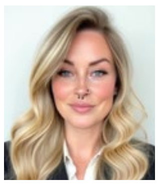
Low-CO_2-Footprint MgO-C Refractory Concept — Properties and Performance Comparable to Standard Virgin Raw-Material-Based Qualities



Recycled aggregates partially replacing virgin primary raw materials in new refractory brick production is a direct approach for CO_2 footprint reduction. However, historic replacement rates tend to be very timid still, given paradigm concerns of property deterioration and reduced performance. This article presents how adequate concepts of correct utilization of properly sorted and processed recycled material can successfully provide a MgO-C brick grade with 30% reduced carbon emissions with improved properties and similar or superior performance compared to its standard primary raw material baseline conception.

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Introduction

Magnesia-carbon brick (MgO-C) is one of the most widely used classes of refractories in steelmaking, used in primary refining processes (basic oxygen furnaces (BOFs) and electric arc furnaces (EAFs)), liquid steel containment, transfer and secondary refining (ladles), and functional class products (purging and taphole bricks).[1] Among these, ladle refractory linings are responsible for the highest consumption volume of MgO-C, given the shorter service campaign of this equipment compared to primary furnaces. Even when used only in the more aggressive zones such as the ladle slagline (SL) cutting, these critical zones have seen their area of coverage continuously extended toward the ladle barrel, due to secondary refining process needs. Recently, some steelmakers have opted for full ladle SL and barrel lined with MgO-C, limiting the use of nonbasic refractories to the bottom and impact pads.

Spent MgO-C residual bricks after dismantling of the equipment linings have become a point of attention, given its steady and considerable volume generation and possible segregation from other refractory classes (e.g., nonbasic), therefore increasing the potential of a feasibly economic recycling practice. For the steelmaker, this may signify reducing refractory scrap accumulation, handling and logistics costs associated with landfill, and for the industry chain overall an opportunity of access to sources of circular minerals to potentially replace virgin raw materials of intense carbon footprint.

Among the main constituents of MgO-C brick, the MgO aggregate (magnesia of some sort, sintered or fused) is by far the major weight percentage component. Magnesia (MgO) is produced from magnesite, which is a carbonate mineral with the chemical composition $MgCO_3$. In the calcination process, 2.1 tons of magnesite are needed to produce 1 ton of MgO, leading to 1.4 tons of CO_2 emissions. With that, MgO aggregates along with other raw materials in a typical MgO-C brick are responsible for up to 90% of the total carbon footprint of the final product.[2]

Despite all of the above reasons for more substantial consumption of circular raw material from recycled spent refractories, this practice is still very timid in the U.S. for several reasons, but it is gaining importance very rapidly. One of the general concerns would be that recycled aggregates are usually of higher internal porosity than primary raw materials and often of higher impurity contents.[3] Of course, a more conscient handling approach starting at dismantling, better sorting