The Effect of Antioxidants on Physical Properities of MgO-C Bricks

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Abstract

In this study, the effect of antioxidants on MgO-C bricks was examined. The physical properities of MgO-C bricks were analyzed after drying for 24hrs at 200ºC and 1000ºC. The results revealed that a sharper stress-strain curve is obtained by adding antioxidants into MgO-C bricks. According to relevant papers, it shows positive effects on anti-stripping properties and tenacity when the stress-strain curve is smoother.

1. Introduction.

The characteristics of magnesia-carbon brick include excellent 1. The resistance of corrosion and 2. The resistance of thermal shock hence they are widely used to AOD Oxygen Furnace and Ladle (Slag Zone) in steel plants. Nevertheless, magnesia-carbon Brick is belong to one of Resin-bond bricks so the resistant oxidation is low when they are operated in middle temperature and they are also eroded by the mechanical work of steel melting. In addition, the performance of magnesia-carbon Bricks mostly depends on their carbon structure of combined system. In addition, the characteristics of heating and operating processes and structure changing in combined system and the effects of combined structure for the thermal mechanical functions of magnesia carbon brick directly influence the performance of magnesia carbon bricks. Moreover, the excellent physical performance of carbon bricks depends on carbide element, but the weakness of carbide is easily oxidized in high temperature environment. Therefore, in order to increase the performance of carbide materials in high temperature environment, the main target is avoided or reducing the oxidation of carbide. This study is compare the physical changing between added the metallic anti-oxidant and the changing combined system of resin bond.

2. Experimental procedure

2.1 Raw materials use.

The raw materials a. 98% Fused magnesite, b. the fixed carbide of 95% Flake graphite and c. Additives: metallic silicon, metallic aluminum and binder. The combined system proportion of magnesia carbon brick' samples as following **Table 1**:

Table 1 Formulations of MgO-C binding system

Item (%)	1#	2#	3#
Phenolic-Formaldehype Resin	2	2	2
Additives P	0	0	1
Anti-oxidant	4~5	3~5	0

2.2 Performance test

(1) The test of anti-oxidant

The anti-oxidant is put a sample of 50 X 50 X 50 mm cube into a high temperature furnace and temperature raising rate was 5℃/min until 1500℃ for 180 mins. We took out the cube sample after it's cooled and scale its weight changing and the sample of section to measure the thickness of oxide.

(2) Thermal bending test

Thermal bending test depends on three-point-bending method to test the sample; the distance of each point is 100mm and a cuboid sample of 25 X 25 X 120 mm was placed in a graphite container with carbon and coked. The temperature raising rate was 5℃/min at 1400℃ for 30mins to test its module rupture.

The sample malleability of magnesia-carbon brick depends on the module rupture which can be measured by bending test. This experiment compared the difference between 1# and 3#. The tested sample was placed in a graphite container with carbon and coked at 1000℃. The control group is RHI-PSL12 and RHI-AC83.

3. Results and Discussion

3.1 The Analysis of Chemical Composition

The alumina and silicon oxide's chemical composition of RHI-PSL12 and RHI-AC83 bricks are both lower then 1%. Comparably, SMGC-12(1#) and SMGC-60(2#) have added anti-oxidant hence the alumina and silicon oxide's chemical composition of them are 6% and 3% that provide the changing of chemical composition come from the added metals, not from the impurities of raw materials (**Table 2**). The purpose of added metallic power makes the oxidization rate of oxides higher than the oxidization rate of carbide in magnesia carbon brick to avoid the oxidization of carbide (**Fig. 1**). Therefore, while the temperature at 600℃, metallic aluminum would react with graphite become Al_4C_3 and increase the strength.[3)] Nevertheless, Al_4C_3 also easily react with mist; $Al_4C_3 + 12H_2O \rightarrow 3CH_4 + 4Al(OH)_3$ and cause the expansion of volume then break the inside structure of materials. As a result, the added quantity of ant-oxide has to be controlled in a certain range, generally.

Table 2

Sample Number		SMGC-12 (1#)	SMGC-60 (2#)	SMGC-60 (3#)
Chemical composition (%)	MgO (%)	≧75		
	F.C (%)	≧10		
Phenolic-Formaldehype Resin		2	2	2
Additives P		0	0	1
Anti-oxidant		4~5	3~5	0

Sample Number	SMGC-12 (1#)	SMGC-60 (2#)	SMGC-60 (3#)
Apparent Porosity (%)	1.75	3.31	2.62
Bulk Density (g/cm³)	3.03	2.99	3.04
Permanent of Linear Change on Reheating (%)	0.32	0.20	1.38
Cold Crushing Strength (MPa)	52.3	44.2	35.9
After heating by coke			
dioxides loss 1000℃ (%)	2.43	9.00	5.00
dioxides loss 1500℃ (%)	5.21	4.15	11.0
high temperature bending strength ; Hot MOR (MPa)	17.6	14.2	10.8

