

SHINAGAWA TECHNICAL REPORT

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Development of Tundish Coating Mix with Excellent Drying and Dismantling Properties

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製品紹介／PRODUCT

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要 旨

TDコーティング材は、内張材表面に塗布された後に急昇熱されて使用される。そのため、優れた乾燥性が求められる。そこで、繊維多量添加技術を確立することで約40%の低熱伝導性を実現し、乾燥性と解体性を両立したTDコーティング材を開発した。

Abstract

After relining with a coating mix, the tundish is usually preheated quickly. In order to prevent incidents caused by quick preheating, such as explosive spalling, adequate drying properties are provided to the tundish coating mix by blending fiber. We establish a fiber blending technique for blending large amount of fiber in order to accomplish the reduction in thermal conductivity of coating mix roughly 40 %. By utilizing a fiber blending technique for the tundish coating mix, gunning and troweling coating mixes with improved drying property and dismantling property were developed.

1. 緒言

TDは取鍋と鋳型をつなぐ中間容器であり、溶鋼の保持、鋳型内への流量の安定化、介在物の浮上や分離促進の役割を担っている。TDの内張りは、鉄皮側にパーマ煉瓦、稼働面側に煉瓦あるいはキャストブルが施工され、鋳造終了後には地金やスラグを除去する必要がある、地金との剥離性を確保するために稼働面にコーティング材を塗布する。コーティング材は鋼の高品質化の観点からマグネシア質が一般的であり、吹付施工とこて塗り施工に大別される(Fig.1)。TDコーティング材には、①乾燥性、②施工性、③解体性(母材との難焼き付き性)が求められ、今回これらの特性の向上を図ったTDコーティング材JTM-M-629、SCOAT-M-71を開発したので以下に報告する。

1. Introduction

The tundish used in continuous casting operation is an intermediate vessel which transfers molten steel from teeming ladle to mold. It has the roles of storing molten steel temporarily, distributing molten steel to each mold at a stable supply rate and promoting floatation/separation of nonmetallic inclusions. As schematically illustrated in Fig. 1, the permanent brick back lining, brick or castable refractory wear layer refractory and coating mix composed of MgO are relined in sequential order in the tundish. Due to the necessity for removing the remaining molten steel and slag after continuous casting operation, a coating mix is relined on the working surface of the wear layer refractory so that the remaining molten steel can be easily removed

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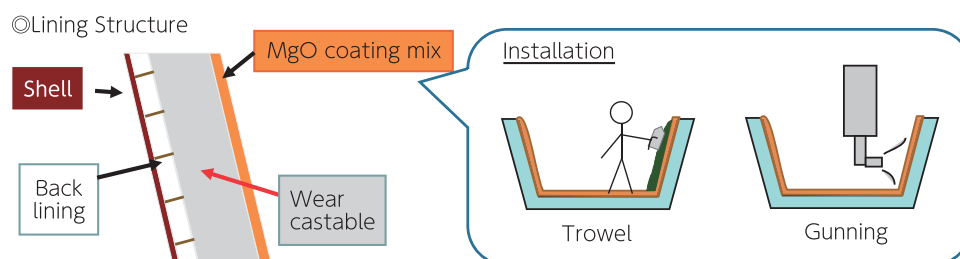


Fig. 1 Tundish refractory relining specifications and two coating mix application methods.

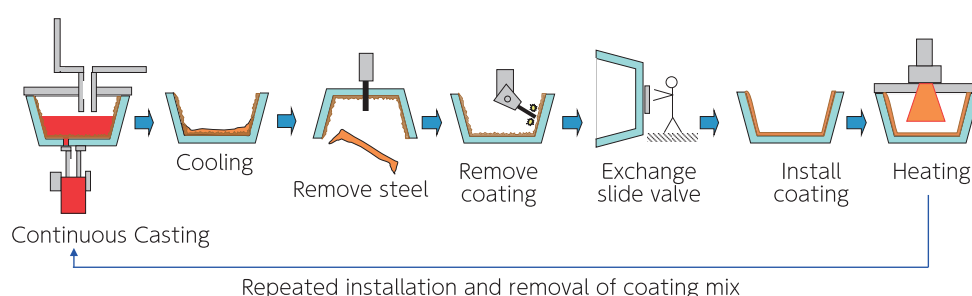


Fig. 2 Operation cycle of tundish.

