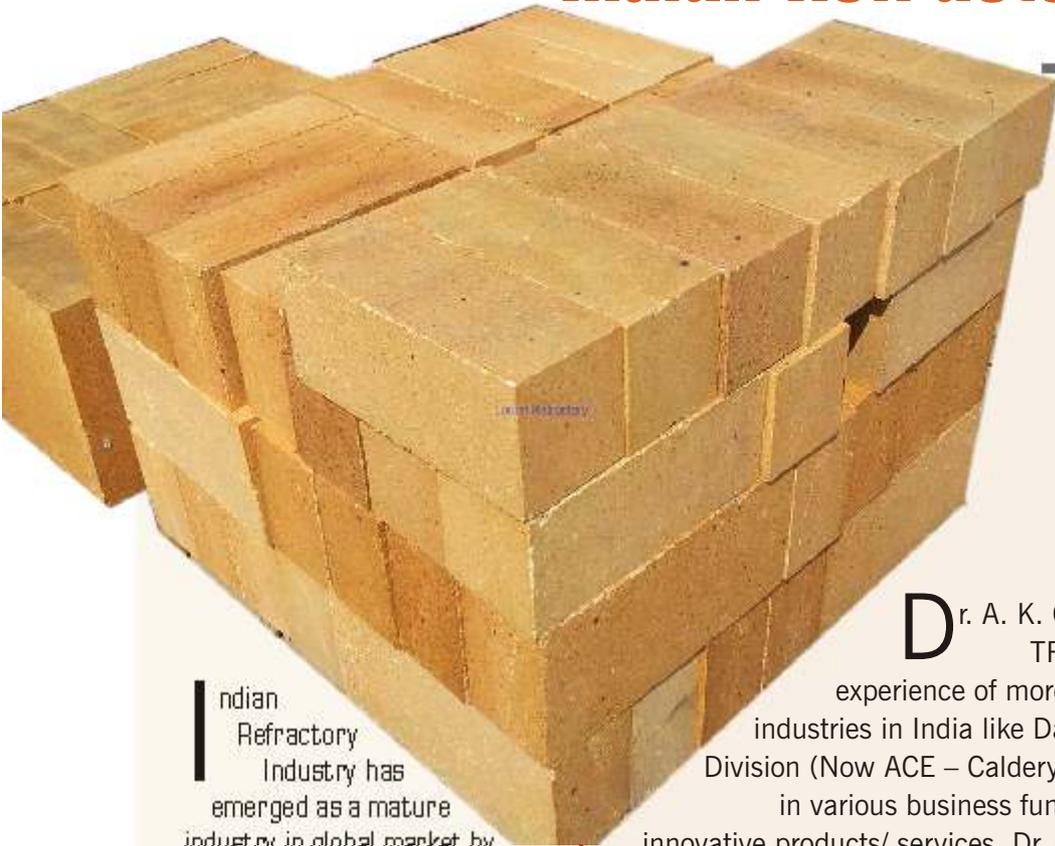


Indian Refractories Industry

- The Path Ahead



Dr. A. K. Chattopadhyay

Indian Refractory Industry has emerged as a mature industry in global market by keeping pace with the technology albeit on a lag as compared to other parts of the world. With rich raw materials availability of Bauxite, Kyanite, Sillimanite and Fire Clays, the industry developed excellent products for steel, glass and cement industry when aluminosilicates were main stream refractories. Gradually best possible technologies were acquired with simultaneous growth in manufacturing set ups by International players. Now refractory Industry in India is blend of domestic manufacturers producing whole spectrum of refractories augmented by manufacturing units of International technology leaders in specific products. At present, most of the major multi-national companies have presence in India and they have the largest market share (more than 70%). Like any other country, steel is the primary consumer of refractories, consuming as much as 75% of the total produce.