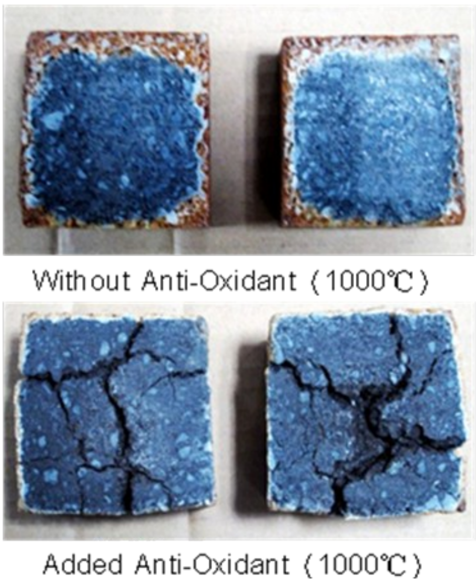


Fig. 1

3.2 The analysis of physical properties

The experiment of all of magnesia carbon bricks under room temperature condition observed the cool crushing strength of 3# is obliviously lower than the serial of SMGC bricks and the porosity is also higher than others (**Fig. 2**). As a result, it also demonstrated the cool crushing strength of magnesia carbon bricks under room temperature doesn't highly relate with its operating performance. The experiment result only proves the strength structure of bricks can bear its moving and installed processes to influence its high temperature performance.

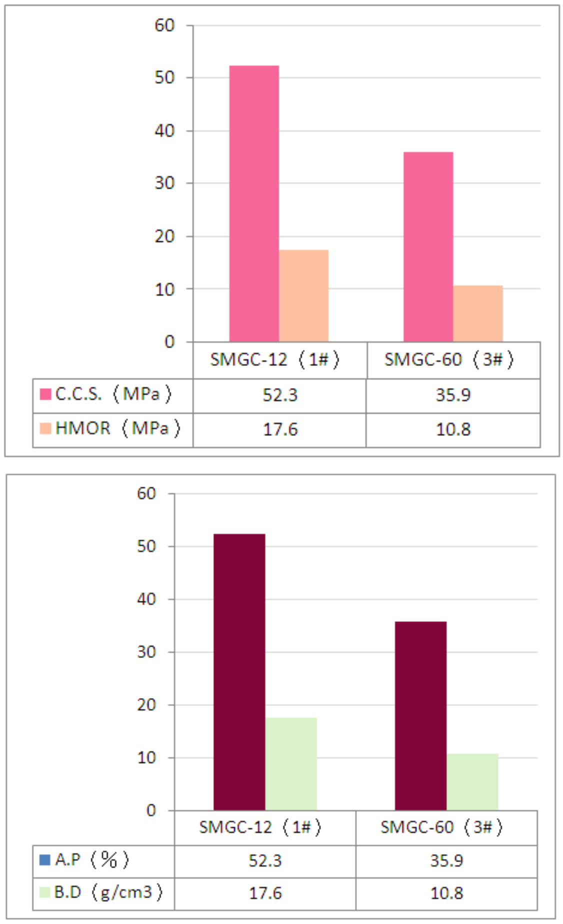
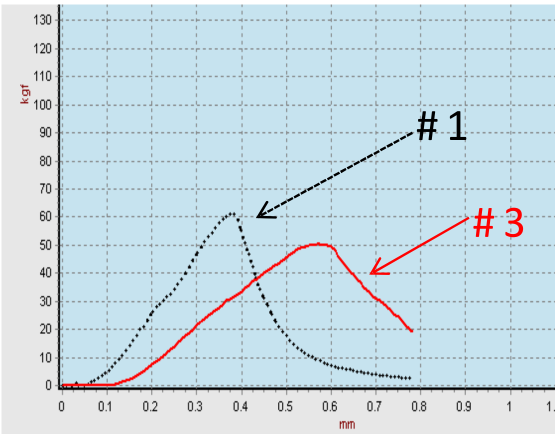


Fig. 2

3.3 The characteristic of Stress and Strain

The strength variation processes of magnesia carbon brick is not only relate with the effect of thermal stress, but it is also influenced by the changing of combined system and structure. Hence, the compared experiment test the samples of SMGC-12(1#) and SMGC-60(3#) that were placed in a graphite container with carbon and coked under 1000℃. The drawing is the Stress and Strain curve by the experiment equipment (**Fig. 3**). The curve showed the strength and brittle characteristics of magnesia carbon brick with resin and metal combined are high than others; it's also easily broken and spalled by thermal shock and its strength decreasing also quickly than others. Vice versa, when the crack of magnesia carbon brick with resin and Carbores P combined approach of threshold limit value, the under stress crack lowly extend which are showed on the curve drawing of stress and strain.



stress-strain diagram

Fig. 3

4. Conclusion

According to the results of analysis, the anti-oxidant ability of magnesia carbon brick doesn't depend on its metallic anti-oxidant. The results of experiment showed the anti-spalling ability of magnesia carbon brick with metallic anti-oxidant is less than others. Nevertheless, the anti-spalling ability of magnesia carbon brick with Carbores P is higher.

References

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