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IRMA
PARTNERING HEATING SOLUTIONS
INDIAN REFRACTORY MAKERS ASSOCIATION

Address : Indian Refractory Makers Association, Duckback House, Flat No. - 2B, 2nd Floor, 41, Shakespeare Sarani, Kolkata 700017
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27, National Highway, PO Box No.202, Hasanpar, Wankaner (Dist.: Morbi) 363621, Gujarat, India.

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41, Shakespeare Sarani, Duckback House,
Unit-2B, 2nd Floor, Kolkata 700017
Phone: 033 4003-2748
Mobile: 98304 24582
E-mail: secretary@irmaindia.org
Website: www.irmaindia.org

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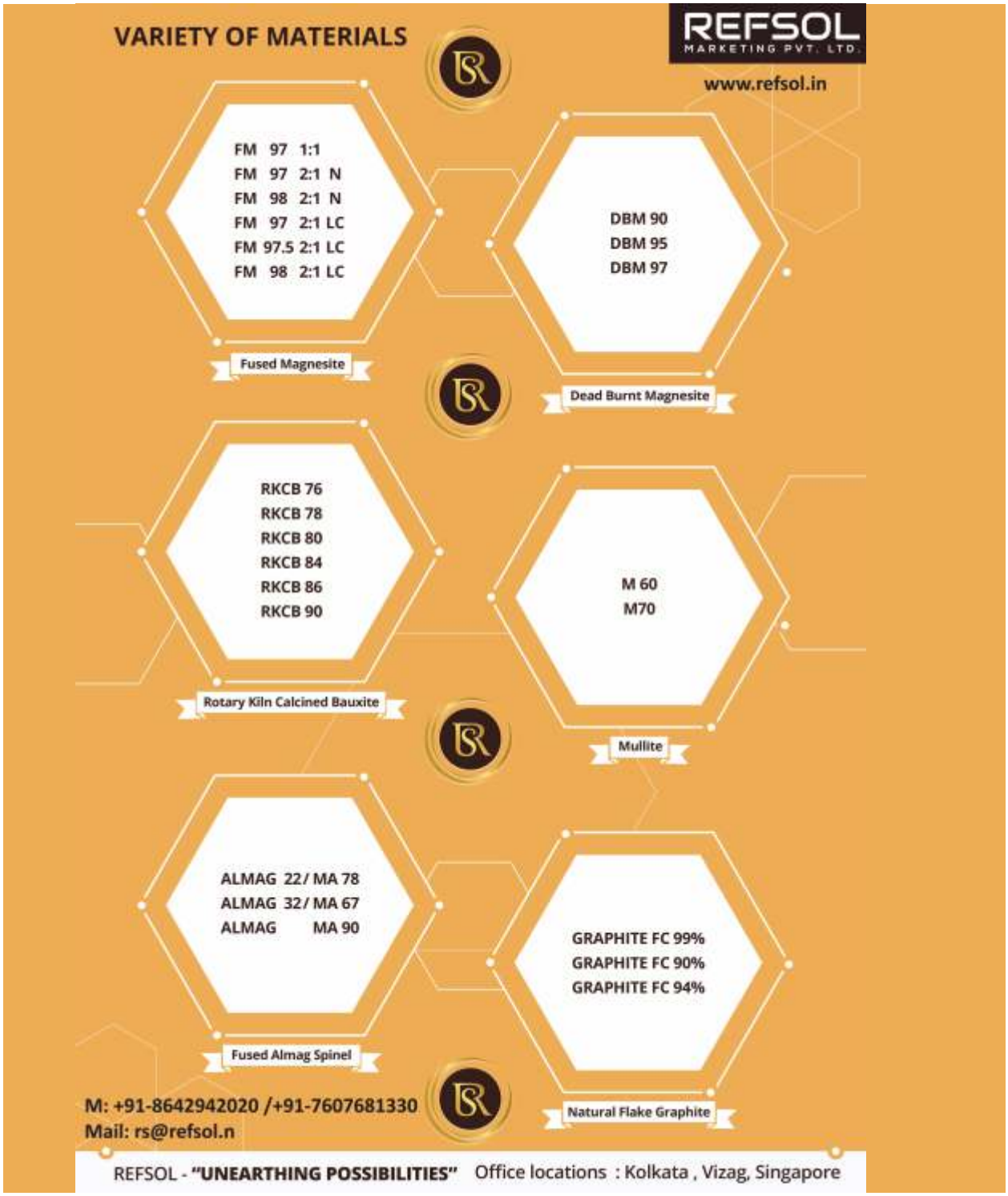
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MESSAGE FROM THE CHAIRMAN

Dear Colleagues,

IRMA Board of Directors in its last meeting in September 2024 has bestowed the challenge of leading this august body for the years 2024-26. This is a moment of immense honour for me as well as a big responsibility. I accept it with due humility and also thank for all the congratulatory notes received from my colleagues and well wishers in the industry. As a guideline to my tenure as Chairman, I would like to stress the importance of being open and inclusive like my predecessors.

IRMA has to continuously evolve by accepting the technological and business challenges being faced by the industry. It means working towards unity while respecting and protecting diversity of each member - big or small. In other words, IRMA is a platform where various stakeholders of the refractory industry irrespective of their size come together due to their admiration and dedication for this industry.

The steel manufacturing process is in a stage of transformation driven by the urge to leave a cleaner and greener earth for our progeny. Structural adjustments in production process and the mantra of recycling is being heard in other industries as well. I am happy to hear that a good number of refractory makers are switching over to cleaner and green fuel, rainwater harvesting and other sustainable methods of production. We from IRMA platform will continue to encourage their efforts and spread their success stories so that others may be inspired to follow suit.

Another key area where IRMA can play an active role is talent development for our industry. We have some ambitious plans in this regard the details of which will be published shortly.

Thanking you, one and all,

Sunanda Sengupta
Chairman

ASSOCIATION ACTIVITIES

New IRMA Chairman & Deputy Chairman

Mr Sunanda Sengupta (TRL Krosaki Refractories Ltd.) has become IRMA Chairman for the period 2024-26. Mr Subrata Roy (Vesuvius India Ltd) has become the Deputy Chairman of IRMA for the same period.

IRMA Annual General Meeting

The 11th IRMA AGM was held on 13th September 2024 at Hotel Hyatt Regency, Kolkata under the chairmanship of Mr Ish Mohan Garg. Mr. Ajoy Chakraborty, ED (MM), Bhilai Steel Plant (SAIL) was the Chief Guest of the occasion. The Chairman thanked the members for attending the AGM. He briefly discussed the present market conditions and Indian economy is growing and so is the steel industry. This has been successively reflected in the recent growth of domestic refractory industry. Outlining the challenges faced by the industry in terms of raw material security and talent scarcity, he urged all the stakeholders to join hands in addressing these issues. The Chief Guest for the occasion, Mr. Ajoy Chakraborty outlined the crucial role played by refractories in the production of steel. The Vote of Thanks was proposed by Deputy Chairman Mr Sunanda Sengupta. All the normal business transactions were carried out as per the rules and regulations of the Association

IRMA Lifetime Excellence Award

This year, Mr Priyabrata Panda has been awarded IRMA Excellence Award for his immense contribution towards promotion of Indian refractories industry. The award was handed over to him during the IRMA Annual General Meeting.

IRMA N Sahoo memorial Award

The winners of IRMA N Sahoo Memorial awards were:

1. SAMIK SARKAR, Govt. College Of Engineering & Ceramic Technology, Kolkata for "Effect of Hydrated Alumina Precursor on the Densification Characterization of Zinc Aluminate Refractory Aggregate "- undertaken by SAMIK SARKAR (Guidance: Prof. (Dr.) Kaberi Das)
2. ARINDAM DAS & ARINDAM PAL, Govt. College Of Engineering & Ceramic Technology, Kolkata, for "Synthesis and Characterization of CNT Reinforced Alumina Based Nano Composites" - undertaken by Arindam Das & Arindam Pal (Guidance - Dr. Barun Kumar Sanfui)
3. ADARSHA MAJHI, University of Calcutta, Kolkata for "Studies on the effect of alumina addition on the densification and mechanical properties of cordierite ceramic prepared through the semi-colloidal route."