Dr. A. K. Chattopadhyay, Ex-managing Director, TRL Krosaki Refractories Ltd. has a rich experience of more than 30 years in leading refractories industries in India like Dalmia Refractories, ACC – Refractories Division (Now ACE – Calderys Refractories), Tata Refractories, etc. in various business functions and responsible for introducing innovative products/ services. Dr. Chattopadhyay has been awarded the best “Refractories Technologist” Award in 1996 from Indian Ceramic Society. He was the Chairman of Indian Refractory Makers' Association from 2006 to 2010. Presently he is Member, Research Council of Central Glass & Ceramic Research Institute, Kolkata, Member, Editorial Board of Journal of Indian Ceramic Society, Chairman, Refractories Sectional Committee, MTD – 15 of Bureau of Indian Standards, Life Member in Orissa Environmental Society. Dr. Chattopadhyay recently received a prestigious international honour. He was honoured as “Distinguished Life Member of Unified International Technical Conference on Refractories (UNITECR)” for his outstanding contribution to the field of refractories and his exemplary services to the refractories industry.

The Indian Steel Industry

Indian steel industry has entered into a new era of development since 2007-08, having borne the brunt of relative slowdown in that period. Robust demand for steel has led to rapid rise in production making India the 4th largest producer of crude steel (Crude steel 102MMT, Finish Steel 87 MMT in 2013-14) and the largest producer of sponge iron in the world. Details shown in Table-1. It is expected that by the end of 2020, India will become world's second largest producer of steel.

Having come out of mining sluggishness,

India's outlook is improving following the election of a new government which has given special focus on infrastructural growth. India will produce at least 120 million tonnes of crude Steel by 2017-18.

The Way Forward

Demand of Refractories for Clean Steel

Steel cleanliness is an important factor of steel quality and the demand for cleaner steels increases every year. The so-called clean steel generally is the steel in which the content of impurity elements, such as phosphorus,

TABLE-1 : STEEL PRODUCTION IN INDIA

INDIAN STEEL INDUSTRY : PRODUCTION (IN MILLION TONNES)					
Category	2009-10	2010-11	2011-12	2012-13	2013-14
Pig Iron	5.88	5.68	5.371	6.870	7.950
Sponge Iron	24.33	25.08	19.63	14.33	18.20
Total Finished Steel (Alloy + Non Alloy)	60.62	68.62	75.7	81.68	87.67

sulphur, total oxygen, nitrogen, hydrogen (including carbon sometimes) and inclusions are very low. The improvement of steel cleanliness has therefore become a more and more important subject in the development of ferrous metallurgical technology, and also an important task for the refractory makers.

The key tasks faced by the refractory for producing clean steel are:

- No re-oxidation of refractories into the steel
- Minimise inclusion size of de-oxidation product
- No formation of liquid oxide that would become detrimentally solid in the final steel product
- Low sulphur pick-up
- Refractory systems that prevent air entrainment or nitrogen pick-up
- Low hydrogen and carbon contents.
- Oxide cleanliness
- Sulphur Cleanliness
- Low Nitrogen Contents
- Low Hydrogen Content
- Low carbon Content.

Understanding of Refractories Failure

The study of refractory failure is a multi-dimensional subject and calls for detailed understanding of the operating parameters and customers' needs apart from the properties of refractories. The main reasons for failure of refractories are as follows:

- Material selected did not match the environment inside the furnace
- Material selected did not match the fuel being burned
- Material was improperly stored, mixed, installed, cured or dried
- Material selected did not match the environment created after the burning of the fuel i.e. ash and slag.

The step-by-step process of addressing the issue is outlined below:

- 1. Step I :** Discovery process
- 2. Step II :** Examine the existing material and testing
- 3. Step III :** Calculate the base acid ratio
- 4. Step IV :** Review process
- 5. Step V :** Review of installation procedure
- 6. Step VI :** Final analysis

Reuse, Recycle & Waste Elimination

Refractory makers along with steel industry have made an immense progress in improving performance, reuse, recycling and waste elimination of refractories in different area of its application. Introduction of repair system which improves the life span of converter & ladle has reduced refractory consumption & as a result the tonnage of refractories available for disposal & recycling is reduced substantially. In 1950, 60% of the refractories used ended up in a landfill, while in 2014 that figure was mere 17%.

Study shows that the steel industry has the highest rate of refractory recycling (55%) compared with other industries (32%). The iron & steel industry has not only developed the practice of reuse of used-refractories in their process but also collaborated with refractory makers to recycle the used refractories.

Emission of Greenhouse Gases

Emission of greenhouse gases like CO, NOX etc. is a common phenomenon in iron & steel industries especially in the area of Coke oven. Special types of refractories like high density and high thermal conductivity silica bricks are being developed for this applications. These bricks have heat transfer properties which help in completion of reaction at comparatively lower temperature which in turn reduces the emission of greenhouse gases. Moreover, this also ensures lower consumption of energy & reduces the depletion of natural resources.

