

New Sliding Gate Mechanism for EAF Tapping System

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Abstract

We have developed new sliding gate valve (SGV) mechanisms for Electric Arc Furnaces (EAF) tapping systems, to reduce slag contamination into the ladle during tapping.

New SGV mechanisms were used in a spout tapping EAF and a bottom tapping EAF, both of which are working well.

1. Introduction

SGV mechanisms, which are used for controlling the molten steel flow, are important equipment in the steel making processes because their performance greatly affects the steel quality and productivity. Flow control is achieved by throttling a plate brick with a hydraulic or electric cylinder, where pressure is loaded on the face of the plate brick. There are several EAF plants where SGV mechanisms are used in their tapping systems to reduce the slag contamination into the ladle¹⁾. There is a strong demand for improving the system and refractory performance. We have developed new SGV mechanisms to answer those strong demands.²⁾

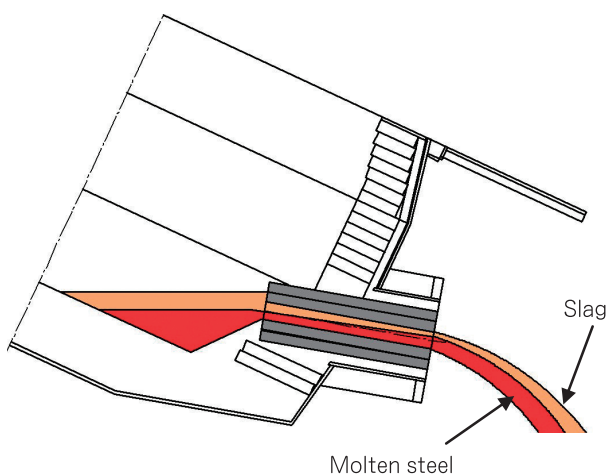


Fig. 1 Schematic image of slag contamination.

2. Reduction of Slag Contamination

In order to reduce slag contamination into the ladle, the tapping flow must be stopped immediately when slag is recognized in the flow. If there is no system to stop the tapping quickly, slag contamination is not avoidable as shown in Fig. 1. On the other hand, as shown in Fig. 2, slag contamination can be minimized with an SGV mechanism.

Benefits of reduced slag contamination by using SGV mechanisms are as follows¹⁾;

- Strict control of the molten steel components
- Shortened refining time for the secondary refining process
- Decrease in electric power consumption

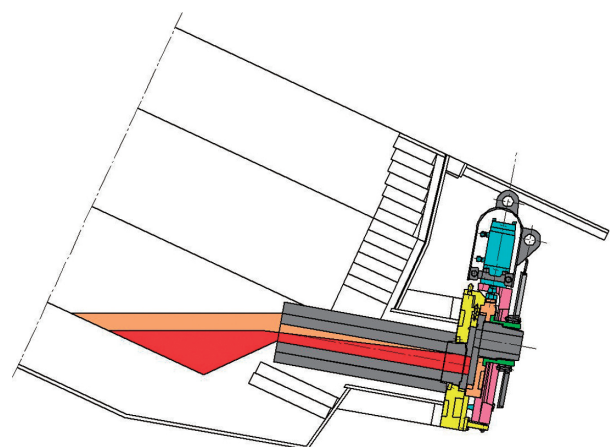


Fig. 2 Schematic image of slag cutting by the SGV mechanism.