IRMA M R Hariharan Memorial Award

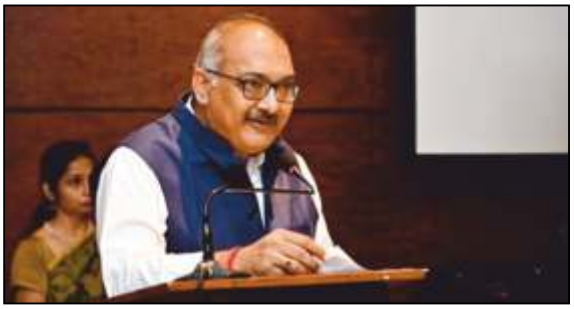
This year the Award was won by Mr. Tanay Nag, Ceramic Engineering Course, Department of Chemical Technology, University of Calcutta, Kolkata for being the overall topper of the Ceramic Engineering Stream

IRMA Board of Directors Meeting

The first meeting of newly elected IRMA Board of Directors meeting was held on 13th September, 2024 under the chairmanship of Mr. Sunanda Sengupta. The points discussed were election of IRMA Chairman and Deputy Chairman, co-option of members to the Board, utilization of IRMA reserves etc.

PHOTO GALLERY

11TH IRMA ANNUAL GENERAL MEETING



Welcome address by IRMA Chairman, Mr. Ish Mohan Garg

Address by Chief Guest Shri Ajoy Kumar Chakraborty, ED(MM), Bhilai Steel Plant

Section of the Audience

Life Time achievement award to Mr. P B Panda

Award giving ceremony to students

Award giving ceremony to students

Award giving ceremony to students

Vote of thanks by IRMA Dy. Chairman Mr. Sunanda Sengupta

IN THE NEWS

National Steel Policy

India has begun a review of the seven-year-old National Steel Policy (NSP) in the wake of some advanced economies such as the EU imposing carbon tariff (Carbon Border Adjustment Mechanism) on steel imports and the growing need to decarbonise the sector. The idea is to assess the impact of the policy on production and usage of the commodity and examine if any tweaks are required in view of the new emerging challenges.

Demand for Steel

According to a report by Deloitte, overall steel demand in India is projected to grow at a CAGR of 5 per cent to 7.3 per cent over the next decade leading to a steel demand of 221-275 million tonnes by FY 34 (under different scenarios). From FY14 to FY24, India's finished steel consumption posted a CAGR of 5.67 per cent. In FY24, domestic finished steel consumption reached 136 million tonnes, marking more than 14 per cent year-on-year growth driven by sustained momentum across developmental projects and increased government spending in various end-use industries.

Tata Steel

Odisha would emerge as Tata Steel's single-largest investment destination after the phase-II expansion of its Kalinganagar plant from 3 million tonnes per annum to 8 mtpa. The steel major has invested Rs 27,000 in phase-II of the Kalinganagar plant expansion, and the company is on the verge of commissioning its expanded capacity at the unit, it said in a release. The ongoing expansion in Kalinganagar will play an important role in Tata Steel's ambition to achieve its target of 40 mtpa capacity in India by 2030, the company said.

Demand for Cement

Cement demand is likely to grow by 5 per cent in FY25, and few more round of price hike by companies is expected in the coming months says a report by Centrum. Multiple factors like delayed government spending post general election, more than normal monsoon and flooding across multiple locations in the country has impacted the demand adversely. On a year on year basis, the cement demand has contracted by 5-6 per cent, but with recent capacity expansion a growth of 2.7 per cent is expected.

Meanwhile, the Indian cement industry has lined up a capex of around Rs 1.25 lakh crore for FY25 to FY27 to meet the growing demand, said a report by rating agency CRISIL. During this period, the industry is expected to add 130 million tonne of cement grinding capacity, which is a fifth of the existing capacity. A healthy 10 per cent annualised increase in cement demand in the past three fiscals outpaced growth in capacity addition, pushing the utilisation level to a decadal high of 70 per cent in FY24.

India's Coal Import

India's coal import rose by 7.8 per cent to 140.60 million tonne (MT) in the April-September period of the ongoing financial year. The country's coal import was 130.34 MT in the year-ago period, according to data compiled by B2B e-commerce company mjunction services ltd. During the April-September period, non-coking coal import was at 91.92 MT, higher than 83.45 MT imported during the same period last year. Coking coal import was at 28.18 MT as against 29.44 MT.

India's Coal Production

The government has expressed optimism that it will achieve the production target of more than 170 million tonnes from captive and commercial coal blocks in the ongoing fiscal year. The production from captive, commercial mines from April 1 to November rose 33 per cent to 100.08 MT over 75.05 MT in the year-ago period, the coal ministry said in a statement. The total dispatch from captive, commercial coal mines during the period rose to 107.81 MT from 80.23 MT.

OVERSEAS NEWS

Tata Steel

Tata Steel has ceased steel-making operations at Port Talbot in the UK, after it shut down the remaining blast furnace, the sinter plant, and some secondary steel-making and energy systems. The largest producer of steel in the region had already shut a blast furnace and coke ovens earlier this year after the assets had reached their end-of-life and were not economically and environmentally viable.

Vesuvius Plc

Vesuvius Plc has announced a revenue decrease 5.9% in H1 2024. The Steel Division performed particularly well, with Flow Control gaining market share overall and in all major regions except the EU and UK. In Advanced Refractories, its market share has increased in Asia with a particularly strong performance in India and China.

RHI Magnesita

RHI Magnesita has delivered a resilient set of results against a challenging market backdrop which was largely dominated by declining sales volumes for both steel and industrial divisions, and lower average pricing. Revenue decreased by 0.3% whilst Adjusted EBITA declined 5% on the prior period to €190 million (H1 2023: €200 million).

Shinagawa Refractories

Shinagawa Refractories Co., Ltd. has experienced a downturn in financial performance, with net sales falling 7.6% and operating profit down by 13.3% in June 2024 compared to the previous year. Profit attributable to owners plummeted by 57.7%, although the company still maintained a strong capital adequacy ratio of 55%. The comprehensive income also took a significant hit, decreasing by 48.7% from June 2023.

Appointment

Members of the global body World Steel Association (worldsteel) have elected Tata Steel MD and CEO Thachat Viswanath Narendran as its chairman. He is the second Indian to be elected to the post after JSW Group Chairman Sajjan Jindal, who was elected as worldsteel Chairman in 2021. Ugur Dalbeler, Colakoglu Metalurji AS, and Leon Topalian, President and CEO of Nucor Corporation have been elected as Vice Chair.

MEMBERSCAN

IFGL Refractories Ltd

Sales of IFGL Refractories declined by 9.75% to Rs 411.12 crore during the September 2024 quarter as against Rs 455.52 crore during the previous quarter ended September 2023. Net profit of IFGL Refractories declined 68.21% to Rs 12.08 crore in the quarter ended September 2024 as against Rs 38.00 crore during the previous quarter ended September 2023.

The company has entered into a joint venture agreement between Marvels International Group Co. Ltd., Seychelles, and Marvel Refractories Company Limited, China to establish a manufacturing facility with a capital outlay of approximately Rs. 300 crores to produce Basic Fired Magnesite Spinel Bricks, Basic Fired Magnesite Bricks, and Fired Magnesia Chrome Bricks, which are used in the cement, glass, non-ferrous, and gasification industries.

Calderys India Refractories Ltd

Calderys is building a new refractory plant in Bhuinpur, Khurda district, Odisha, India. Known as 'Capes' (Calderys Plant in East and South India), the project will be the world's largest single-site greenfield plant dedicated to refractories and steel casting fluxes. It represents a strategic move from Calderys to expand its product range with acidic and basic bricks, and overall production capacity in line with the evolving needs of the Indian refractory market, particularly in the eastern and southern regions.. Production at the plant is planned to begin in the 2H25.

RHI Magnesita India Ltd

RHI Magnesita India Ltd has secured its first robotic order in India with JSW Vijayanagar Metallics Ltd. For JSW Vijayanagar Metallics' new SMS#4 expansion project, RHI Magnesita India will supply a technology package. This includes the latest generation SX3 slide gate, EMLI LadleSlag sensors as well as robotic cells on the CCM for ladle shroud handling and tundish sampling and probing as part of a long-term contract.

ECONOMY AT A GLANCE

- India's CAD has narrowed to 1.9% of GDP in fiscal 2023 (and is expected to go down further in the next fiscal), while foreign exchange reserves have nearly doubled to US$568 billion.
- Current inflation stands at 5%, and the fiscal deficit is targeted to be 5.9% of GDP in fiscal year 2024.
- The government prioritised capital spending in its recent budgets and supported the state governments for doing so. As a result, gross capital formation increased by over 11 per cent during the 2022–23 fiscal year and is expected to expand by over 10 per cent during the 2023–24 fiscal year.
- Private investment fell from over Rs 14 lakh crore (US$168.6 billion) in February 2023 to below Rs 2 lakh crore (US$24.1 billion) in October 2023 before recovering marginally to Rs 2.2 lakh crore (US$26.5 billion) in December 2023.
- According to research conducted by the State Bank of India, out of the estimated INR 5 trillion capex, government has received investment commitments for INR

3 trillion and 21% of committed capex, while 12% of planned capex has been spent in fiscal year 2023 with most capex activity likely to happen between fiscals 2024 and 2026.

