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Study on the Recycling of Hot Decarburization Slag in Dephosphorization Converter

Yan-hui SUN [1], Xuefeng BAI [1], Chang-liang ZHAO [2], Lei LUO[2], Zhi-hong TIAN[2], Guo-Zhong PENG[2]

1 Collaborative Innovation Center of Steel Technology, University of Science and Technology Beijing, Beijing 100083, China

2 ShouGangJingTang Iron & Steel United Co., Ltd, Tangshan 063200, Hebei, China, China

baixf90@163.com

Introduction

The recycling technology of the decarburization(De-C) converter slag which can be reused in the dephosphorization(De-P) converter plays a significant role in producing clean steel with high efficiency and low cost [1, 2]. In Sumitomo metal industry and Baosteel, the pre-treated De-C slag is charged into the De-P converter. Furthermore, operation with remaining slag is applied in Kimitsu Works of Nippon Steel and Fukuyama Works of NKK[3, 4]. Several researchers have explained the mineralogical and melting characteristics of slag in De-C converter[5,6]. However, the direct recycling of hot decarburization slag in De-P converter is scarcely reported in public literature.

In the current study, industrial research on the recycling of hot De-C slag in De-P converter were performed based on desilication and dephosphorization pretreatment process in De-P converter and less slag smelting technology in De-C converter in Shougang Jingtang. The dephosphorization effect and the appropriate amount of hot recycling slag were also discussed with the help of thermodynamic calculation.

Fig. 1 Schematic diagram of a new slag pot with special slag spout.

Industrial Test

Industrial experiments were carried out using 300t De-P converter at Shougang Jingtang Iron & Steel Co. Ltd. in China. The main process of ShouGangJingTang contains 4×KR, 2×De-P converters, 3×De-C converters, 1×LF, 2×RH, 2×CAS, 4×continuous casters with tow strand each. The KR is used to remove sulphur with mechanical stirring.

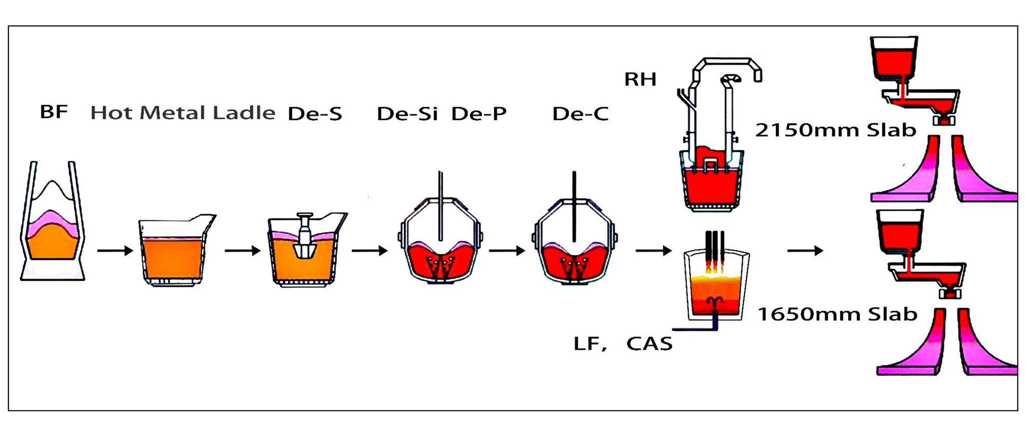

Fig. 2 The main process for production.

All hot metal must be desulfurized through KR stirring process to ensure the content of sulfur less than 0.002 wt% before dephosphorizaiton. In De-P converter, hot metals were charged after around 10 wt% scrap addition. The refining time and the basicity (wt% CaO)/(wt% SiO_2) of the end refining slag were about 45 minutes and 2.0, respectively. The slag forming materials were lime, light-burned dolomite and cold-bonded pellet. In addition, a new slag pot with a special division mouth was designing for the charge of hot slag in De-P converter. The chemical composition of the hot metal and slag taken in the trials were determined by Optical Emission Spectrometer and X Ray Fluorescence (XRF) method, respectively.

Results and Discussion

•Slag-Steel reacting status in De-P converter

The final phosphorus content of the experiment heats was 0.0364%, which was about 0.006% lower than that in the normal heats. Moreover, the average tapping temperature was 6℃ higher than the normal smelting heats.

Table. 1 The main parameters of Hot Slag Test .

		C/%	Si/%	Mn/%	P/%	S/%	T/°C	η_P/%
Test Heats	Hot Metal	4.29	0.158	0.201	0.1085	0.0006	1345	66.37
	Semi-Steel	3.24	0.026	0.053	0.0364	0.005	1333	
Normal Heats	Hot Metal	4.25	0.158	0.197	0.1070	0.0007	1343	60.43
	Semi-Steel	3.29	0.022	0.038	0.0421	0.005	1327	

The slag in different processes had the same content of CaO and basicity. The heats for hot slag test had 3.39 wt% lower TFe content than normal heats, which demonstrated that the loss of iron was reduced obviously during recycling test.

Table. 2 Slag Composition in De-P converter.