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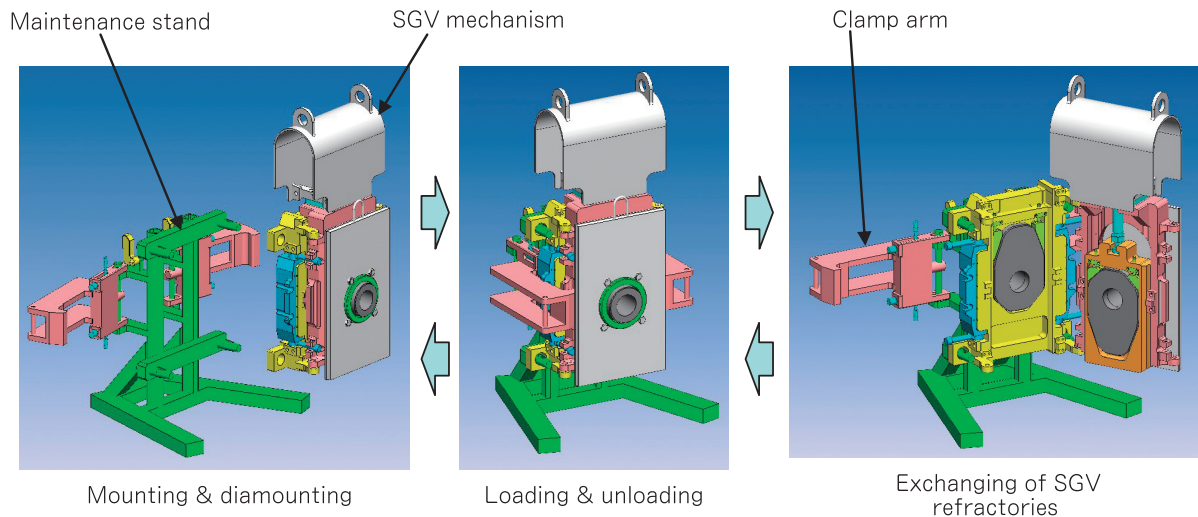


Fig. 3 Procedure for SGV refractory exchange work.

3. Features of New SGV Mechanisms

3.1 Required performance

SGV mechanisms require the following performance;

- Ability to stop the tapping flow quickly (Quick slag cutting).
- Easy and quick exchanging of mechanism.
- Long refractory life.

It is especially important to design the mechanism with easy and quick exchange work because the durability of SGV refractories is shorter than the EAF lining life. That means SGV mechanisms need to be exchanged frequently for replacing the plate brick.

3.2 Refractory exchange work

The exclusive maintenance stand is used for exchanging the refractory. The operation procedure in Fig. 3 is as follows. The working procedure is as follows;

- ① The SGV mechanism is mounted on the maintenance stand and fixed with cotters.
- ② Clamp arms are set on the mechanism, then, the face pressure is unloading by a hydraulic jack mounted on clamp arm.
- ③ The sliding case is opened and the refractory is replaced.
- ④ The sliding case is closed and face pressure is loaded by clamp arm.

Thus, the refractory exchanging work is easy and quick.

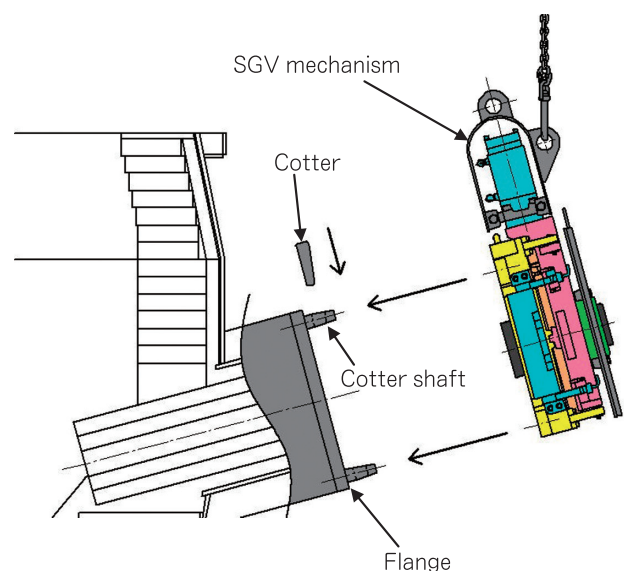


Fig. 4 Installation of the SGV mechanism to the spout tapping EAF.

4. Application to the Spout Tapping EAF

4.1 Installation

Fig. 4 shows how to mount the SGV mechanism to the spout tapping EAF. The SGV mechanism is mounted to the flange installed at the end of the spout by using a crane, and then, the mechanism is fixed by cotters. Positioning of the mechanism is performed easily by using the cotter shafts as guides. Installation of the mechanism can be done quickly.