2. TDコーティング材の特性

Fig.2に、TDの使用サイクルを示す。連続 casting 終了後にコーティング材を解体し、新たにコーティング材を塗布した後に急昇熱されて次の casting に備える。そのため、高い耐爆裂性が求められ、一般的に繊維が添加される。一方で、繊維を添加すると、吹付け材では材料の搬送性が低下して安定した施工体が得られない、こて塗り材では付着性が低下してずれ落ちるといった問題が発生する。そのため、繊維種や形状などの技術確立が重要であり、繊維使用技術向上により実現した新製品2種類を紹介する。

3. 吹付けコーティング材JTM-M-629の特徴

Fig.3に、1000℃での熱伝導率を示す。開発品の吹付けコーティング材JTM-M-629は、繊維の多量添加により組織を多孔質化することで、従来品と比べて約40%の低熱伝導性を実現した。それにより、母材との境界温度が低下し、実炉において焼き付き抑制効果を得た。繊維の多量添加は通気率向上に寄与し (Fig.4), 爆裂抑制にも影響を及ぼしていると考えられる。また、多量の繊維を混合しているにもかかわらず、改良された繊維混合技術により開発品の粉体搬送性は十分確保されていた。

without damaging the wear layer refractory. The coating mix, which is generally composed of MgO in order to secure clean molten steel in the tundish, is relined by gunning or troweling before every casting campaign. Required properties of the tundish coating mix are cited as: (1) good drying property for quick preheating operation without incidents such as explosive spalling, (2) adequate workability for relining operation and (3) easy dismantling property with minimized sticking to wear layer refractory. Newly developed tundish coating mixes, JTM-M-629 (gunning) and SCOAT-M-71 (troweling), with such required properties are appropriately improved, are introduced in this article.

2. Characteristic Features of Tundish Coating Mix

The operation cycle of the tundish is shown in Fig. 2. After completion of continuous casting, the coating mix is dismantled, usually along with removal of the remaining metal in the tundish. After a cycle of tundish refractory maintenance work, the coating mix is relined again. Before use in continuous casting operation, the tundish is preheated quickly. In order to prevent explosive spalling during quick preheating, fiber is generally blended to

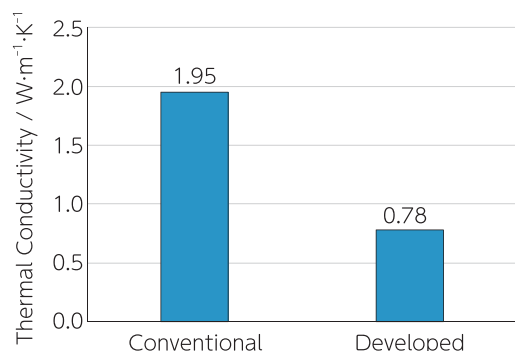


Fig. 3 Comparison of thermal conductivity of gunned coating mix body at 1000 °C.

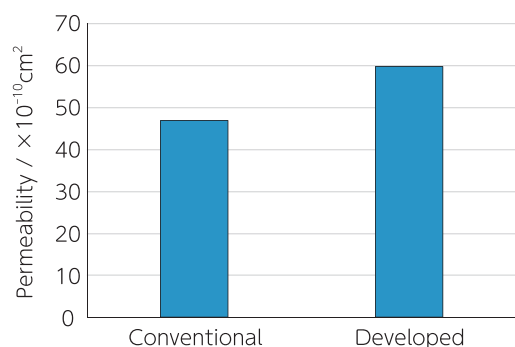


Fig. 4 Comparison of permeability of gunned coating mix bodies.

4. こて塗りコーティング材SCOAT-M-71の特徴

開発品のこて塗りコーティング材SCOAT-M-71は、吹付けコーティング材と同様の繊維多量添加技術により母材との焼き付き抑制効果を有する製品である。また、高粘性で硬化特性に優れた添加剤を組み合わせることで施工性と両立を図っている。

Fig.5に、こて塗り材接着試験の概略図および試験結果を示す。実施工を想定し、傾斜角度80°以上とした鉄製トレイにこて塗り材を全体に塗り込み、施工性と接着性を評価した。開発品は鉄製のトレイ上でもずれ落ちることなく、良好な施工性と接着性を示した。

