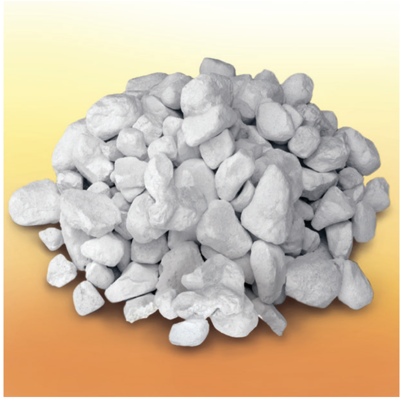
Article

HOW HIGH CALCIUM AND DOLOMITIC LIME ADDS VALUE AND BENEFITS TO THE BASIC OXYGEN PROCESS



Basic oxygen process (BOP) is a method of primary steelmaking in which carbon-rich molten pig iron is made into steel. In BOP steelmaking, molten iron from a blast furnace is charged into a refractory-lined furnace, and then oxygen is injected into molten iron at high speeds, resulting in oxidation of carbon and impurities. High calcium and dolomitic lime is used in several steps throughout this process and results in several enhancements and benefits.

To begin, lime is an important step toward protecting refractories and maintaining basicity, which helps with the removal of sulfur and phosphorus and provides a safer platform to withstand violent reactions in the basic oxygen furnace (BOF). Many steel plants desulfurize the hot metal externally in torpedo cars or ladles utilizing a flow-aided pulverized lime blend before charging into the BOF. Lime may be used for sulfur and phosphorus removal at this stage. Most importantly, quicklime is typically added to the mixture in the steelmaking furnace after the beginning of the oxygen "blow" where it reacts with impurities (primarily silica and phosphorus) to form a slag which is later removed.

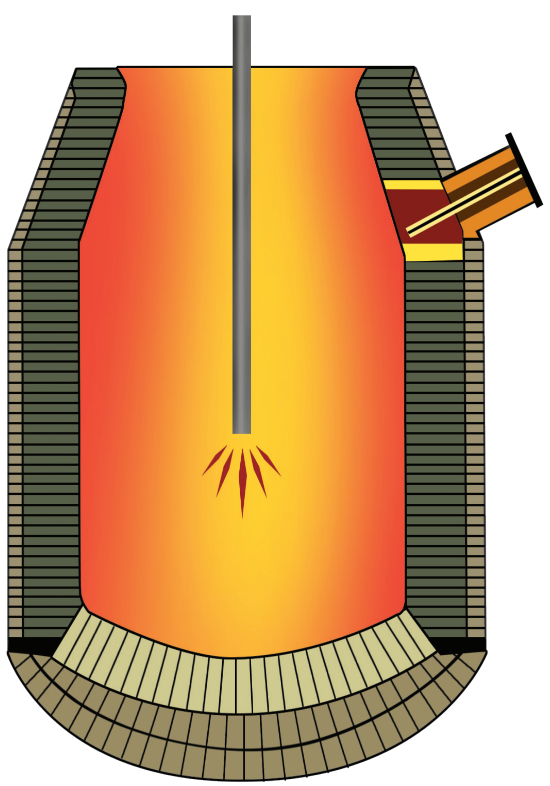
Although steel plants flux with high-calcium quicklime, most of the BOF plants substitute or add 30 to 50 percent dolomitic (high magnesium) quicklime because experience shows it extends the refractory lining life of the furnaces. While most BOF steel plants use pebble quicklime, the injection systems used in some processes require pulverized quicklime, according to the National Lime Association.

Flux practices involving lime in the BOF has evolved over the years. As with any process, the flux practice employed in the BOP is the result of some basic cost trade-offs. The relative cost of refining needs, iron recovery and refractory savings need to be considered. The typical steelmaking flux practice also is dependent on the starting raw materials.

The ore available to the iron making operation will determine the tramp and trace element load the steelmaking operation will see. The slag chemistry and flux practice of the iron making step is critical for a low-cost operation, and it will strongly determine the practices that will be employed in the basic oxygen steelmaking step.

