

Status & Outlook of Indian Refractory Industry

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Introduction :

Refractory is a term given to a class of materials which are produced from non-metallic minerals and possess capability to withstand heat and pressure. These are products that confer properties like high temperature insulation, resistance to corrosive and erosive action of hot gases, liquids and solids at high temperatures in various kilns and furnaces.

The fortunes of the refractory industry are linked to the growth of iron and steel sector which consumes a mammoth 75% of the refractories produced. Sector wise consumption of the refractories in India is shown in Fig.1. The specific refractory consumption is about 27 Kg/T in steel industry, 1.7 Kg/T in Cement and 55 Kg/T in glass industry. These sectors are giving high thrust on productivity, quality, cost, energy conservation and cleaner environment which necessitates new generation of refractories with specific requirements.

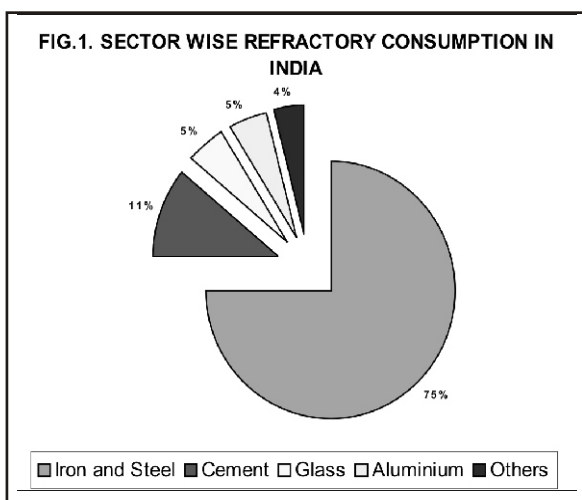
Production Scenario :

The installed capacity for refractory production in India is 1.65 million tons and today runs at 62.37% of the total capacity. The production was a mere 47.25% of the installed capacity in

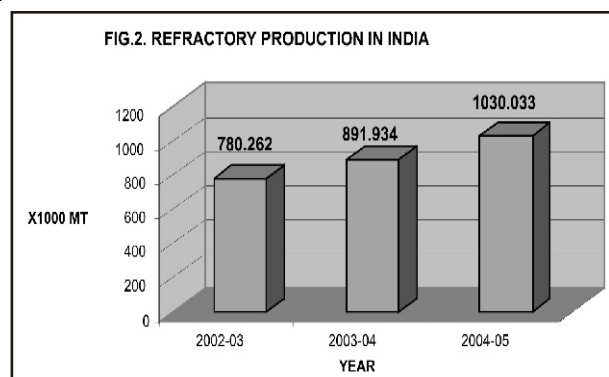
2002-03. Refractory production in the country has been showing a growth of 16% per annum from 2002-03 till now as is evident from Fig.2. This is attributed to the stupendous growth in

steel production for the past few years.

Among the refractories, high alumina bricks/shapes constitute 35.13%, fire clay bricks/shapes about 25.33%, basic bricks/shapes 19.02%, others comprising of monolithics about 15.43%, special products 2.71% and silica bricks/shapes about 2.38% of the total refractory production during 2004-05 in India. A look at the individual refractory wise capacity utilization indicate that the production of high alumina is running at 88.25%, special products at 81.60%, monolithics about 62.61%, basic at about 58.31%, fire clay at 46.60% and silica at 42.65% of the installed capacities. The above figures reveal the growing popularity of high alumina, special, monolithics and basic refractories which is attributed to the technological changes in the steel industry.