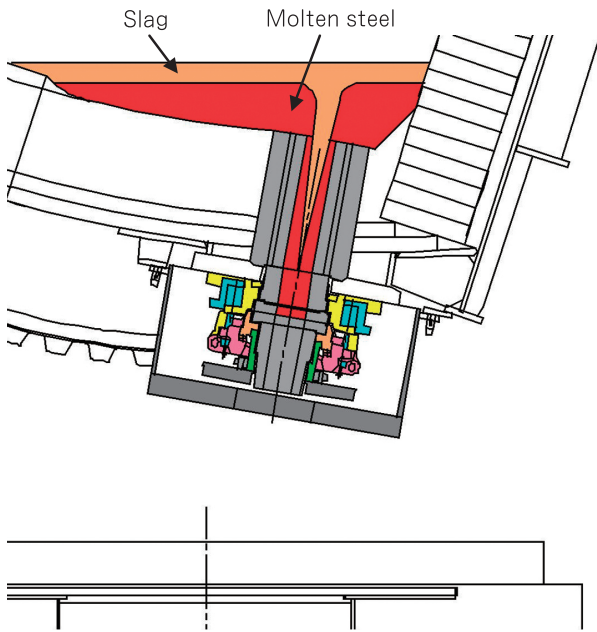


Fig. 5 Schematic image of vortex and slag cutting by the SGV mechanism in the bottom tapping system.

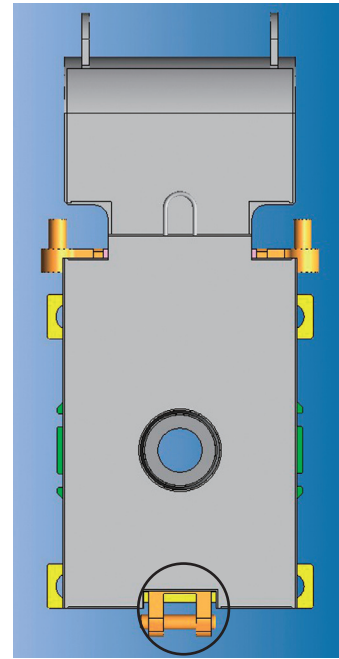


Fig. 6 Supporting bracket.

4. 2 Actual usage

The installation work can be done quickly. Mechanism removal and exchange work of the refractory can be done quickly as well.

5. Application to the Bottom Tapping EAF

5. 1 Installation

Even with the bottom tapping EAF, slag contamination in the tapping flow is observed when a vortex carries slag into the tapping hole as shown in Fig. 5. Therefore, having an SGV mechanism is also effective in order to ensure slag cutting.

In order to install the mechanism to the bottom of the EAF, we made a supporting bracket which is mounted on the mechanism as shown in Fig. 6. The SGV mechanism is mounted to the flange of the bottom with the supporting bracket, and then, it is fixed by cotter pins.

5. 2 Heat protection

In the case of bottom tapping, some heat protection countermeasures are required because the mechanism is located at a close distance from the mouth of the ladle.

We applied the following countermeasures:

- ①Application of heat resistant packing to the hydraulic cylinder.

- ②Modification of the mechanism cooling system to obtain a stronger effect.

- ③Application of a heat protection box type cover.

By taking these actions, the temperature measured at the bottom face of the mechanism was kept under 100°C all the time even during the tapping.

5. 3 Actual usage

The installation and exchange work were done quickly. There was no adverse effect which can be caused by heat loads thanks to the heat protection countermeasures.

6. Refractory

6. 1 Plate shape

In general, a plate bricks needs to be replaced when the plate bricks are damaged. Increased plate brick durability is strongly demanded. Optimization such as downsizing the plate brick is necessary to reduce refractory costs.

