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Oxidation Mechanisms in MgO-C Refractories

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Abstract

An investigation on the oxidation mechanism of the graphite in the MgO-C refractory materials is helpful to improving both the quality of these materials and to preventing and/or lowering of the adverse effects of the high - temperature oxidation. In this research, the oxidation behavior of the MgO-C refractories containing 5 ~ 20 wt% graphite was studied via weight-loss method. Atmospheric air was used for oxidation at temperatures ranging from 900℃ to 1300°C and the experimental data were compared with those obtained from the dimensionless kinetic equations of the shrinking core model, in order to determine the oxidation mechanisms of the refractories. The best fit was achieved with the porous layer diffusion control regime. Oxidation mechanism tends, however, to slightly deviate from pure pore diffusion control to pore diffusion - external gas transfer regime in the samples having more graphite contents (e.g. 20%).

Keywords: MgO, Carbon, Diffusion, Refractories, Oxidation

1 Introduction

MgO-C refractories have recently been developed for new steel making technologies requiring reduction of refractory consumption per ton of steel production[1]. The main problem in utilization of MgO-C refractories is oxidation of graphite, especially below 1400℃. Oxidation of the graphite can result in the property degradation and lifetime shortening of the refractory materials. These problems are caused by the structural bonding deterioration and excess porosity production which eliminates the beneficial effects attributed to the presence of graphite in the refractory materials[2]. Below 1400℃, dense layers do not form, causing a very fast graphite burn-out by air[3-5]. An example is the BOF furnace in which the oxidation of refractories usually occurs during oxygen blowing, hot metal tapping, slag tapping, molten metal and scrap charging and the furnace resting time. Graphite oxidation may be attributed to the following three mechanisms:

(a) solid-gas reactions, (b) solid-liquid reactions and (c) solid-solid reactions. During recent years, a great deal of research has been conducted to find out the influential parameters that affect the oxidation rate and the role of the antioxidants that reduce this rate[6-9]. Different methods have been designed for measuring and comparing the data obtained from oxidation experiments[10-11]. A few researchers have, however, tried to determine the kinetics of the oxidation from weight loss measurements and/or gas analyses[12-17]. Gas analysis studies conducted by Li and Rigaud[15] and weight loss measurements performed by N. K. Ghosh et al[16] and Faghihi and Yamaguchi[17] resulted in oxidation equations showing a diffusion controlled regime.

The air oxidation of samples with 5-20 wt%G in the temperature range 900℃ ~ 1300℃ was measured by weight loss measurements in this research. The effects of graphite content and the oxidation temperature on the kinetics of the process and the mechanism through which the oxidation proceeds were determined. The shrinking core gas-solid model could appropriately describe the oxidation process[18].

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