Table 1に、吹付けコーティング材およびこて塗りコーティング材の品質表を示す。両製品ともにマグネシア質のコーティング材であり、鉄鋼ユーザー、電炉ユーザーで使用され、高評価を得ている製品である。

secure permeability of the relined coating mix body. When large amounts of fiber are blended, however, transportation efficiency of the coating mix is reduced in gunning operation, resulting in an unstable gunned coating mix body. When large amounts of fiber are blended into the troweling coating mix, the troweled coating mix tends to slip down because of insufficient adhesiveness. That is, fiber blending technique which includes selection of appropriate fiber material and/or fiber shape is quite important to suppress/minimize negative influences of fiber blending on coating mix properties. By utilizing an elaborately improved fiber blending technique, new coating mixes, JTM-M-629 (gunning) and SCOAT-M-71 (troweling), were developed. Features of these coating mixes are introduced in the following sections.

3. Features of Gunning Coating Mix, JTM-M-629

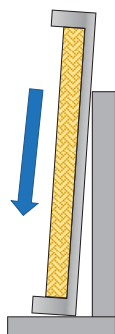
The thermal conductivity of the newly developed coating mix, JTM-M-629, at 1000 °C is shown in Fig. 3. Compared with a conventional coating mix, by blending large amounts of fiber, the gunned body structure of the newly developed coating mix becomes more porous, resulting in reduction of thermal conductivity at 1000 °C by roughly 40 %. Since, because of lower thermal conductivity, temperature at interface between wear layer refractory and coating mix is lowered, sticking of coating mix to wear layer refractory is suppressed. As shown in Fig. 4, in which permeability of the gunned coating mix body is compared between the conventional and developed product, large amounts of fiber blending contributes to improvement of permeability of the gunned coating mix body. It is inferred that improved permeability of the gunned coating mix body positively influences suppression of explosive spalling. It is noted that, despite the large amount of fiber blending, transportation efficiency of the developed coating mix during gunning operation has been adequately secured by improved fiber blending technique.

4. Features of Troweling Coating Mix, SCOAT-M-71

Similar to gunning coating mix, JTM-M-629, large amounts of fiber are blended into the newly developed troweling coating mix, SCOAT-M-71, in order to suppress sticking to the wear layer refractory. In addition, shape retainability of the relined coating mix body, i.e. workability in troweling operation has

Table 1 Typical characteristics of gunning and trowel coating mixes

		JTM-M-629	SCOAT-M-71
Chemical composition / %	MgO SiO ₂	87 5	88 5
Permanent linear change / %	1000 °C-3h 1500 °C-3h	-0.01 -3.48	-0.30 -2.97
Modulus of rupture / MPa	110 °C-24h 1000 °C-3h 1500 °C-3h	1.2 0.8 4.4	1.5 1.9 5.7
Added amount of water / %		18~22	15~18
Installation weight per unit volume / kg·m ⁻³		1,900	1,900
Notes		Gunning mix	Troweling mix



Troweling in steel tray likened to side wall for adhesiveness evaluation



Fig. 5 Test method for evaluating adhesiveness of troweling coating mix.

5. まとめ

繊維多量添加技術の確立により、TDコーティング材の具備特性である乾燥性、施工性、解体性の向上を図った吹付けコーティング材とこて塗りコーティング材を開発した。すでに、実炉にて使用され、高評価を頂いている。

been realized by using an additive agent with high viscosity and quick setting characteristics.

Fig.5 shows the test method for evaluating the adhesiveness of the troweling coating mix and appearances of conventional and developed coating mix troweled in a steel tray. The coating mix was troweled in a steel tray which was set up at 80 degrees of tilt angle so as to liken it to a tundish side wall for evaluating workability and adhesiveness. As is observable by the appearance of the troweled coating mix bodies shown in Fig.5, the newly developed coating mix exhibits almost no slip-down in its relined body, namely, better shape retainability and adhesiveness.

Typical characteristics of the newly developed gunning and troweling coating mixes are summarized in Table 1. Both coating mixes are composed of magnesia and have been used in both integrated steel plants and electric furnace steel shops with good reputation.

5. Conclusion

By establishing a fiber blending technique for the tundish coating mix, gunning and troweling coating mixes with improved drying, workability and dismantling properties were developed. These coating mixes have been used in practical operation with good reputation for their performance.