In Fig. 7, our plate shape is compared to that of a conventional one. The volume of our plate is approximately 30% less than that of the conventional one. Furthermore, a ring refractory is inserted around the bore in order to increase durability.

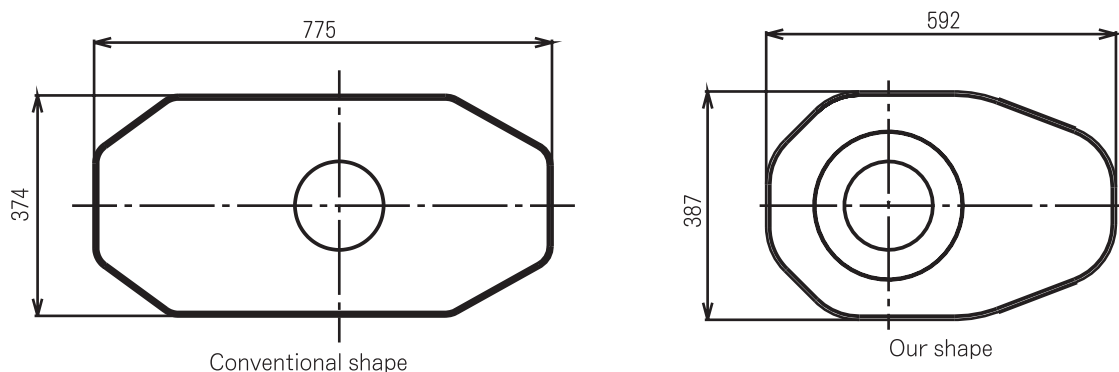


Fig. 7 Comparison of plate shapes.

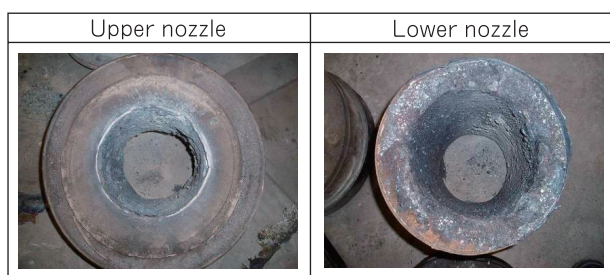


Fig. 8 Appearances of used upper and lower nozzles.

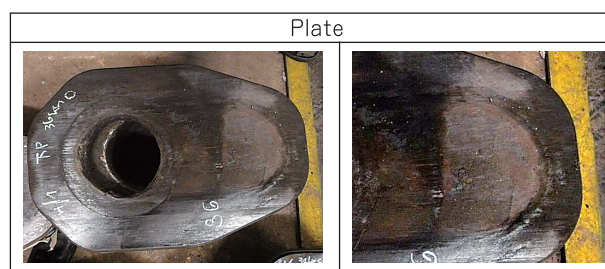


Fig. 9 Appearance of used plate brick.

6. 2 Actual usage

In Fig. 8, photographs of an upper nozzle and lower nozzle used for 36 heats in the spout tapping SGV mechanism are shown. Both nozzles showed quite good condition with no cracking and no excessive erosion recognized.

Fig. 9 shows the appearance of a plate brick after 36 heats which was used in the spout tapping as well. The plate brick refractory material was selected to be specialized for high oxygen steel tapping. The after usage condition was good with only slight erosion of the bore and no sign of peeling on the surface.

Durability of the refractory is about 35 heats for the spout tapping system and 25 heats for the bottom tapping system.

7. Summary

We have developed new sliding gate valve (SGV) mechanisms for tapping systems of Electric Arc Furnaces (EAF), with the purpose of reducing slag contamination into the ladle during tapping.

New SGV mechanisms were put into service of the spout tapping EAF and the bottom tapping EAF, both of which are working well.

References

- 1) D. Anderson, D. Taylor and I.V. Cameron : UNITECR 1385-1394 (1997)
- 2) A. Takata, K. Yamamoto, T. Saeki, M. Kajimura : Technical Committee on Refractories for Steel Refining in TARJ, 101, 31-36 (2011)