- Foreign direct investors reduced their participation in India. Between April – November 2023, gross foreign direct investment inflows declined by about 4 per cent compared to the corresponding period in 2022. Despite this decline, India seems to have performed better, as foreign direct investment inflows in developing countries declined by 12 per cent in 2023, according to the UN Conference on Trade and Development.
- The government expects retail headline inflation to be marginally higher in 2024 at 5.4 per cent, increasing from about 4 per cent in 2023.
- The external sector has been impacted by the global economy's loss of momentum, with exports of goods and services declining during the first nine months of the current financial year. But with imports declining — notably merchandise goods — India's imbalance on the trade account has reduced by almost 36 per cent compared to the previous year.
- The expected decline of the growth of agriculture and allied sectors in 2023–24 is a worrying sign for the economy. These sectors must grow consistently and at a significantly higher rate, given the depressed state of farm incomes.
- India to grow between 6.9% and 7.2% through fiscals 2023 to 2024.

BUSINESS SECTION:

ENERGY MAPPING OF EAST & WEST GODAVARI REFRACTORY CLUSTER: A SAMEEKSHA DOCUMENT

(Original work of TERI done under the project "INDIA: TERI-SDC Partnership: Scaling up Energy Efficient Technologies in Small Enterprises (EESE)

Introduction

Refractory Manufacturing Cluster is spread across in East & West Godavari districts of Andhra Pradesh. The reason behind the spread is availability of raw material i.e. Clay. Majority of industries are installed near to city of Rajamundry, head quarter of East Godavari district. These industries are well connected to road, rail and air. The location of cluster is 400 km from Hyderabad, state capital Andhra Pradesh and 200 km from Vishakapatnam of Andhra Pradesh.

There are around 50 refractory industries with different capacities are installed in east and west Godavari District. All the units are manufacturing different refractory products in the cluster.

East Godavari District

There are approximately 25 Refractory manufacturing industries established for manufacturing of refractory products. These industries are engaged in manufacture of various types of products like firebricks, potteries and Ceramics. The industries are spread over in and around Rajhamundry, Morampudi and Dhavaleswaram with in a radius of 5 km from Rajamundry.

These industries are spread across the district due to availability abundant resources of raw material and skilled and unskilled man power from near by locations. All these industries fall under the category of SME sector and run by well experienced proprietorship management.

These plants are operated through out the year and few are operating 24 hrs and many have 8-10 hrs of operation.

West Godavari District

Approximately 20 refractory manufacturing Industries are engaged in manufacture of various types of fire bricks in this district. These industries are spread across Chebrolu, Bhimdole, Dwarka Tirumala, Timmaya Palem Road locations in the district.

These industries are spread across the district due to availability abundant resources of raw material and skilled and un skilled man power from near by locations. All these industries fall under the category of SME sector and run by the well experienced proprietorship management.

These plants are operated through out the year and few are operating 24 hrs and many have 8-10 hrs of operation.

Products

All refractory manufacturing Industries located in East & West Godavari district are manufacturing different refractory material products. The following products are manufacturing in Refractory cluster in East & West Godavari District.

- Fire bricks
- Ceramic Jars
- Potteries

Majority of industries are manufacturing refractory Fire Bricks followed by potteries and ceramic jars.

Equipment in Cluster units

The equipment/machinery required for manufacturing refractory materials are

- DD kiln
- Grater
- Pug Mill
- Muller Mixer
- Hammer Press
- Electric Motors

The main part of equipment/machinery is Down Draft Kiln which is constructed by locally available suppliers. The other machinery are procured from available local service providers.

Raw Material

The spread of refractories manufacturing industries in East & West Godavari District is due to the availability of raw material. The raw material required for the manufacturing refractory products is mineral based clay. The following clay is available and suitable for manufacturing the refractory products.

- Fire Clay
- China Clay
- Vemigiri Clay
- Grog

Fuel Used

Any Industry requires energy to produce the different products. The type of energy required for manufacturing the product depends upon the requirement of the equipment / machinery.

The following energy is used by refractory industries in East & West Godavari District of Andhra Pradesh

- Thermal Energy
- Electrical Energy
- Renewable Energy

All the industries require thermal energy for major consumption followed by electrical energy.

Thermal Energy

Thermal energy is required in refractory industries for heating up the refractory material up to 1200^{0}C. The following fuels are used in refractory cluster located in East & West Godavari District.

- Coal
- Wood

All the Down draft kilns require thermal energy for heating the refractory material up to 1200^{0}C. The source of thermal energy is from firing the coal and wood in kiln. None of the industries are using other forms of energy for heating applications in Kilns. The coal is procured from the Singareni Colleries Company Limited (SCCL) and Coal India limited (CIL) and wood is from local suppliers. The required quantity of coal is procured from coal traders and suppliers. (the electricity is mainly consumed in grinding raw materials, the clinker and additives and in minor measure operating the kiln and ancillaries).

Installed Capacities-Products Manufactured

Different Installed Capacities exist in refractories manufacturing cluster located in East & West Godavari district. All these industries are batch type production due to lengthy process of operation i.e.6-10 days. The equipment and machinery are same for all the refractory products manufacturing except the process duration and raw material type. The installed capacity depends up on the size of the kiln and type of product to be manufactured. The following table gives idea about the different installed capacities exists in refractory cluster in East & West Godavri District.

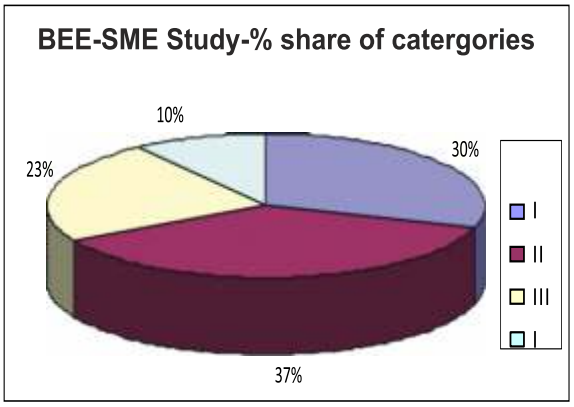
Table No: 1 Installed Capacities and Products manufactured in Cluster

S.No	Capacity range	Products
1	up to 50 TPD	• Fire Bricks • Potteries • Ceramic jars
2	50-100 TPD	• Fire Bricks • Potteries
3	100-200 TPD	• Fire Bricks • Ceramic jars
4	Above 200TPD	• Fire Bricks • Ceramic jars

The study of the Energy Use and Technology audit was conducted in 30 Refractory Manufacturing Industries to identify the Energy Efficient Technologies. The identified Energy Efficient Technologies in 30 units represent all the Industries in the Cluster.

Percentage Sharing of Refractoriness cluster under BEE-SME Program.

Cluster profile – Asansol refractory industries



These 30 units cover all the four installed categories of refractory manufacturing industries. Energy Use and Technology Audit was conducted in 30 % Industries in category I Type, 37% Industries in category –II Industries, 23% in category III Industries and 10% Industries in category-IV Type Industries.

Due to spread of industries in different locations in East & West Godavari Districts and to cover all the locations in the districts, energy use and technology audit were conducted in the following locations.

Table 2. BEE-SME Program- No of plants covered in all locations.

S.No	Place	No of SMEs	% share
1	Mohrampudi	12	40
2	Dhawleshwaram	9	30
3	Dwarka Tirumala	6	20
4	Bhimdole	3	10
	Total	**30**	**100**

Production

The annual production in identified 30 Refractories Industries was evaluated based on the % utilization and no of batches per year operating.

Table 3: Category wise production and % production share

S.No	Category	Installed capacity range	No. SMEs	Production in TPA	% share
1	I	up to 50 TPD	9	13930	25
2	II	50-100 TPD	11	15540	28
3	III	100-200 TPD	7	13020	24
4	IV	Above 200TPD	3	12500	23
5		**Total**	**30**	**54990**	**100**

The annual production of 30 Refractory Industries with four different capacities was evaluated and estimated as 54990 MT Tons per year.

Issues with the Cluster

The following issues were identified while interacting with owners and employees during the Energy Use and Technology Audit.

Energy Issues

All refractory manufacturing industries require both thermal and electrical energy for manufacturing of refractory material. For generation of thermal energy coal and wood is used as fuel and electrical energy is supply APEPDCL.

