National Lime Association
LIME
The Versatile Chemical

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METALLURGY

Iron & Steel

Iron & Steel Manufacture - In the metallurgical field, quicklime-both high calcium and dolomitic-enjoys its most extensive use as a flux in purifying steel in the traditional basic oxygen furnace **(BOF)** and the newer electric arc furnace (EAF). For basic oxygen steelmaking, the lime factor per ton of steel ingot averages 150 Ib./ton as against 85 Ib./ton in electric arc furnaces. Lime is particularly effective in removing phosphorus, sulfur, and silica, and to a lesser extent, manganese. Generally, as the silica and phosphorus content of iron ore increases, consumption of quicklime increases.

In basic oxygen steelmaking, molten iron from a blast furnace is charged into a refractory-lined steelmaking furnace, and then oxygen is injected into molten iron at high speeds, resulting in oxidation of carbon and impurities. Lime is used in several steps in this process. First, both quick and hydrated lime can be used in the production of self-fluxing iron ore pellets suitable for charging into the blast furnace. Lime is pre-mixed with the sinter charge before processing on sintering strands. Second, many steel plants desulfurize the hot metal externally in torpedo cars or ladles following the blast furnace and before charging into the BOF, and use quicklime and magnesium metal as the sulfur scavenger. Lime may be used for phosphorus removal at this stage as well. Third, and 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 slag which is later removed. Although steel plants flux with high calcium quicklime, most of the basic oxygen plants substitute or add 30 to 50% dolomitic (high magnesium) quicklime because experience has shown that this extends the refractory lining life of the furnaces. While most basic oxygen steel plants use pebble quicklime, the injection systems used in certain processes (such as QBOP) require pulverized quicklime. In addition, dead-burned or refractory dolomite is used in the production of refractory brick used to line basic oxygen furnaces.

Because electric arc furnaces are more economical to build and operate, they have made significant inroads into the U.S. steel industry, and compete directly with basic oxygen furnaces in many markets. In the electric arc furnace, scrap iron and steel, iron ore, and beneficiated iron ore are placed in a furnace and melted by the use of heat from an electric current. Quicklime (typically 75 to 100 Ib/ton steel) and dolomitic quicklime (about 30 Ib/ton), either individually or in a blend, are added. The lime flux removes impurities and forms a slag that can be separated from the steel and poured from the furnace as a liquid. Pebble quicklime is used, unless a finer product is required by specialty furnace injection applications. A recent trend has been the use of pre-mixed blends containing 80% high calcium quicklime and 20% dolomitic quicklime (ranging from 6% to 25% magnesium oxide).

Whether produced in a basic oxygen or electric arc furnace, steel often requires secondary refining to transform it into a saleable product, especially where ultra pure steel is required. Many secondary refining processes use lime to perform key functions, such as the adjustment of steel temperature or chemistry, the removal of additional impurities, and the prevention of reabsorption of impurities from slags. In addition, quicklime may be used with

other materials, such as fluorspar or alumina, to form a synthetic slag, which is used as a flux to remove additional sulfur and phosphorus after the initial steel refining process.

Steel Products - Hydrated lime (either dry or as a slurry) has a number of miscellaneous applications, in the manufacture of steel products. It is commonly used in wire drawing, acting as a lubricant as the steel rods or wires are drawn through dies, and in pig and stag casting, in which a lime whitewash coating on the molds prevents sticking.

Lime is employed in the neutralization of sulfuric acid based waste pickle liquor, in which iron salts are also precipitated. After pickling, steel products are often given a lime bath to neutralize the last traces of the pickling acid adhering to the metal. In addition, hydrated lime is used to provide temporary corrosion protection in the form of a whitewash coating on steel products, and to neutralize sulfuric acid in coke by-product plants.

Nonferrous Metals

Ore Concentration - Both quicklime and hydrated lime are widely used in the flotation or recovery of many non-ferrous ores-in particular copper ore flotation in which lime acts as a depressant (settling aid) and maintains proper alkalinity in the flotation circuit. In the recovery of mercury from cinnabar, lime is used to remove sulfur. Lime is also used in the flotation of zinc, nickel, and lead bearing ores. It is often used as a conserving agent to assist in the recovery of xanthates, another flotation chemical.

Lime is also extensively used in the recovery of gold and silver in the cyanide leaching process to curtail the loss of cyanide, a costly dissolution reagent, and for pH control. In both "mill" and "heap" leaching, gold and silver ores are crushed and mixed with lime, and then combined for leaching with a cyanide solution. Lime maintains proper pH in the cyanide solution, thereby keeping it in the liquid phase, preventing the formation of hydrogen cyanide gas and its loss into the atmosphere.

Alumina & Bauxite - Quicklime is used in varying amounts to remove silica from bauxite ore and for causticization in the manufacture of alumina. The extent of its use depends largely on the quality of the bauxite used. Purer ores require less lime and more limestone (Sinter process) while ores high in impurities require more lime (Bayer process). In both cases, lime is required for desilification.

Magnesium - Lime is used to produce metallic magnesium. In thermal reduction techniques, magnesium oxide is reduced with ferrosilicon at high temperatures, with dolomitic quicklime providing the magnesium oxide. This process produces a gaseous magnesium which is ultimately condensed. Lime can also be used in electrolytic processes of magnesium production.

Other Metallurgy - In the smelting and refining of copper, zinc, lead and other non-ferrous ores, noxious gas fumes of SO_2 can be neutralized by passing these gases through "milk-of-lime" (dilute hydrated lime in an aqueous suspension) in a scrubber to avert the formation of sulfuric acid in the atmosphere, as well as the corrosion of plant equipment.

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After the smelting of nickel, the nickel is precipitated in a boiling solution with "milk-of-lime." In the electrolytic refining of copper the cathode sheets are dipped in lime water to protect them from sulfur in the "melting down" process. Some plants have used lime to reduce zinc chloride from galvanizing skimmings, reclaiming zinc hydroxide in the process. Substantial quantities of quicklime are used as a flux in the manufacture of low carbon and ferro chromes.

Lime is employed in uranium beneficiation mills operating acid leach systems. Lime neutralizes the acidic waste effluent before discharge.

In the concentration of rock phosphate, there is frequently a build-up of waste fluorine. Lime is used to precipitate these fluorides.