Improvement of Steel Quality by Application of Carbon Free Mold Powder

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Abstract

Carbon free mold powder was developed in order to improve the quality of steel in where it is required to have no carbon pick up. Improvements to steel quality by the application of the carbon free mold powder on ultra-low carbon steel, high oxygen steel, and stainless steel are introduced.

1. Introduction

Carbon material, such as carbon black or graphite, is contained in the mold powder for continuous casting of steel. The carbon material can prevent roping in the mold and control the melting speed of the mold powder. However, when the unmelted mold powder containing carbon material directly comes in contact with the molten steel, carbon pick up in the molten steel occurs. In many cases, the carbon pickup causes defects on the surface of cast steel. In particular, it is important to reduce the carbon pick up in ultra-low carbon steel, high oxygen steel, and stainless steel. This report introduces our carbon free mold powder designed for reducing the carbon pick up in the molten steel and its applications.

2. Mechanism of Carbon Pickup

Fig. 1 shows the schematic drawing of a top section of the casting mold. Mold powder added to the surface of molten steel in the mold melts and forms a molten slag layer. The molten slag layer prevents the unmelted mold powder from contacting the molten steel. In some case, however, the molten steel is exposed to the unmelted mold powder layer through the molten slag layer. This is caused by the floatation of gas bubbles from molten steel through the molten slag layer and the upward movement of steel near the narrow face of the mold. As a result, the molten steel directly contacts the carbon containing unmelted mold powder, causing carbon pickup.

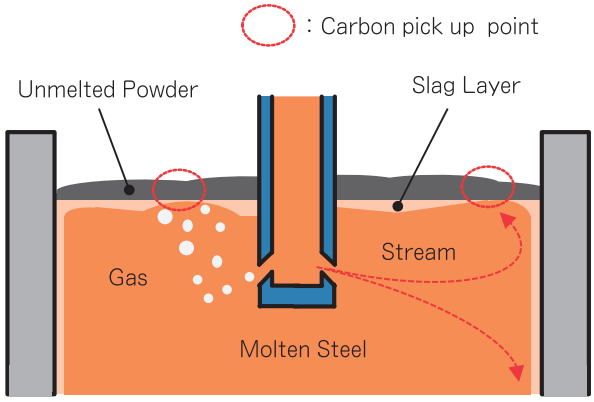

Fig. 1 Probable mechanisms of the carbon pick up.

3. Carbon Free Mold Powder

Mold powder usually contains 1–10 % carbon material as graphite and carbon black, and the carbon material has important roles in controlling melting properties. Therefore, reducing the carbon material in mold powder for preventing carbon pickup can cause problems with the melting behavior, such as abnormal sintering or decarburization of mold powder. In addition, it also lowers the insulation properties of the mold powder and the effect of heat supply through its combustion. In order to solve these issues, a metallic material is added in the carbon free mold powder instead of carbon material. The metallic material provides heat through an exothermic reaction and can improve the melting properties without carbon

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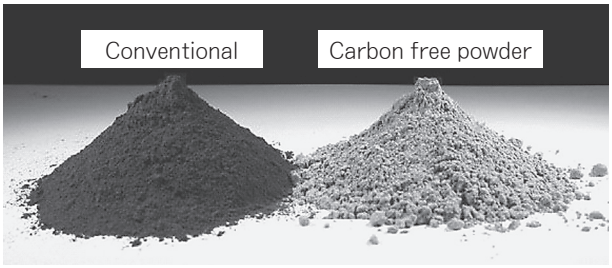

Fig. 2 Appearances of mold powder.

material. Fig. 2 shows the appearance of conventional mold powder and the carbon free mold powder. The carbon free mold powder shows a whitish color, hence, it can reduce stains on facilities and operators.

4. Application

4. 1 Application to ultra-low carbon steels

The quality demands on ultra-low carbon steels for automobile is increasing, hence, it is important to improve the steel quality not only by optimizing casting condition but also by improving mold powder. Preventing carbon pickup in the steel is one of the most important issues, and carbon free mold powder is required.

Fig. 3 shows the amount of carbon pickup for the conventional mold powder with carbon material and the carbon free mold powder. The carbon free mold powder achieved very low carbon pickup during casting.