All the units require electrical energy to operate equipments installed in their Industries. All the units in this cluster are having grid connection - commercial and power availability is not a problem except some small power cuts of 30 – 40 mins daily.

The availability of coal is one of the major problems encountered in the cluster. The Commissioner of Industries allocates the coal for the Industries from SCCL. The quality of coal supplied is inferior and the quantity too is in adequate. The owners are purchasing the good quality of coal i.e. CIL from open market through the dealers/middleman.

There is potential for energy saving in both thermal as well as electrical energy by adopting

the energy efficient technologies in refractory Industries. By introducing Coal / Wood Gasification, waste heat recovery systems in refractory Industries will save more than 30% of thermal energy as well as help clean the environment. These two technologies have not been implemented so far in the cluster due to lack of awareness on technology, energy font conservation techniques and identification and approach towards implementation.

In the cluster, energy conservation awareness and consciousness is required among the refractory manufacturing units on how to conserve energy.

Technological Issues

Another major issue of the Cluster is identification of the right technology and equipment for improvement of efficiency. The efficiency of kiln is low due to high energy losses during process. To minimize energy loss in refractory manufacturing industry, it is essential to adopt energy efficient technology.

The identification of energy efficient equipment in refractory manufacturing industry is very difficult proposition for the owners. This is due to lack of technical information, financial constraints to invest and absence of skilled manpower. The technical service providers of equipment suppliers are another issue in the cluster.

The operation and specific energy consumption and efficiency of kiln play a vital role in kiln efficiency. The operators and owners should be made aware of efficiency of kiln and also specific energy consumption to find whether energy loss is there or not.

The refractory cluster owners / operators are not fully aware of updated technologies, equipments available for manufacturing of refractory materials. To overcome the situation in the cluster it is essential to generate awareness amongst on relevant technologies amongst local service / equipment suppliers with in the cluster.

Financial Issues

The industry owners have good contacts with the local banks to avail financial service from banks i.e. loans, salaries, and working capital requirements

Among all SMEs, the larger units, if convinced, are capable of either financing themselves or get the finance from their banks. The smaller units will require loan at comfortable rates and other support to raise the loan. However, most of them have been able to expand their setup and are ready to install / invest for energy efficiency technologies which have good payback periods. Schemes like Energy Efficiency Financing are provided by SIDBI's and other Govt Schemes will play a catalytic role in implementation of identified energy conservation projects & technologies.

Skilled and Unskilled Manpower issues

All refractory industries in East & West Godavari, requires skilled and unskilled manpower. The skilled workers are required for the operation of kiln, motors, molding press etc for efficient operation. The available skilled manpower is not from technical back-ground but experienced through in the job training. The skilled man power require training on operation and maintenance of kilns, motors, molding operation for efficient use of machinery which leads to minimize the energy consumption in Industry.

In refractory industries in East & West Godavari, availability of skilled and trained manpower is one of the limitations.

The units have age-old inefficient practices and well-experienced non-qualified staff in these industries. Even if the qualified staff join for the sake of experience later they jump to other industries after getting sufficient experience due to low salaries.

Specialized and focused training by the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures among industry owners and workforce will result in energy savings and life of equipments.

Issues related to Service Providers

Many of the Energy Efficient technology

providers have not shown keen interest in implementation of new innovative technologies in the cluster due to higher price which cannot be afforded by the SMEs.

The service providers for refractory manufacturing industry cluster are available in the radius of 400 to 200 km and are mainly from important cities such as Vijayawada, Hyderabad and Vishakhapatnam.

Energy Resources and Sources

The details of energy required in refractory manufacturing cluster in East & West Godavari District discussed below.

Table 4 Details of Thermal Energy Used in Refractories Cluster

S.No	Particulars	Unit	Coal	Wood
1	State of fuel	Solid/Liquid/gas	Solid	Solid
2	Type of Fuel	Name	Coal	Wood
3	Fuel Source	Name of Company	SCCL/CIL	Local suppliers
4	Calorific Value	Kcal/kg	3500	2000
5	Price of Fuel	Rs../Ton	3000	2000

Table 5 Details of Electrical Energy Used in Refractories Cluster

S.No	Particulars	Details	
1	Type of Energy	Electrical	Diesel
2	Source of Energy	APNPDCL	Open Market
3	Type of Connection	LT	LT
4	Category	Type-1	-
5	Tariff	3.75/kWh	38.90/L

The power tariff from the APEPDCL is ₹3.75 per unit and the price of diesel in open market is ₹38.90/L which fluctuates from time to time.

Energy use & consumption analysis of Refractory Manufacturing Industries

The energy use & consumption analysis of different categories of refractory industries are presented below. The categorization of refractory manufacturing industries in East & West Godavari is presented below.

Table 6 Categorization Refractory Plants

S.No	Installed capacity range	Category
1	Up to 50 Tones per Batch	I
2	50-100 Tones per Batch	II
3	100-200 Tones per Batch	III
4	Above 200 Tones per Batch	IV

Analysis of Energy use in Category – I Refractory Industries

Energy Consumption & Profile of Category-I Refractory Industries.

S. No	Particulars	Units	Total
1	No of refractory industries	No	9
2	Avg. production per batch	T/batch	44
3	Avg. Yearly Production per Industry	TPY	573
4	Total Production by Cat-I Industries	TPY	5160
5	Avg. Electrical Energy consumptionby a Plant	kWh/Year	26015
6	Total Energy Consumption By cat-I Plants	kWh/Year	234135
7	Avg Coal consumption per Industry	T/Year	816
8	Total Coal Consumption by Cat-IIndustries	T/Year	7346
9	Sp. Electricity consumption	kWh/Ton	45.37
10	Sp. Coal Consumption	Ton Coal/Ton Product	1.42

The average total electrical energy consumption by 9 refractory industries in Category –I (Up to 50 Tones per Batch) consumes 234,135 kWh / year and sp. electricity consumption is calculated by above Industries is 45.37 kWh/Ton of product.

The average total coal consumption by 9 refractory Industries in category-I type consumes 7,346 T/Year and sp. coal consumption worked

out to be 1.42 Ton of Coal/Ton of Product.

Analysis of Energy use in Category –II Refractory Industries

The following table gives about the energy consumption for Category-II refractory Industries.

Table 8 Energy Consumption & Profile of Category-II Refractory Industries.

S. No	Particulars	Units	Total
1	No of refractory industries	No	11
2	Avg. production per batch	T/batch	85
3	Avg. Yearly Production per Industry	TPY	737
4	Total Production by Cat-II Industries	TPY	8,110
5	Avg. Electrical Energy consumption by a Plant	kWh/Year	25,567
6	Total Energy Consumption By cat-II Plants	kWh/Year	281,235
7	Avg. Coal consumption per Industry	T/Year	962
8	Total Coal Consumption by Cat-II Industries	T/Year	10,585
9	Sp. Electricity consumption	kWh/Ton	34.6776
10	Sp. Coal Consumption	Ton of Coal/Ton of Product	1.31

The average total electrical energy consumption by 11 refractory industries in Category –II (from 50 to 100 Tones per Batch) consumes 281235 kWh/ year and sp. electricity consumption is calculated by above industries is 34.68 kWh/Ton of product.

The average total coal consumption by 11 refractory Industries in category-II type consumes 10585 T / Year and sp. coal consumption is worked out to be 1.31 Ton of Coal / Ton of Product.

Analysis of Energy use in Category –III Refractory Industries

The following table gives the energy consumption for Category-III refractory Industries.

Table 9 Energy Consumption & Profile of Category-III Refractory Industries

S.No	Particulars	Units	Total
1	No of refractory industries	No	7
2	Avg. production per batch	T/batch	134.29
3	Avg. Yearly Production per Industry	TPY	1860.00
4	Total Production by Cat-III Industries	TPY	13020.00
5	Avg. Electrical Energy consumption by aPlant	kWh/Year	27838.52
6	Total Energy Consumption By cat-III Plants	kWh/Year	194869.67
7	Avg Coal consumption per Industry	T/Year	1046.43
8	Total Coal Consumption by Cat-III Industries	T/Year	7325.00
9	Sp. Electricity consumption	kWh/Ton	14.97
10	Sp. Coal Consumption	Ton of Coal/Ton of Product	0.56

The average total electrical energy consumed by 7 refractory industries in Category –III (from 100 to 200 Tones per Batch) consumed 194870 kWh / year and sp. electricity consumption is calculated to be 14.97 kWh/Ton of product.

The average total coal consumption by 7 refractory Industries in category-III type consumes 7325 T/Year and sp. coal consumption worked out to be 0.56 Ton of Coal / Ton of Product.