Any trace element that cannot be removed in refining must be avoided all together if the load will meet or exceed the steel specification. Examples of this are copper and chrome. This is more of a problem for steelmaking operations that are heavily reliant on scrap metal for most of the metallic charge.

CROSS SECTION OF A TYPICAL BOF



This is an advantage for the integrated shop because most ore-based metallic sources are low in these problem tramp elements that cannot be removed. Another element of concern to the integrated steelmaker is phosphorus because many commercial iron ores available are high in phosphorus. The iron-making step will also recover all the phosphorus charged to the process. The BOP steelmaking step can remove most of the phosphorus with the proper blowing, flux and tapping practice.

COMPARING FLUX PRACTICES IN THE UNITED STATES AND EUROPE

U.S. integrated steelmaking shops have adjusted their flux consumption as specifications have gotten tighter, and the technology has progressed as a result.

In addition, total lime consumption has been reduced over the years because there are fewer larger blast furnaces which has resulted in a drastic reduction in hot metal silicon levels. Although, this trend has stagnated in the last 10 years as U.S. blast furnaces have established optimum practices for the current raw materials available.

A comparison of U.S. to European flux practices shows that Europe is faced with a different set of challenges from a raw material standpoint. The European profile for flux usage is a bit different. Although the total lime used per ton of steel is about the same, the relative amounts of dolomitic and high-calcium lime are very different.

The practice difference is best summed up as a difference in priorities. Late in the 1990s, slag blowing was being developed to enhance lining life in the steelmaking vessel. This practice quickly caught on in the U.S., and today every U.S. integrated shop uses some version of it.

The European practice is generally more focused on "refining optimization" and less on "refractory optimization." In the U.S., the shop flux practice is a mix of "refining" and "refractory." In most cases there is an attempt to achieve both. This creates a very small window for the refining needs of the heat.

The refining challenge for the U.S. producer cannot be overstated. The raw materials for ironmaking and integrated steelmaking will be of lower quality tomorrow than they are today. The lime industry is faced with reducing the CO_2 related to fuel consumption used to produce a ton of lime through efficient pre-heater kilns. The fuels used in the process are of increasingly higher sulfur levels. This issue is critical enough to cause several producers to revisit secondary refining options, and evaluate or implement a more European-type flux practice. The implications of this on the quality and type of lime needed for U.S. integrated steelmakers in the future are of concern.

Most U.S. integrated flux practice today can be best defined as trying to have the best of both worlds. The fluxes used in the vessel are being asked to perform more of the refining under chemically and thermodynamically adverse conditions.

CHALLENGES—WHAT THE FUTURE HOLDS

The U.S. and North American steel industry has shown its resiliency to survive the recent economic chaos by adapting through consolidation, addressing technical advancements to improve efficiency, and quality and cost reductions. It has accepted a new paradigm that requires management to be flexible in controlling output when conditions indicate the market is shifting, and it must embrace the concepts of sustainability in a competitive global economy. The challenges facing a mature BOP industry for the future revolves around these key issues:

- Strategy for sustainability and capital investments
- Energy
- Technological improvements
- Macroeconomics
- Impact of environmental regulations facing steel producers and suppliers of raw materials
- Is delivered dry, therefore the end user does not pay for water content

Data suggests that in the future, we will see further declines in raw material qualities and increased demand for higher quality levels in steel products. The refining challenge will require re-evaluation of flux practices for controlling such residuals as phosphorous and sulfur.

SUMMARY

The clean steel process starts from the early stage of iron making and the process becomes critical toward the last stages in secondary metallurgical process. High calcium and dolomitic lime selection process plays a critical role in defining productivity, quality and cleanliness from sintering stage to steel melting and finally secondary metallurgy processes.

In particular, lime characteristics and process control is key to cleanliness factors such as phosphorus removal and avoiding over oxidation of steel during steel melting in BOF.

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CARMEUSE

INNOVATION CENTER
3600 Neville Road
Pittsburgh, PA 15225

P: 1-866-780-0974
salesinfo@carmeuse.com

www.carmeuse.com

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