Multiple-Use Basic Slidegate Plate for Corrosive Steel Casting

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Conventionally, corrosion-resistant, basic materials have been applied in slidegate plates for corrosive steel. However, their durability is limited by cracks and sticking/peeling between plates. This article investigates the effects of adding spinel and changing grain size distribution, different carbon raw materials, and changing the amount/size of metal additives. Adding grain size-optimized spinel improved thermal spalling resistance by suppressing crack formation with minimal deterioration of corrosion resistance. Furthermore, subsequently adding different carbon and metal additives mitigated sticking/peeling damage and improved oxidation/wear resistance, respectively. Considering all these countermeasures together, multiple-use slidegate plates for corrosive steel grades can be developed.

Introduction

In steelmaking, slidegate (SG) plates are used to control the flowrate of molten steel from ladle to tundish and tundish to mold during continuous casting. SG plates are exposed to molten steel and as a result experience thermal shock and corrosion. Therefore, SG plates must have superior thermomechanical properties including good resistance to thermal shock, corrosion, sticking and wear damage.

Conventionally, alumina-carbon (Al_2O_3-C) materials are used to manufacture SG plates for steel ladles and tundishes, as they meet the requisite properties, which include resistance to thermal spalling and corrosion. However, these materials experience excessive corrosion when exposed to corrosive steels with high oxygen content or calcium treatment.[1]

Consequently, basic materials like magnesia-carbon (MgO-C) are often utilized for SG plates due to their superior corrosion resistance.[2,3] In current steelmaking, MgO-C refractories have been successfully applied not only as linings for converters, electric furnaces and ladles, but also as SG plates for calcium-treated steel.[4,5] These refractories have become integral components supporting safe and stable operations in the steel industry. However, despite having good corrosion resistance, MgO-C materials typically exhibit poor thermal spalling resistance, so they are generally single use. Stemming from the utilization of multiple-use Al_2O_3-C for general steel grades and single-use MgO-C for corrosive steel grades, SG plates are frequently, yet irregularly, replaced. This practice contributes to increased refractory material waste and replacement workload.

The adoption of basic materials that can be used multiple times would mitigate these challenges by eliminating the need for SG plate replacement based on steel grade. Therefore, this article investigates new, highly durable basic materials designed to address corrosion-related deterioration, single-use limitations, as well as reduce sticking, peeling and wear damage. The newly developed materials were then successfully used for multiple heats in tundish and ladle plates, yielding favorable results.

Effect of Spinel Content and Grain Size on Corrosion Resistance

Prototypes of MgO-spinel were prepared by mixing magnesia with spinel