Analysis of Energy use in Category –IV Refractory Industries

The following table gives about the energy consumption for Category-IV refractory Industries.

Table 10 Energy Consumption & Profile of Category-IV Refractory Industries.

S No	Particulars	Units	Total
1	No of refractory industries	No	3
2	Avg. production per batch	T/batch	330
3	Avg. Yearly Production per Industry	TPY	6,250
4	Total Production by Cat-IV Industries	TPY	12,500
5	Avg. Electrical Energy consumption by aPlant	kWh/Year	30,954
6	Total Energy Consumption By cat-IV Plants	kWh/Year	61,908
7	Avg Coal consumption per Industry	T/Year	1,775
8	Total Coal Consumption by Cat-IV Industries	T/Year	3,550
9	Sp. Electricity consumption	kWh/Ton	4.95264
10	Sp. Coal Consumption	Ton of Coal/Ton of Product	0.28

The average total electrical energy consumption by 3 refractory industries in Category –IV (more than 200 Tones per Batch) is 61908 kWh/ year and sp. electricity consumption is 4.95 kWh/Ton of product.

The average total coal consumption by 3 refractory Industries in category-IV type is 3550 T/Year and sp. coal consumption is 0.28 Ton of Coal / Ton of Product.

Note: The specific coal consumption in refractory industries mainly depends on type of DD kiln, efficiency and % utilization.

The Specific Electrical consumption depends upon efficiency of equipment, environment, operating parameters and % utilization.

Summary of Energy Consumption

The summary of energy consumption for 30 refractory units studied during BEE-SME Program in Refractory Units are presented below based on data collected.

Table 11 Summary of Electrical and Diesel Consumption in 30 Ice Plants

S. No	Cate-gory	No	Plant Wise Details(Yearly)			Total Plants Details(Yearly)			Specific Energy Consumption (ton of Product)	
			Produ-ction(T)	Coal(T)	Electr-icity (kWh)	Produ-ction(T)	Coal(T)	Electr-icity (kWh)	Coal (Tons)	Electr-icity(kWh)
1	I	9	573	816	26015	5160	7346	234135	1.42	45.38
2	II	11	737	962	25567	8110	10585	281235	1.31	34.68
3	III	7	1860	1046	27839	13020	7325	194870	0.56	14.97
4	III	3	6250	1775	30954	18750	5325	92862	0.28	4.95
	Total	**30**	**9420**	**4599**	**110375**	**45040**	**30581**	**803102**		