The production of refractories started in India in the form of fire clay bricks in 1874. Today, a wide variety of refractory products are manufactured tailor made to suit the requirements of the application in various sectors which include iron and steel, cement, glass, non-ferrous metal, petrochemical, fertilizer, thermal power plants etc. The refractories are



Source IRMA

Category of Refractories & Application

Fire Clay Bricks/Shapes :

These are basically aluminosilicate refractories possessing alumina not exceeding 42%. Fire clay refractories earlier used to find use in lining of blast furnaces for hearth and bosh portion due to the dense structure, reheat shrinkage, resistance to slag and load characteristics of these bricks. However, today, the dense low heat duty fire clay refractories find use in top part of the blast furnace where abrasion resistance is required and upper in wall portion where slight slagging action & abrasion resistance are necessary, intermediate duty fire clay bricks are applied. Though these are the most economical variety of refractories but suffer from poor slag resistance & low refractoriness characteristics. In many steel plants, these find extensive use in lining of soaking pits & reheating furnaces, bottom pouring refractories for steel casting, safety lining of the steel ladles and kilns in cement industry due to their good insulating, spalling resistance, dense structure preventing erosion characteristics.

High Alumina Bricks/Shapes :

The change in the quality of the raw materials, increased productivity and higher temperature and increased campaign life in iron/steel making arena resulted in drastic reduction in consumption of fire clay products and evolution of high alumina refractories. 60%-72% alumina mullite bricks are used in hearth and bottom of the blast furnaces. The stoves and hot blast system where the hot blast temperature gradually increased from

800°C to 1250°C, 72% alumina bricks with improved insulation are used. In steel plants involving in production of carbon steels, 72% alumina bricks are still used for working lining of ladles due to high refractoriness and moderate slag resistance properties. Well blocks and sleeves used in steel ladles for fixing at gas purging cones which are subjected to localized turbulence created by flow of gases through porous plugs requires refractory material that sustains good number of thermal cycles and increased campaign life. Here, 96% alumina bearing material are used for high temperature abrasion resistance, low porosity, high mechanical strength and result in uneven erosion on top surface of the block. Even, slide gate refractories of 96% alumina are in use in steel ladles. The increasing trend for production of cleaner steels led to use of 70% alumina refractories for bottom pouring.

Silica Bricks / Shapes :

Silica refractories possess the ability to withstand substantial load [50 lb/sq.in] to within a few degrees of its cone fusion point of 1710°C to 1730°C, high resistance to attack by steel furnace fluxes comprising iron oxide, lime etc., freedom from shrinkage at temperatures up to melting point and high thermal shock resistance in temperatures ranging from 600°C to 1700°C. However, silica refractories are highly sensitive to thermal shock below 600°C or below 300°C. These refractory products find extensive use in arch roofs of the furnaces, door jambs of furnaces and in coke ovens due to their excellent resistance to spalling.

Basic Bricks/Shapes :

The need to produce steels of high quality resulted in greater stresses on

refractory as a result of aggressive slag, prolonged turbulence by rinsing/lancing, high temperatures etc. led to adoption of basic refractories to resist slag attack while being chemically stable. Broadly, these refractories are classified as the dolomite variety and magnesite variety.

Dolomite is the most common basic refractory for both metallurgical and economic reasons. These are further classified as the sintered and unburnt materials. The high silicon in hot metal led to use of dolo bricks for working lining of BOF. In steel ladles, dolomite bricks are used but the holding time of steel in the ladle should be less and should be hot in circulation. In contact with air, the free lime of the dolomite refractory reacts leading to crumbling of the refractory which is its major disadvantage. Ceramic bonded sintered dolomite possess high mechanical strength and possess good resistance to hydration. Here, addition of zirconia permits improvement in resistance to thermal shock while enrichment with magnesia lessens sensitivity to slag attack. The high carbon dolomite products and chemically bonded products emerged in the market as an alternative to resin bonded ones and are expected to be lower in cost with absence of fumes during heating.

