. Figure 1 is a photo of rotten steel generated during the steel-heaping accident in the steel rolling process. After cutting, polishing and polishing the rotten steel, metallographic samples were made for microscopic observation and Energy Dispersive X-ray Spectroscopy (EDS) analysis.

RESULTS AND DISCUSSION

Figure 2 shows typical photos of Scanning Electron Microscopy (SEM) and EDS of the sample. It can be seen from Figure 2 that oxide particles were found in the electron microscope analysis of the metallographic samples of the rotten steel, and the EDS analysis showed that obvious characteristic peaks of Na and K elements were found in all the oxide particles.

In the rotten steel produced by the rolling heap, the composition of the slag entrapment of the sample was detected, but it was not possible to trace whether the billet that caused the slag entrapment accident was the

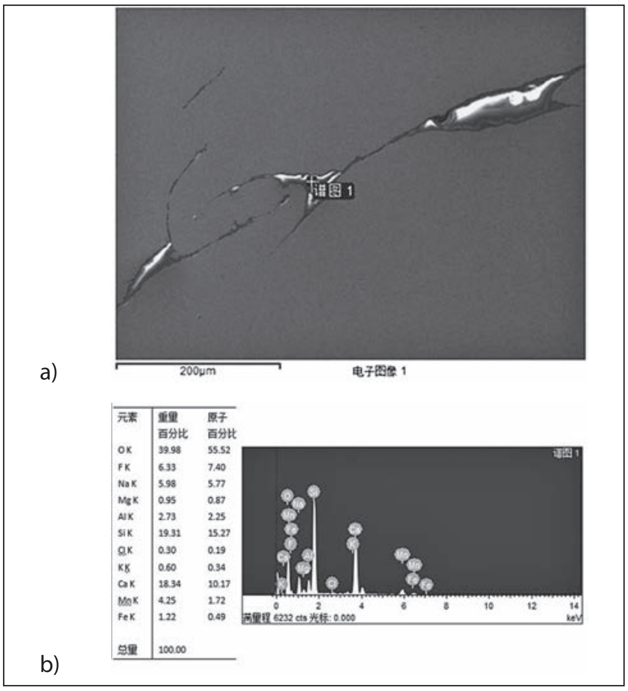

Figure 2 (a) SEM and (b) EDS analysis of rotten steel produced by heap steel

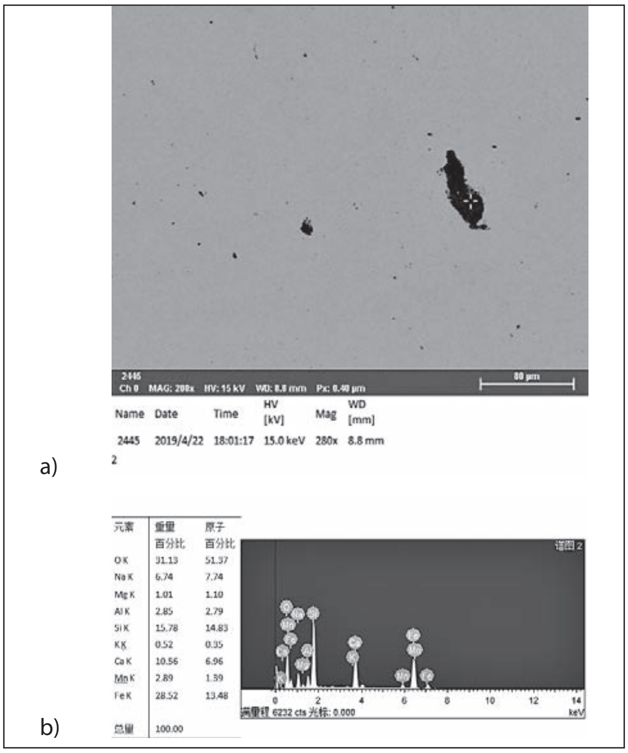

Figure 3 (a) SEM and (b) EDS analysis of inclusions in continuous casting billet

head billet, the tail billet or the intermediate billet. Therefore, it is impossible to judge whether mold slag is generated in normal continuous casting process. Therefore, a batch of steel was randomly selected and sampled in the middle of continuous casting casting to detect inclusions in the continuous casting billet. The test results are shown in Figure 3.

It can be seen from Figure 3 that there are large inclusions in the continuous casting billet with a size of about 100μm. In order to accurately analyze the composition of the inclusion, EDS analysis was carried out on the inclusion. It can be seen from the Figure 3 that the main component of the inclusion is silicate, and the inclusion also contains part of Na_2O and K_2O. As only the mold covering slag and tundish covering powder used in the process of steel making contain a lot of alkali metal oxides, it can be concluded that the large inclusion comes from the tundish or mould slag, and the slag entrapment behavior also occurs in the normal continuous casting process.

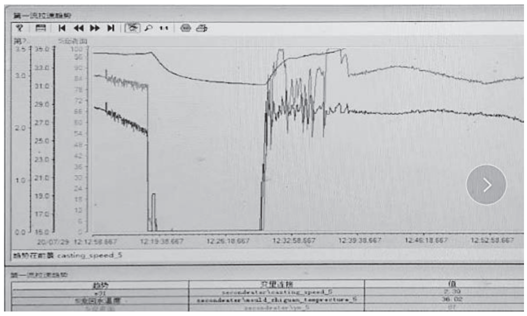

Figure 4 Casting curve of continuous casting billet in the accident furnace

TRACEABILITY OF PROBLEMS

The main reason for the steel-heaping phenomenon was determined to be the slag entrapment in the continuous casting mold. According to the production information of the billet in the accident furnace, the pouring data of the billet in the accident furnace in the production site were traced back. Figure 4 lists the typical casting curve of continuous casting billet for the accident furnace.

In the casting curve of continuous casting billet, the red curve represents the mold liquid level in the casting process, and the dark red represents the drawing speed. It can be seen from the investigation and Figure 4 that the mould liquid level fluctuates violently in the casting process of continuous casting billet in several furnaces where the steel-heaping is generated, and the fluctuation of mould liquid level is accompanied by the variation of casting speed of continuous casting billet. This shows that the large scale adjustment of casting speed will lead to the instability of mold liquid level, and the violent fluctuation of mold liquid level is the main reason for the slag entrapment in continuous casting billet. In addition, some casting curves show that the liquid level of the mold drops to 0, which indicates that the continuous casting has been interrupted, such as the accident of changing the mold nozzle.

PROCESS IMPROVEMENT MEASURES / CONCLUSION

Based on the above detection and analysis, the following process improvement measures are proposed:

(1) According to the test results, it is suggested that the liquid level of tundish should be controlled

more than 600 mm and the liquid level fluctuation of mold should be controlled within 5 mm in the pouring process of the factory.

(2) Try to keep constant speed, speed adjustment range is less than 0,1m/min. Ensure that the thickness of liquid slag layer of covering slag is about 10 mm, and the thickness of tundish covering powder is greater than 40mm.

(3) The storage environment of materials in contact with molten steel, such as covering slag and covering powder, should be dry. The baking time of ladle and tundish should be more than 4 h, and that of nozzles should be more than 2 h.

Through these measures, Enterprises greatly reduce the occurrence of heap steel in the production process.

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Note: Dong Xu is the responsible translator and the corresponding author, Handan, Hebei, China.