Future Direction-Product Development

With newer technological innovations,



clean technological requirements and unique needs of each customer, refractory industry is now a knowledge industry where success depends on obtaining, managing, and using knowledge in a focussed manner. Till date little attention has been paid for development of new products which is of paramount importance in order to create a niche market in a globally competitive market. Some key issues related to product development are:

- Development of some innovative materials – new binders, new additives
- Development of new installation methods
- Magnesite carbon bricks with high density and controlled porosity
- Study of compressive stress-strain curve for determination of the type of C bond and its thermal evolution.
- Producing MgO-C castables and other C-containing monolithics
- Development of water-free ready to use mixes.
- Study of mechanical and thermal stresses in the lining
- Carbonless SEN for avoiding clogging
- Improvement of thermal shock resistance of Carbon bonded material
- Al₂O₃-Cr₂O₃-ZrO₂ porous plugs by fusion route.
- Sialon added trough castable
- Relation between elastic modulus and mechanical resistance for optimal solution of lining material
- Reproducibility of processes in manufacturing plants

Use of more Monolithics and Improvements

Monolithics constitute approximately 25% of the total refractory production in India unlike some developed countries like Japan where it forms bulk of the production. Nonetheless, consumption of monolithics is expected to grow to 30%+ although there are some technical issues



associated with it:

- Ability to deliver stable placing property through controlled reactivity of the calcium aluminium binder
- Understanding of the chemical interactions and mechanisms of deflocculated castable system
- Inadequate knowledge of the equipments for placement of the castables.

Key Issues being Faced by the Industry

A major factor that constraint the refractory makers is their limited bargaining power due to modest size. Refractories a \$1-Billion industry in India while SAIL alone stands at \$10 Billions. It accounts for a mere 2% of input cost of steel although it is the first to face the onslaught in case of meltdown.

To sum up, the main issues faced by the industry is as follows:

- Around 30-35% of steel production will still be through induction furnace route where very low quality refractories (mostly silica ramming mass) is used. This is because large scale acquisition of land is now difficult in India along with getting iron ore and coal linkages.
- There is intense internal competition as well as threat of cheaper imports which is almost 30% of the market share. The domestic manufacturers too, operate at 50-60% capacity and many are forced to sell products below sustenance level to manage the everyday overheads.
- Timely payment is delayed by 6 months-

year (or unilaterally deducted) by many steel plants although the refractory makers have to pay upfront for raw materials, energy and human resource.

- With the onset of Total Refractories Management, the onus is on the refractory makers to supply, install and maintain the refractory linings. On one hand, it beckons new business opportunity but on the other hand the refractory makers are kept in the dark by many users about various operating parameters, production target etc which affect the refractory lining life.

• As discussed earlier, refractory industry's turnover is miniscule compared to its users which results in poor negotiating power. The Governmental policy too does not favour the domestic refractory industry as import duty of raw materials as well as finished product is pegged at same rate (5%). As a result, their issues are not highlighted in the proper forums and suffer from indifference from the policy makers. Although refractory cost is only 2-3% of steel making, in case of downturn, refractory industry is targeted first for cost cutting.

• The growth of the refractory industry in terms of sales volume has hovered around 7-9% but the profit margin has come down rapidly.

- Lack of profitability has resulted in minimal investment in R&D especially in the area of indigenous raw materials which is of poorer quality. As a result, India is dependent on imports for good quality raw materials.

Way Forward

The growth of steel is envisaged at 125-130

MT by 2018 and nearly 200 MT by 2025. The present refractories capacity can support upto 120 MMT of crude steel production further which capacity expansion (in terms of world class facilities), technological infusion and raw material linkage is needed. This calls for nurturing of refractories industry by steel industry for its own benefit and sustenance. Refractory makers too, need to provide value added service to the steel industry like:

- Strengthening of Total Refractories Solutions
- Application equipment like Shooters, Robotics and Laser guided automatic gunning
- Advanced design software (FEM,CFD)
- Strengthening of R&D Team
- Constant innovation in refractories for life and quality enhancement
- Joint projects between refractory industry and the steel industry

The sustenance of both the industries lies in creating a win-win situation for both of them for which there is a need to take a collaborative approach.

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