Among the magnesite refractories, Magnesite-Carbon and Magnesite-Chrome bricks are highly popular. Magnesite-C bricks find use in the hot spot area of EAF and BOF vessel lining as the refractoriness is high, highly resistance to slag and thermal shock. In LF/VAD steel ladles, magnesite-carbon variety refractories with high oxidation resistance and high hot modulus of rupture are applied in

strike pad & slag zone areas. These refractories help in improved lining life under severe operating conditions like high tapping temperature, longer holding times and highly basic slags. For VOD/AOD, dense magnesia-chrome co-clinker grains with low apparent porosity and high hot strength applied for full wear lining in side wall and bottom for slags of lower basicity [as is the case for stainless steel] and provide properties such as excellent penetration of low basicity slags, high hot modulus of rupture, excellent thermal spalling resistance and good abrasion resistance. Magnesia-chrome steel clad bricks are used in working lining of EAF and in certain zones magnesite bricks are applied.

Monolithics :

These refractories are well known to produce joint less structure which are stable from dimensional aspect at high temperatures and are resistant to thermal shock and abrasion. It comprises of castables, plastic mass, ramming mix, mortars, slinger mix and coating material.

Magnesia based gunnitting mix is used for patching of eroded areas in EAF. Mortars of magnesite and high alumina are applied for patching of steel ladles. High alumina mortars are used for fixing ladle nozzle with well block, joint portion of plate and nozzle, fixing well blocks to steel ladle etc. Alumino-silicate [60% Al₂O₃] trough and tap hole mixes are used in blast furnaces. Even in coke ovens, there is extensive use of silica based mortars for hot patching and gunnitting. Magnetite ramming mass is applied above the safety lining in EAF and for lining in basic induction furnaces

involving in production of special /alloy steels. In acidic induction furnaces used for melting cast iron/carbon steels, silica ramming mass is applied as the lining material. Another important application is in the form of ceramic coating of oxygen/rinsing lances for prolonged lancing/rinsing to meet the metallurgical requirements.

Among the monolithics, castables especially of low cement variety have dominated presence in various applications. This variety of castables possess about 5%-7.5% calcium aluminate cement requiring only around 5% casting water and are less prone to explosion, no loss of cold crushing strength at any temperature, low moisture content enabling faster drying/pre-heating, high degree of volume stability at high temperature providing and excellent abrasion resistance. 90% alumina castables find use for hoods of VAD/AOD/VOD units, delta region of EAF, permanent lining of tundish, walking beam furnace hearth, precast burner block of walking beam furnaces etc. 60%-70% alumina castables are applied for covers of soaking pits, stand pipes, charging hole blocks and covers of coke ovens.

Special Products :

In continuous casting, Garnex boards of silica/magnesite for cold tundishes are used to facilitate sequencing of heats. Various flow control devices such as baffles / dams / weirs made of magnesite are used in tundishes for improved quality of the steel. For crack and corrosion resistance, submerged entry nozzles used between tundish outlet and mould are made of alumina-carbon/

magnesia-zirconia refractory. Shrouds and monoblock stoppers made of alumina-carbon/alumina-zirconia are used in tundishes of various bloom/slab/billet casting machines. 95%zirconia metering nozzles are used for flow of steel into mould of billet continuous casting machines for excellent erosion resistance. Also, for eliminating non-metallic inclusions thus improving the steel quality, ceramic filters in tundishes have evolved recently.

Prefabricated single block launders of high alumina with SiC, Cr₂O₃ are used in EAFs to minimize lip jam formation, improved hot load characteristics with resistance to slag and thermal shock. Ceramic fibres due to their insulating nature are used in reheating furnaces, blast system/stoves of blast furnace etc. High magnesia porous plugs is another area which involves inert gas purging for homogenisation of steel with regard to temperature and composition.

Future Outlook :

Refractories cost about 8%-10% of the total cost of steel production. There is greater possibility in reducing the specific consumption of refractories by 9 kg/T in steel industry, 0.4 kg/T in cement industry in the coming 3 to 4 years. However, the refractory production is expected to increase by 16% per annum in the coming few years due to the major expansion and green field projects coming up in the steel segment. Refractories still have many areas in various sectors to enter in and it would be the monolithics & special products that would dominate the production in future.