4. 2 Application to high oxygen steels

High oxygen steel, such as enameled steel, has blow hole defect issues. When unmelted mold powder contacts the molten steel, carbon material in the mold powder reacts with oxygen dissolved in the molten steel. This reaction generates CO gas. The CO gas causes blow hole defects in the steel shell.

Fig. 4 shows the quality results on the surface of the slab. The developed carbon free mold powder showed remarkable improvement in the quality due to the reduction of carbon pickup.

4. 3 Application to ferritic stainless steels

Although the major grade of stainless steels is austenitic SUS 304, ferritic stainless steels which is less expensive due to lack of nickel, have come to be widely used for many applications. In case of SUS409, a ferritic stainless steel, there is a problem where the ferritic phase easily transforms into the dual phase of ferrite and martensite when carbon pickup is occurred. This phase transformation changes properties and color of the steel. A change in color on the steel surface is an important issue with stainless steel, where cleanness is required on its surface.

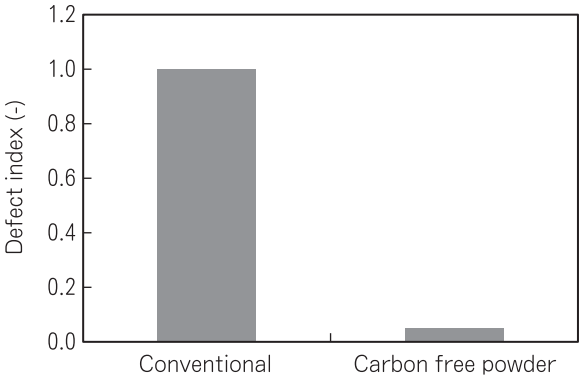

Fig. 4 Defect index of high oxygen steel.

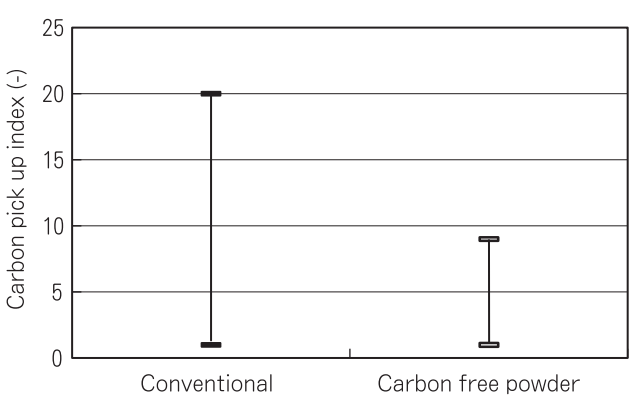

Fig. 3 Amount of carbon pick up in ULC steel.

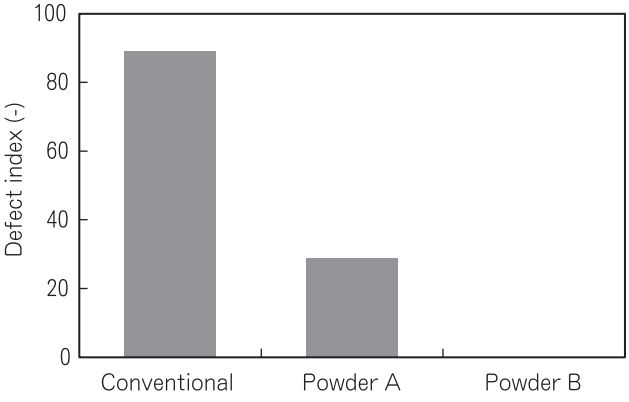

Fig. 5 Defect index of SUS409.

Fig. 5 shows the defect occurrence ratio of color variation on SUS409. Powder A containing very low carbon material reduced the defect compared with conventional mold powder which contains a normal level of carbon material. Powder B is the newly-developed carbon free mold powder. Powder B completely prevented the defect and improved the yield of the steel product.

5. Conclusion

This report introduces a carbon free mold powder for steels which have quality issues due to carbon pickup. This mold powder improves the steel quality and also improves the steel product yield by reducing steel treatments at many steel mills.