HOT METAL PRETREATMENT FOR OXY-CONVERTER MELTING

Chschetinina I., Khaidukov V.

Lipetsk State Technical University, Moskovskaya 30, 398600 Lipetsk, Russia

Abstract
World experience of metallurgical development is characterized the intensive application of the various methods of hot metal pretreatment for oxy-converter melting. Known methods of hot metal pretreatment are two-three-stage technology, the reduction the content of silicon, phosphorus and sulfur is carried out in two or three stages of the refining of hot metal. The purpose of the present research is working out the technology of hot metal pretreatment for oxy-converter melting. The task was finding a complex reagent, which could reduce the content of silicon, phosphorus and sulfur in hot metal simultaneously. In connection with that was conducted series of laboratory experiments on the refining hot metal by complex flux of different composition. New technology was treated on the chute of blast furnace №2 at Novolipetsk Iron and Steel Corporation. The industrial tests confirmed the good refining characteristics of complex flux. Using a new technology made it possible to get not only high quality steel, but to increase the converter productivity and also to reduce the cost of product.

Nowadays it’s of great importance for the metallurgy to increase the quality of steal not raising its cost. In order to achieve this purpose the research aims to reduce the content of undesirable elements in all the production phases, starting from the cast iron melting, by improving existing technologies and working out the new ones. Studying the existing methods of hot metal pretreatment which are employing different reagents and their mixtures allows to make the conclusion that all this methods are assuming the two-stage technology, e.g. the reduction of silicon, phosphorus and sulfur content in hot metal is achieved by gradual refining. Taking into account the development of the metallurgy in Russia it seems to be of current interest to work out a new resource saving technology, to take away silicon, phosphorus and sulfur, and to improve technical and economical performance of blast furnaces and oxy-converter department operation. The task of the research was to create a complex reagent, which should allow not only oxidizing silicon in hot metal, but desulfurizing and dephosphorizing it simultaneously. Also the aim was to analyze and optimize technical methods of producing the hot metal having low content of silicon, phosphorus and sulfur, and to work out technological variant of using pretreated hot metal in oxy-converter process. In connection with this, the series of laboratory experiments have been carried out to refine hot metal by different refining materials. As a result of this, the new technology of complex treatment by carbon containing complex flux was examined on the chute of the blast furnace №2 at Novolipetsk Iron and Steel Corporation. One of the technology schemes which was tested is depicted in the Fig.1. Complex flux (size of the parts 6,0-50,0 mm) is delivered to the hot metal flow from the bunker, which is driven to the point above the chute by means of its own weight after the distributing pit. The initial composition of hot metal and experimental flux is represented in the Table 1.
Fig. 1 Technologic variant of end-to-end hot metal refining
1 – hot metal from the blast furnace;
2 – chute;
3 – distributing pit
4 – reagent delivery
5 – shank

Table 1

Chemical composition of the initial hot metal and complex flux used in the experiment, %

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>S</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot metal</td>
<td>4.32</td>
<td>0.56</td>
<td>0.58</td>
<td>0.012</td>
<td>0.12</td>
</tr>
<tr>
<td>Complex flux</td>
<td>SiO₂</td>
<td>CaO</td>
<td>MgO</td>
<td>Al₂O₃</td>
<td>Mn</td>
</tr>
<tr>
<td></td>
<td>6.00</td>
<td>30.96</td>
<td>5.69</td>
<td>1.01</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Hot metal and slag, appearing as a result of hot metal treatment by complex flux, goes through the chute into the shank. Then in the mixing department slag is taken out by mechanical scraper. The industrial tests confirmed the good refining characteristics of carbonic complex flux. When 30 kg of complex flux is used per 1 tonne of metal the content of silicon in hot metal decreases from 0.56 to 0.38%. The reduction of silicon content in hot metal is simultaneous with the recession of phosphorus (from 0.12 to 0.08%) and sulphur (from 0.019 to 0.012%). It can be easily explained by optimal physico-chemical characteristics of active ferrite calcium slag.

The rate of dephosphorization is 33.3 %, and the rate of desulphurization is 36.8 %.

The results of processing hot cast iron with carbonic complex flux on the chute of the blast furnace are represented in the table №2.
<table>
<thead>
<tr>
<th>Phase</th>
<th>[Si], %</th>
<th>[Mn], %</th>
<th>[P], %</th>
<th>[S], %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before the distributing pit</td>
<td>0.56</td>
<td>0.58</td>
<td>0.12</td>
<td>0.019</td>
</tr>
<tr>
<td>In the end of the chute</td>
<td>0.48</td>
<td>0.54</td>
<td>0.08</td>
<td>0.013</td>
</tr>
<tr>
<td>In the shank</td>
<td>0.38</td>
<td>0.50</td>
<td>0.08</td>
<td>0.012</td>
</tr>
</tbody>
</table>

The correlation between the probe points (fig.2), the linear dimensions of the chute and the change of silicon, phosphorus and sulphur content shows that the reaction of desiliconization takes place through whole length of the chute and continues in the shank. As for desulphurization and dephosphorization it doesn’t go in the shank.

![Fig. 2. The dynamics of Si, P and S content: A, B and C – initial Si, P and S content; 1, 2, 3 - samples' probe points.](image)

The temperature of hot metal decreased lightly after complex processing on the chute. Before the processing it was $T_{\text{hot metal}} = 1440 \, ^\circ\text{C}$. In the mixing department (60 minutes after the processing) it was $T_{\text{hot metal}} = 1330 \, ^\circ\text{C}$.

The experimental melting with pretreated cast iron was carried out in Oxy-Converter Department of Novolipetsk Iron and Steel Corporation. The produced steel had the following characteristics:

$50 \times 10^{-4} \% \, P$ and $10 \times 10^{-4} \% \, S$.

The usage of pretreated cast iron allowed to decrease oxygen consumption by 6.3 m³ per tonne of steel, and by 12.7 kg of lime consumption per tonne of steel. The efficient way of slag development, the decrease of slag amount, steel losses and dusting, absence of splashes and sparkles helped to increase productivity of steel by 1.5%. The usage of pretreated hot metal makes technological process easier, cause oxygen converter is exploited only for decarbonation.

The new technology of cast iron pretreatment going together with the new technology of steel-making production allowed to get high quality steel, to improve technical and economical performance of oxy-converter department operation, and to reduce the cost of product.