Zero-Carbon Tempered MgO-ZnO Brick as an Alternative of Fired Magnesia Chrome for Safety Lining of Stainless Steel Ladle

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New environmentally friendly processes and the reduction of pollutant emissions are the new driving force of the steelmaking industry. Magnesia chrome bricks fired above 1,700°C are used in the safety lining of stainless steel ladles due to their high physical and mechanical properties and dimensional stability. Tempered bricks were developed using a special binder system that eliminates the firing process and CO_2 emissions related to burning fossil fuels. The new brick is based on MgO-ZnO with free chrome and carbon. Properties and performance results of fired and tempered brick used in the safety lining of the stainless steel ladle will be presented in this article.

Stainless steel was first introduced in 1912–1913, and it is an important class of alloys with high corrosion resistance. It is used in different applications, from cooking utensils and furniture to very sophisticated uses in construction and space vehicles. Although stainless steel has a higher cost compared to carbon steel, it possesses additional beneficial properties that may provide cost savings in terms of durability, elevated temperature behavior, ductility, impact resistance, reuse and recycling.[1]

There are various grades of stainless steel with different properties. They are classified into five main groups according to their metallurgical composition: austenitic, ferritic, duplex (austenitic-ferritic), martensitic and precipitation hardening. This type of material contains a minimum of 10.5% of chromium, which is responsible for guaranteeing its corrosion resistance because the chrome reacts with the oxygen and forms a thin film over the surface of the material. In addition to the required chromium content in this type of steel, a number of alloy elements may be added such as nickel, manganese, copper, molybdenum, silicon, nitrogen and phosphorus.[2]

During the secondary refining of stainless steel, the molten steel goes through a steel ladle, which is used for transportation and alloy addition. A steel ladle is assembled with different refractory grades depending on wear mechanisms that are present during operation. In this context, in stainless steel ladles the use of Doloma refractory bricks in the working lining and magnesia chrome bricks in the safety lining are common.

The two major components of Doloma are CaO and MgO, and this grade of refractory is commonly used in Si-killed steel production, due to its high compatibility with basic slags and low cost. Direct-bonded Doloma bricks are obtained by the firing process in the tunnel kiln at high temperatures until the ceramic bonding is developed. Although the CaO presence gives a hydration susceptibility to the bricks, it is responsible for the chemical behavior of the material. The slag resistance of Doloma bricks is due to the free lime, which is able to form a dense layer of Ca_2SiO_4 (C_2S) with high refractoriness (2,154°C) and protect the material against further slag infiltration and corrosion.[3]

Different groups of stainless steel are produced in the same steel ladle, which makes the process widely aggressive to refractories. As this type of steel has higher amounts of chrome, magnesia chrome bricks