REFRACTORIES FOR THE CONSUMER

RESISTANCE OF BLAST FURNACE REFRACTORIES TO THE ACTION OF AGGRESSIVE REACTANTS UNDER CONDITIONS OF AN OXIDIZING GASEOUS ATMOSPHERE

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The products of the chemical reactions occurring in a blast furnace in melting of iron have a significant influence on the life of its refractory lining. The most active of them under conditions of high temperatures and a reducing gaseous atmosphere are alkalis and slag [1, 2]. The established rules of influence of these destroying factors on the life of linings in service may be used as the basic key factors in controlling the processes of their wear for the purpose of increasing interrepair periods of blast furnace operation.

Many works on investigation of the wear of refractories in a blast furnace stack indicate the ambiguity of opinions in determination of the most important destroying factors [3-7]. This may be explained by the complexity of the physicochemical processes in a blast furnace and the difference in them in the height and diameter of the stack.

For example, the alkali content in the burden materials in the peripheral areas of the lower portion of the stack reaches 10-15%, and in the center area at the same level of the furnace only 1-2%. The alkalis which are introduced by the burden before and after reduction of it interact not only with the burden materials but also with the refractory of the lining. As the result of these interactions low-melting alkali-containing eutectics or compounds such as leucite (K2O·Al2O3·4SiO2), kaliosilite (K2O·Al2O3·2SiO2), sanidine (K2O·Al2O3·6SiO2), β-alumina (K2O·6Al2O3), and others, which loosen the refractory and cause scaling off of it, are formed.

This article presents the results of tests on revealing the action of iron oxides, alkalis, blast furnace slag, and blast furnace gas on specimens of industrial chamotte-kaolin blast furnace refractories containing 41 and 37% Al2O3 and having an open porosity $P_{open}$ from 5 to 17%. For comparison specimens of silicon carbide refractories with binders of silicon nitride and oxynitride were tested. In the investigation static (crucible) and dynamic test methods were used.

The specimens of the refractories were cut from production blast furnace bricks of the corresponding types to GOST 1598-75. In the static method a hole, which was filled with powder of the reactant, was drilled in the center of the specimen, after which the specimens were heated in air at the selected temperatures for 10 h. Then the specimens were cut in half, the depth of penetration or attack was measured, and the content of the reactant in the penetrated portions of the specimen was determined. In the investigation static (crucible) and dynamic test methods were used.

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Chemically pure K2CO3, scale from under a rolling mill with a ratio of FeO:Fe2O3 = 1:1, and final blast furnace slag with a basicity of CaO/SiO2 = 1.2 with 5.5% Al2O3 and 3% MgO were used as the reactants. To prepare an initial (or intermediate) type slag 12.5% FeO and 6% K2O were added to the final slag. The blast furnace dust had a composition of (wt.%) 13.34 SiO2, 1.76 Al2O3, 0.62 TiO2, 55.69 Fe2O3, 6.98 CaO, 1.71 MgO, 0.84 K2O, 0.28 Na2O, 0.49 tot. SO3, and 17.57 Al2O3.

Since cutting of a specimen for determination of the physicoceramic properties of the refractories in the zone of their interaction with the reactants under the conditions of the experiment was not possible, the changes in these properties were determined on special specimens prepared in the Experimental Plant of the Ukrainian State Scientific-Research Institute for Refractories by addition of alkalis and iron oxides directly to the charge of parts of the corresponding types in a quantity of 3 and 5%.

The external appearance of specimens of production blast furnace refractories after testing by the static method for the action of K2CO3, a mixture of K2CO3 and Fe2O3, blast furnace dust, and scale is shown in Figs. 1 and 2.
The test results showed that $\text{K}_2\text{CO}_3$, decomposing, is partially volatilized from the hole, partially forms around it a white loose deposit, and penetrates into its wall to a depth of 5-15 mm. The zone of penetration has twisting but clear boundaries (Fig. 1). With an increase in temperature from 1100 to 1200°C the $\text{K}_2\text{O}$ in the zone of penetration (Table 1) increases from 3.8 to 6.3 wt.% but then at 1300°C decreases to 4.2 wt.% as the result of more intense volatilization. With distance from the walls of the hole toward the least changed portion of the refractory the quantity of alkalis decreases to 1.15-0.6%. Clearly expressed corrosion of the walls of the hole did not appear under the conditions of the experiment in the 1100-1300°C range but after testing at 1300°C adhesion of the alkali melted on the surface to the refractory is noted.

In heating of the specimens with additions of alkali to the charge in preparation this highly volatile component diffused to the surface with formation of zones enriched with it. In heating in the 1200-1300°C range accumulation of alkali in the outer upper layer of the specimen was from 2 to 3.1% and led to loosening of it. Sintering and then fusion of the crust with formation of coarse cellular pores occurred at a higher temperature (1450°C) with a higher (5.7%) $\text{K}_2\text{O}$ content. At an even higher temperature volatilization of $\text{K}_2\text{O}$ became stronger and its residual content in the fused crust dropped to 3.3%. In the center portion of the specimen the $\text{K}_2\text{O}$ content was 2.9 wt.% at 1300°C and 2.1 wt. % at 1550°C.