		CaO/ wt%	SiO_2/ wt%	MgO/ wt%	P_2O_5/ wt%	MnO/ wt%	FeO/ wt%	TFe/ wt%	Al_2O_3 /wt%	R
Test Heats	Max.	42.87	20.90	7.26	8.85	12.43	34.92	27.17	6.40	2.45
	Min.	22.80	13.34	4.96	2.47	5.30	7.93	6.17	1.74	1.15
	Ave.	31.81	16.18	5.91	5.87	8.69	12.17	9.36	2.92	2.00
Normal Heats	Ave.	31.64	15.63	5.38	6.70	9.95	16.58	12.75	2.49	2.04

•Thermodynamic for dephosphorization capacity of the slag

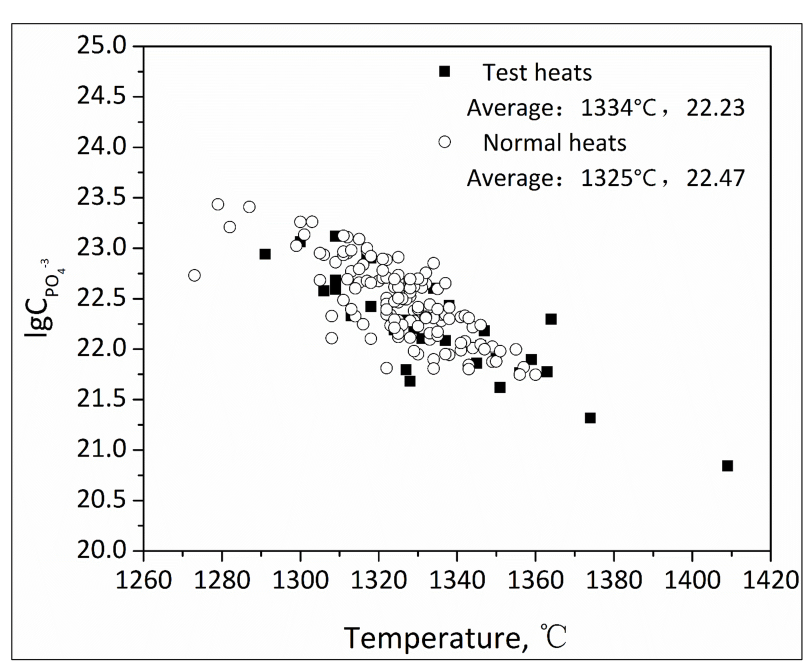

Fig.3 Change of phosphorus capacity during blowing processs.

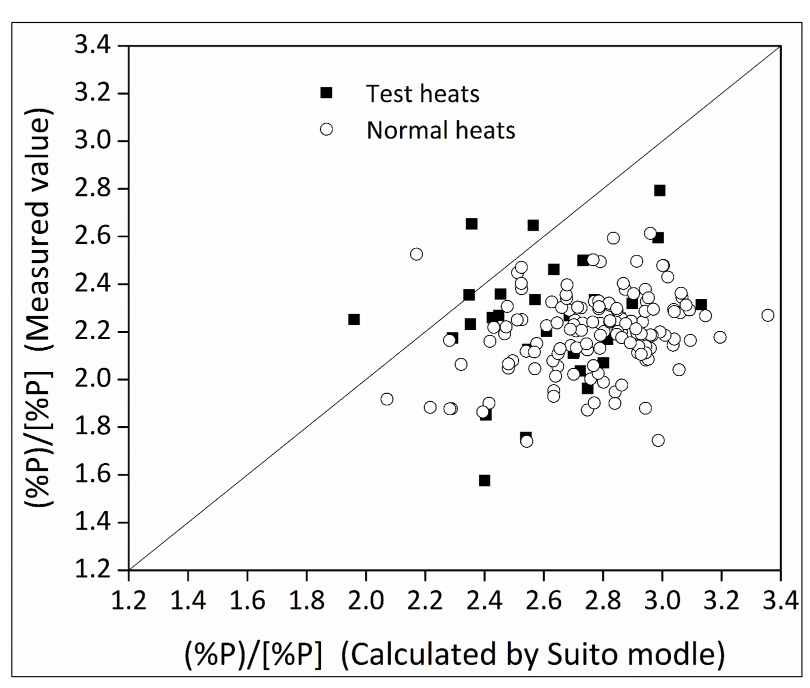

Fig. 4 Change of phosphorus partition ratio between slag and steel during blowing process.

The measured value of (%P)/[%P] is closer to the calculated value for test heats compared with normal heats. That's means the hot slag can promote the reaction equilibrium between slag and steel.

•Hot slag and auxiliary material consumption

he theoretical amount of hot slag charged was calculated mainly based on Si content of molten iron and the end slag basicity of 2.0. Furthermore, too much hot slag always led to metal splash. In addition, the slag output in De-C converter was only 12 t per heat when less slag smelting technology was applied in the decarbonization converter. The appropriate amount of hot slag charged into dephosphorization converter was 15~25 t per heat under comprehensive consideration.

During normal smelting process, 3.54 t per heat of lime and 1.58 t per heat of light-burned dolomite were added in De-P converter. While the amount of lime and light burned dolomite reduced by 2.75 t and 0.03 t for each heat when the returned slag was used in De-P converter. More than half of the test heats achieved zero consumption of lime and light burned dolomite.

Conclusion

(1) Comparing the normal smelting process, the phosphorus content reduced by 0.006 wt%, semi-steel temperature increased by about 6 ° C and TFe content in end slag decreased by 3.39 wt% when hot slag was charged into De-P converter.

(2) Process of the De-C hot slag recycling was closer to the equilibrium values of slag and steel reaction than normal smelting process in De-P converter according to the thermodynamic calculation.

(3) The appropriate amount of hot slag charged into De-P converter was 15~25 t/heat, which depends on the Si content of pig iron, end slag basicity and decarburization slag output.

(4) The amount of lime and light burned dolomite reduced by 2.75 t and 0.03t for each heat after using returned slag in De-P converter. More than half of the test heats achieved zero consumption of lime and light burned dolomite.

Acknowledgements

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