Energy consumption Details-Plant Wise for Different Categories

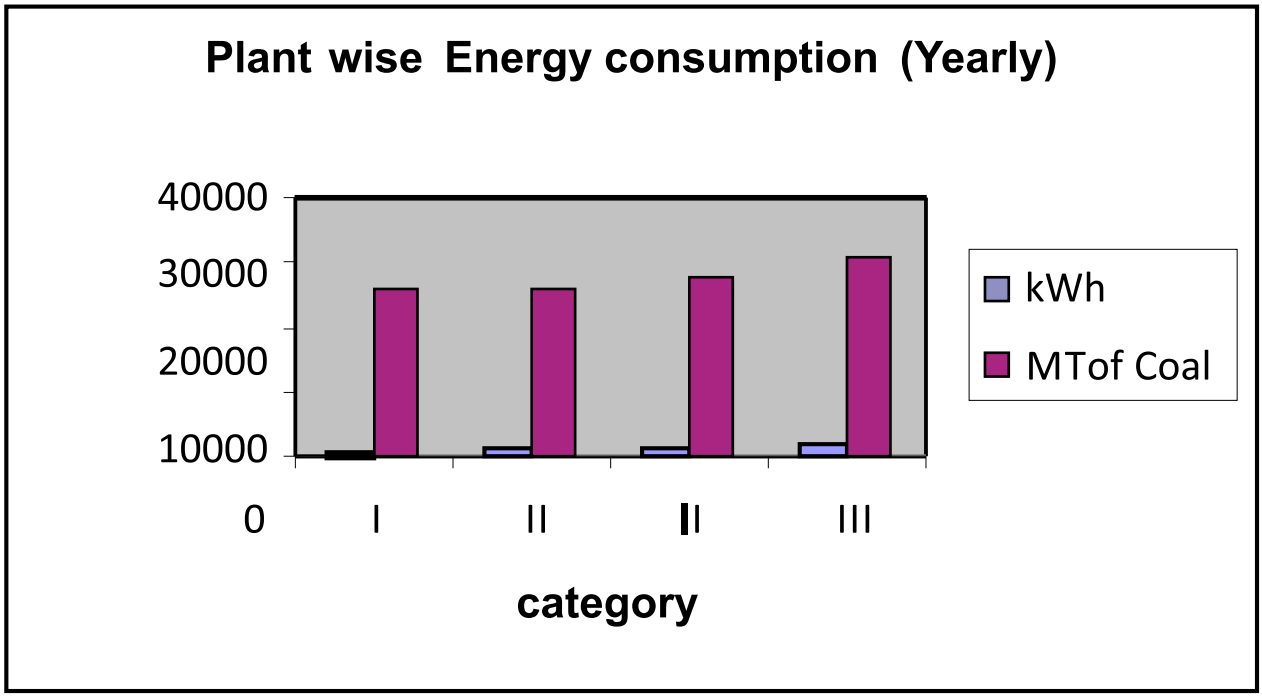


Fig 2 Production details of Category Wise plants

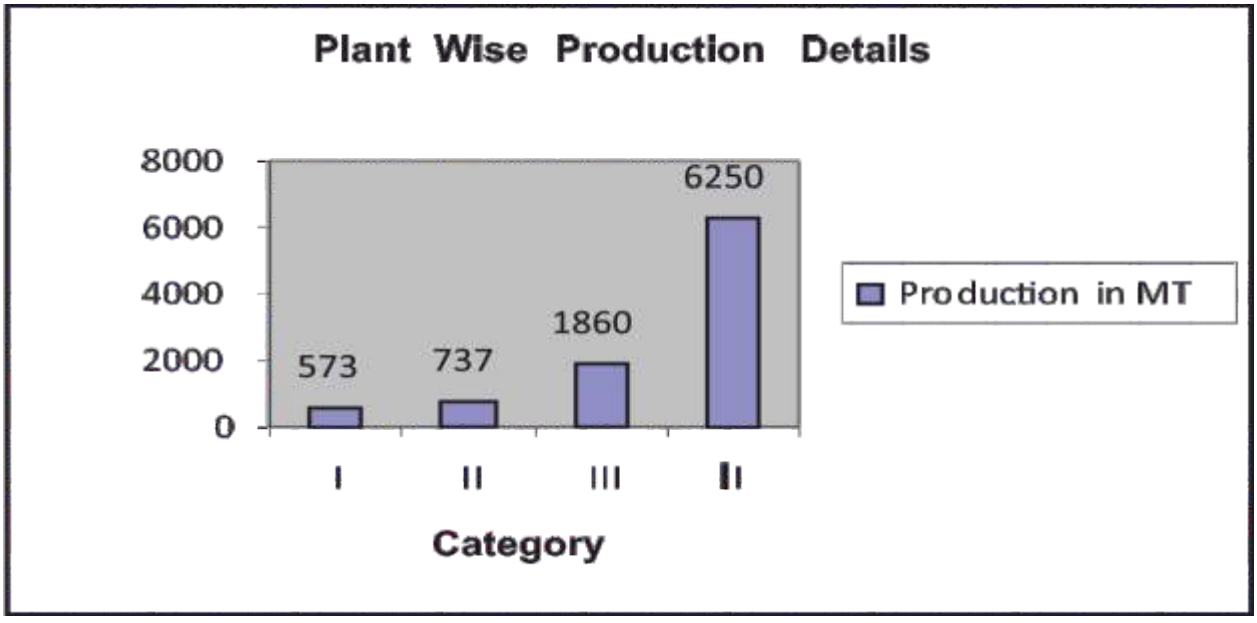


Fig 3

Fig 4 Total consumption Details -Category Wise for 30 Industries

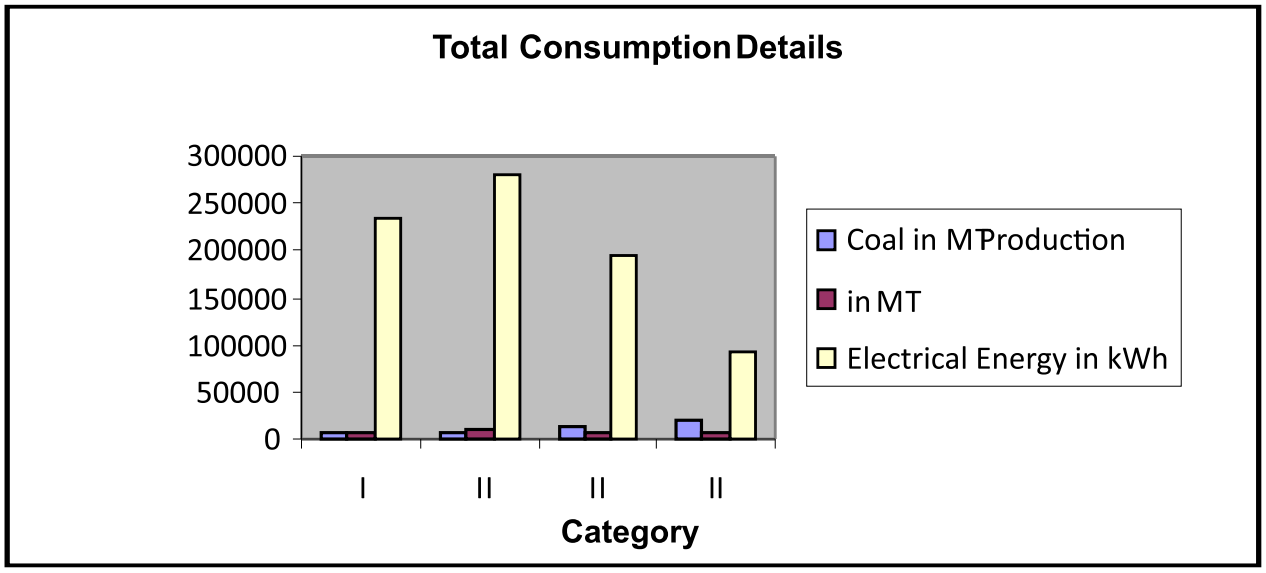
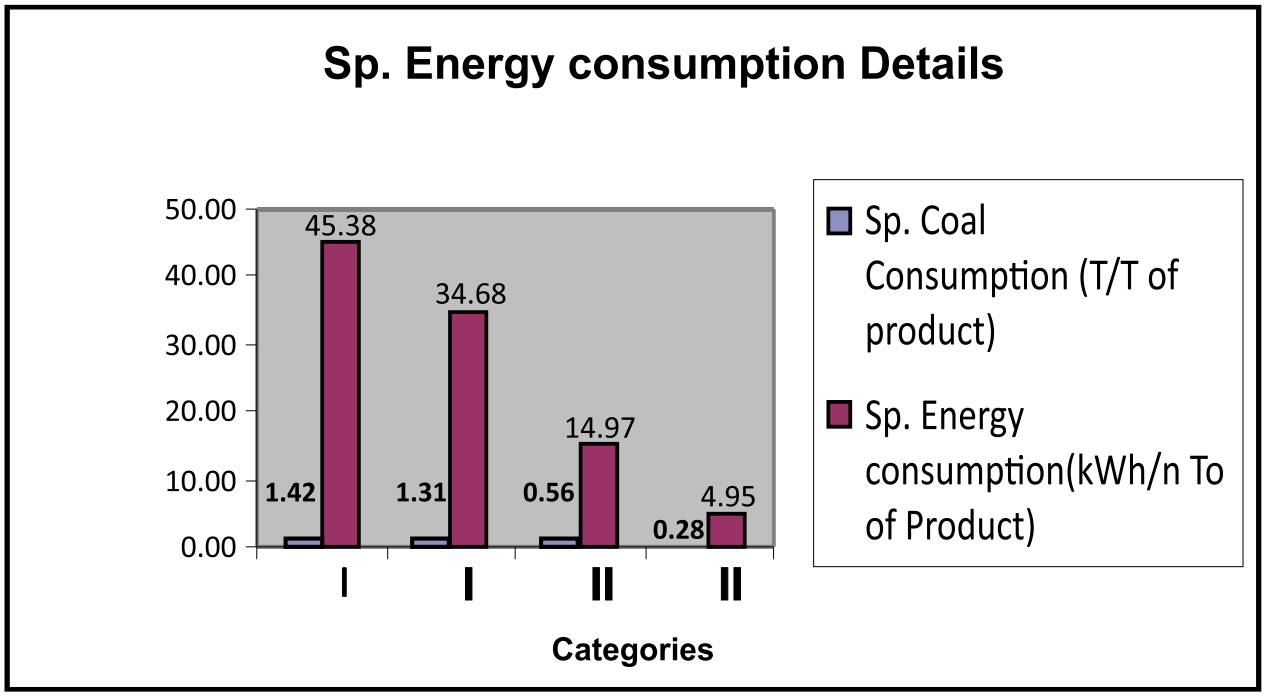


Fig 5 Specific Energy Consumption Details in different Categories



The total electrical energy consumption by 30 refractory Industries is about 8 lakhs kWh/ year, coal consumption is about 30581 MT/ year and total production is 45040 MT.

Note: The energy consumption in the refractory Industries depends up on DD kiln efficiency,% utilization and type of products manufactured.

Availability of Energy resources

The availability of energy resources in cluster level is assed based on the information collected from different sources and suppliers in the cluster. The below table give about the energy consumption details of various energy sources is provided.

Energy Consumption and Availability in Cluster

S. No	Type of Fuel	Units	Quantity/year	Availability
1	Electricity	kWh	8 lakhs kWh	Available from DISCOMS
2	Coal	MT	30581	Available form SCCL and CILand Traders

The total electrical energy consumption in 30 Industries in the cluster is 8 lakhs kWh/ year and power tariff is 3.75 /kWh. The power is supplied from APEPDCL through DISCOMs. The coal consumption by 30 Industries in the cluster is 30581 MT per year and coal is procured from SCCL by allotting the licenses from the Industries department and also open market and traders available in Rajamundry.

Factors Effecting in Energy Consumption

The following factors effects in Industries for higher energy consumption.

Efficiency of Kiln

The efficiency of kiln in refractory industries plays a vital role in coal consumption. All refractory industries are age old construction and consume more coal for the same out put. The reason behind high energy /coal consumption is due to heat loss from surfaces, incomplete combustion, inferior quality of raw material and operating parameter. Normally the DD kiln efficiency is around 45% which is higher side. But during the observation the kiln efficiencies were in between 20-25 % in all 30 units. This results in the higher energy consumption.

Capacity utilization

The capacity utilization is one of the factors for high energy consumption in refractory industries. The refractory industries located in East & West Godavari is depends upon the market requirements. Based on market requirements the refractory industries are producing 30-36 Batch of product and remaining days in between, the operations are kept idle. Due to this reason the heat in kiln is wasted and consumes more coal to start fresh operation.

Electrical Equipments

The electrical equipments in refractory Industries are mainly crushers followed by ball mill, clay mixture and pug mill. The environment in refractory industries are dusty in nature due to operation of crushers, clay etc. The efficiency of motors in above equipments decrease in dusty operation.

Another factor for equipment of higher energy consumption is efficiency of motors operated in those equipments. The old and re winded motors consume high energy consumption.

Skilled and Unskilled Man Power

Majority of the equipment operators and helpers deployed in cluster units are non technical and illiterates and had been taken based on past experience and do not have any technical skills and knowledge on energy conservation. This is also one factor for the inefficiency of the process and energy losses.

Technology Gap Analysis

Various technological gaps were identified in the units and these may be due to lack of awareness of technologies available in the market, lack of knowledge in tapping the potential from saving of energy losses and its monetary benefit, lack of awareness among the workforce.

All refractory manufacturing industries require kiln for heating of refractory material. The design and construction of kiln is done locally. The sp. coal consumption depends mainly on kiln efficiency.

There is a tremendous need to modernize / upgrade its technology and adopt energy efficient technologies in some of the areas. There are many technologies and energy efficient equipments available in the market which can be sourced from local service providers dealing in these technologies. Further, as per the discussions made with the management, they are interested to adopt the energy efficient motors in their refractory Industries.

During the study of energy use and technology audit in refractory industries, energy efficient motors, waste heat recovery systems and gasification are found to be feasible and energy efficient in the cluster. It requires only a retrofit of equipments to the existing machinery so as to make energy consuming components of the machinery efficient and also use of automation to ensure precise process control.

The following technology gaps were identified during the energy use and Technology Audit.

Energy Efficient Motors

The motors installed in refractory industries for the operation of crushing, pressing and ball mill are in efficient motors which were found with 75-90% operating efficiency and few motors were several times re winded. The reasons for such low efficiencies are mainly due to dusty environment, re-winded and low efficiency motors.

Now-a-days energy efficient motors are available at least 95 % efficiency in the market with latest technology. By implementing the energy efficient motors in crushers, ball mill, clay mixture, pug mill and mold pres, there will be tremendous energy savings.

Gasification Process

The operating thermal efficiency of the present traditional down draft kiln is only 10.1%, due to poor combustion efficiency, no proper air circulation, and high un burnt coal. Further, the heat treatment of the refractory bricks with coal is costly and the efficiency is also low. The biomass is available in plenty in the area and also easily available. As a long term option, it is recommended to install biomass gasifier system for supplying heat to the down draft kiln.

Biomass Gasification

Gasification is the process of converting solid fuels to gaseous fuel. It is not simply pyrolysis; pyrolysis is only one of the steps in the conversion process and is combusted with air (partial supply of air) and reduction of the product of combustion, (water vapour and carbon dioxide) into combustible gases, (carbon monoxide, hydrogen, methane, some higher hydrocarbons) and inerts, (carbon dioxide and nitrogen). The process produces gas with some fine dust and condensable compounds such as tar.

The producer gas generated is used for thermal application and heat generated by combustion of biogas is used for various heating purposes. Like other gaseous fuels, producer gas can also be controlled critically. This also paves way for more efficient and cleaner operation. The producer gas can be conveniently used in number of applications.

Wood Gasifier

This system is meant for biomass having density in excess of 250 kg/m3. Theoretically, the ratio of air-to-fuel required for the complete combustion of the wood, defined as theoretical air required for combustion is 6:1 to 6.5:1, with the end products being CO_2 and H_2O.

Whereas in gasification system, the combustion is carried out at sub-stoichiometric conditions with air-to-fuel ratio of 1.5:1 to 1.8:1. The product gas thus generated during the gasification process is combustible. This process is made possible in a device called gasifier with

limited supply of air. A gasifier system basically comprises a reactor where the gas is generated, cooled, cleaned and is burnt. The clean combustible gas generated can be used for power generation in diesel-generators or for thermal use by directly supplying to the combustor through an ejector.

It is estimated that a minimum of 25% to 30% of the present coal consumption savings can be reduced due to the following reasons:

- Improved combustion
- Better control of the kiln temperature and reduces over heating
- Less radiation losses from the grate
- The fuel feeding can be critically controlled
- Less flue gas losses

Waste Heat Recovery System

The waste heat recovery system is meant to utilize generated flue gas during the plant operation. The flue gas from chimney has high temperature which can be used for heating of stocks and raw material.

So, it is recommended to install waste heat recovery system for pre-heating the refractory bricks for removing moisture content by using heat in waste flue gases. The ambient air can be supplied to the heat exchanger by blowers and heat may be recovered from the flue gases. The heated air can be used for pre-heating of the refractory bricks.

TECHNICAL SECTION

CHALLENGES IN REFRACTORIES FOR SECONDARY STEEL MAKING FOR CUSTOMISED CLEAN STEELS PROCESSING IN STEEL WORKS OF INDIA

Susanta Sarkar, Ex-GM, SRU (SAIL), J.Dasgupta, Ex-GM (Tech.), SINO-Global, Ajay Kr. Dasgupta, Ex-ED I/C, RDCIS (SAIL), Kolkata

Abstract

The environment friendly clean steelmaking demands adoption of varied secondary steelmaking processes, coupled with high speed continuous casting of steels in the operating steel plants. The steel ladles are, therefore, subjected to longer residence time, higher tapping temperatures from BOF, besides stringent operating conditions of ladles for inert gas purging, vacuum degassing/arcing and alloying of steels for adherence to superior qualities of customised end use products.

There are wide categories of SSM facilities, which are available in the country today. Broadly, Secondary Steel Making units are based on:

- Stirring Systems (OLP, LRS, etc.)
- Ladle Heating System (LF, VAD, etc.)
- Vacuum Degassing Systems (VOD, VD, RH, RH-OB, etc.)

However, it is the final steel products that determine the choice of SSM processes. Currently in the steel works of India, the Cost components of refractories, are comprising direct refractory maintenance of steelmaking furnaces (RED), operational refractories (FCP) and related project activities for tonnage carbon steel plants is ranging from 3-4% of the end steel products, i.e. Rs. 2,100-2,600/-tfs approx., with the selling price of end steel products as Rs. 65,000/- per tonne. From these refractories consumption components, about 2-2.5 kg/tcs of refractories are consumed only in Secondary Steel ladles, from total consumption of 5-6 kg/tcs(refts.) in new generation steel plants.

The paper describes some popular vacuum degassing systems for clean steelmaking and the ladles zoned lining as practised in 300T SSM Ladles of SMS-2, Bokaro Steel Plant, SAIL and 160T SSM Ladles of SMS-2, Vishakhapatnam Steel Plant (RINL), Vizag along with the process regimes, trend of life and characteristics of MgO-C bricks used in critical slag lines of these ladles.

(Keywords: Clean Steel, Secondary process, SSM Ladle, Slag Zone MCB, Wear profile, etc.)

Introduction

Recent times have seen an exponential growth in the demand for high quality low carbon aluminium killed steel sheets for use in automotive and white goods industries. In addition to this silicon and aluminium – silicon killed long products like, plate, rails, auto-segments, etc. are also having stringent quality parameters of end products, which are environment friendly also. Thus, there is continual emphasis on the production of clean steels using the primary and secondary steelmaking units, and subsequently, on the prevention of exposure of liquid steel to air at various stages during its transfer, as well as entrainment of oxygen – rich ladle slag into the tundish.

Several steps have been taken in both the Public & Private Sectors Steel Works of India, towards production of clean steels on a consistent basis and for this reason the secondary steelmaking processes and the lining performances of SSM ladles have been highlighted in this paper.

Cleanliness Requirements of End Steel Product(s)

The different aspects of cleanliness and their distinct influence on product quality need to be understood. In the present day scenario of demanding qualities of end use steel products,

the following attributes are normally expected in clean homogeneous steel products:

- Restricted amount and size of NMIs of mainly complex oxides, sulphides, nitrides, etc.
- Low content of residual impurity elements such as, S, P, O, N, H, etc.
- Absence or minor amount of trace elements like, As, Sn, Sb, Cu, Pb, Bi, etc.

The undesirable impurities are present in steel products, either in the form of elements in solid solution of simple or complex compounds depending upon their content and thermodynamic stability. The cleanliness requirements for the various steel grades are, therefore, application-specific.

The **Table No. 1** shows a broad consensus on the cleanliness requirements of different steel products for specific end uses.

Table – 1
Cleanliness Requirements of Steel Product(s) for End use needs

Product	Max. impurity content		Max. inclusion size (um)
	Total (O)	Total (N)	
Line Pipe	30 ppm	30 ppm	100
Deep drawn Sheet	-	30 ppm	100
Heavy Plate	20 ppm	30 ppm	Cluster 200; single 20
Drawn & Ironed Can	20 ppm	30 ppm	20
Wire	30 ppm	60 ppm	20
Tyre Cord	15 ppm	40 ppm	15

Metallurgical Aspects of Secondary Refining of Steel

The secondary refining covers metallurgical operations like, deoxidation, desulphurization, alloying, heating, inclusion removal / shape modification and degassing. These processes have made it possible to achieve stringent composition and quality requirements to meet customer's requirement. Further, Secondary refining has provided the vital capability of making special and alloy steels.

Depending on the desired end result, a large number of ladle refining processes have been developed, which can be classified into the following:

- Stirring Process: Gas Rinsing and Rinsing with Synthetic Slag.
- Injection Process: Pneumatic Injection & Wire Injection.
- Vacuum Process: Steam Degassing, Re-circulating Degassing, Ladle degassing, etc
- Heating Process: Ladle Furnace, VAD, etc.

Some of the important ladle refining processes are described briefly as follows:

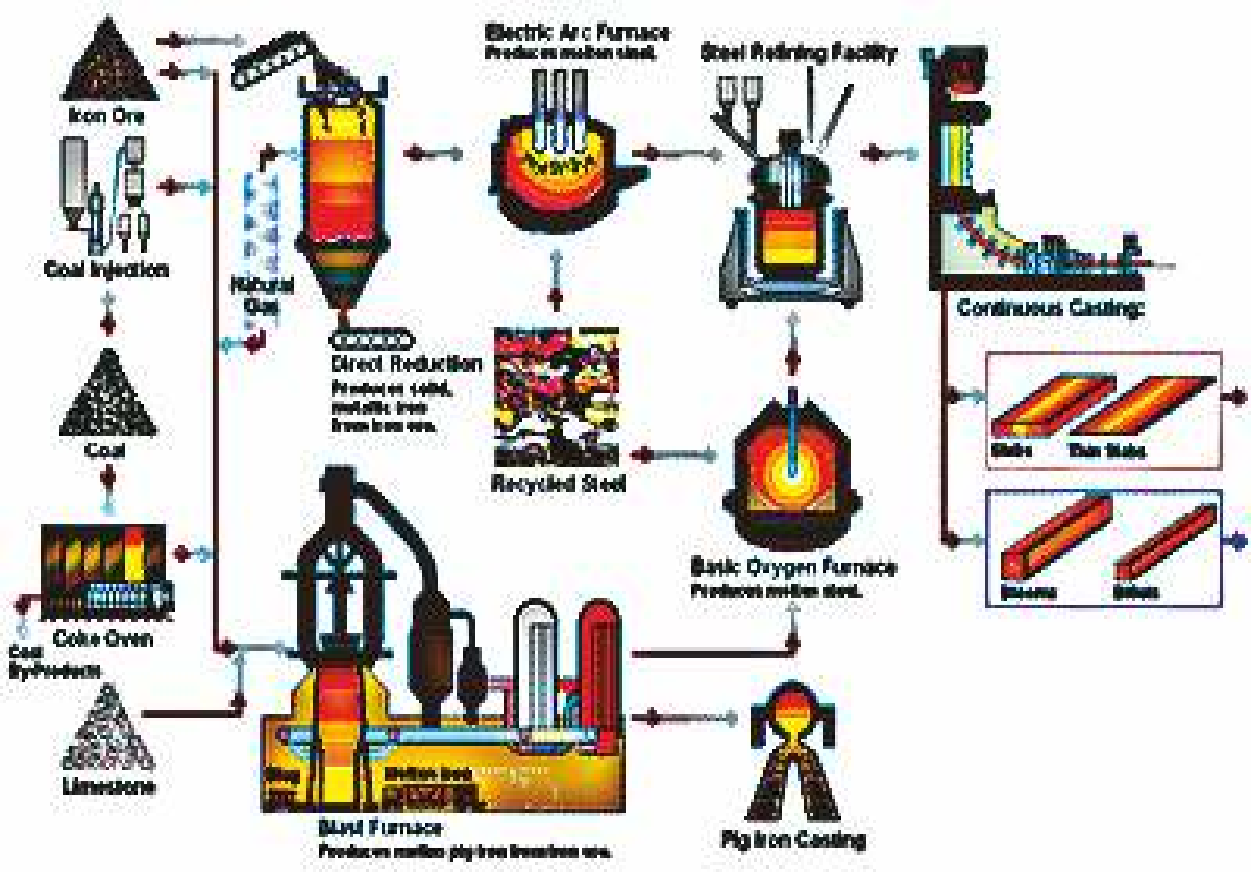
Vacuum Refining Processes

Vacuum refining technology started in the late fifties for removing hydrogen from steel in forging quality ingots. Application of vacuum and stirring results in highly agitated bath surface, facilitating stag-metal reaction, inclusion removal, etc.

As the application requirements for special steels like, steels for auto-sector, line pipe steels, electrical steels, stainless steels, etc. are becoming more severe, the stringency in respect of residuals and cleanliness of steel is also increasing. Today progressive steel makers have achieved total non-metallic residual content (C+S+P+H+N+O) of less than 100 ppm. A typical flow chart of current steelmaking process using ladle metallurgy for production of high value products is given in **Fig.1.**

Vacuum refining processes can be sub-divided into two basic popular categories:

i) Ladle Degassing, and
ii) Recirculating Degassing



Process Diagram of Secondary Steel Making with BOF & Concast Route
Fig.No. 1

Ladle Degassing

Ladle degassing can be divided into:

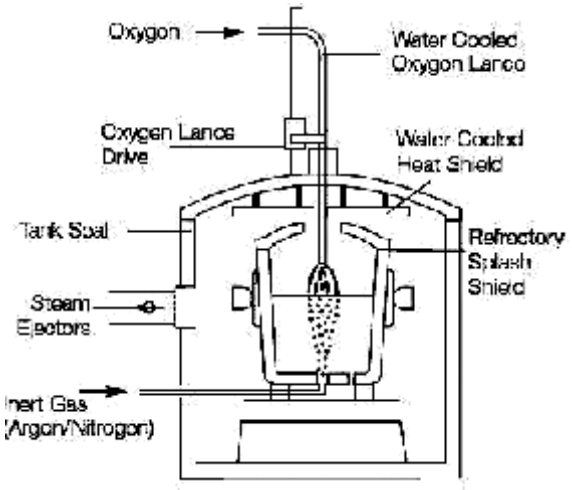
- Vacuum ladle degassing or tank degassing, where the ladle is placed inside a vacuum vessel, linked to the steam ejectors. Processes like, Vacuum Degassing (VD), Vacuum Oxygen Decarburisation (VOD), etc. fall in this category.
- Vacuum ladle degassing with heating facility, which include Vacuum Arc Degassing (VAD), ASEA – SKF, etc. Out of these VAD is more commonly used in processes for steel plants of India.

These processes are briefly described below for easy of understanding.:

Vacuum Oxygen De-carburisation

Vacuum Oxygen De-carburisation and refining is an important vacuum refining process for production of **stainless steels** that require extra-low carbon (0.03% max), nitrogen and hydrogen levels. In this process, the ladle is placed in the vacuum chamber and oxygen is blown from the top lance under vacuum to carry out preferential oxidation of carbon in presence of high chromium leading to reduced chromium loss.

Fig.2 gives an overview of the VOD Process with different components.



Schematic View of VOD Process

Fig No. 2

The rate of de-carburisation at the beginning of the treatment depends upon the bath temperature and silicon content of liquid steel. The rate of de-carburisation during intermediate period is controlled by oxygen flow rate and height of the oxygen lance.

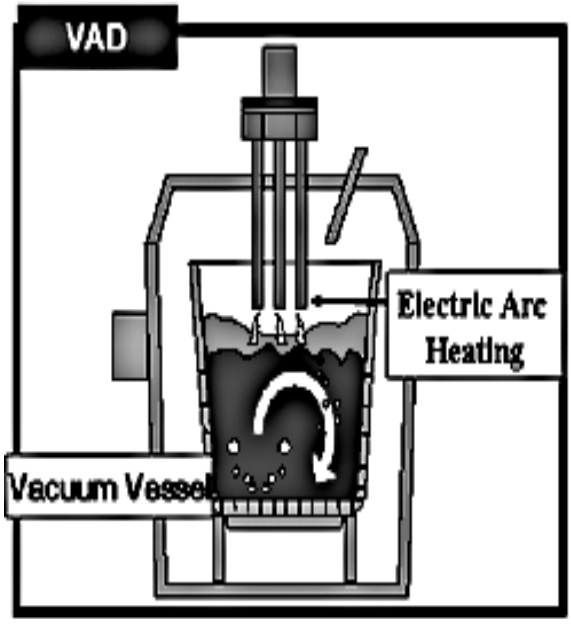
The CO/CO_2 ratio and vacuum level are monitored continuously to determine end of oxygen lancing. The vessel pressure is reduced to lower level and argon stirring is carried out further to proceed the reaction between the dissolved oxygen and the remaining carbon. In this process, through vigorous stirring carbon can be reduced to levels of (<0.01%).

Vacuum Arc Degassing (VAD)

Vacuum Arc Degassing (view in **Fig.3**) and refining is a stationary unit, in which the ladle is placed in a vacuum tank and is stirred by inert gas through porous plug at the bottom with provision for heating through electrodes and alloy addition. The function of this process is similar to that of LF, but the advantages of this process over LF are:

a) Faster and higher level of desulphurization, as high as 80% is achieved for production of special steels with sulphur levels as low as 0.005%.

b) Removes entrapped gasses like, hydrogen (<2ppm), nitrogen, oxygen, etc. from liquid steels.



Schematic View of VAD Process
Fig. No. 3

Recirculating Degassing

In this process, liquid steel is circulated between ladle and a vacuum chamber at a very fast rate, as high as 150 t/minute. The refining of steel takes place in the refractory lined vessel under vacuum. In order to facilitate the metal circulation, vacuum is created in the chamber above the snorkels of degasser, snorkels are immersed into the liquid steel and argon is injected through one of the snorkels. After exposure to vacuum, the steel re-enters the ladle through the other snorkel. Thus a dynamic vacuum is created and recirculation flow is established.

Alloy additions are carried out under vacuum using a vacuum lock. RH and its modified version - RH-OB, are the most widely used degassing process today for steel plants of India.

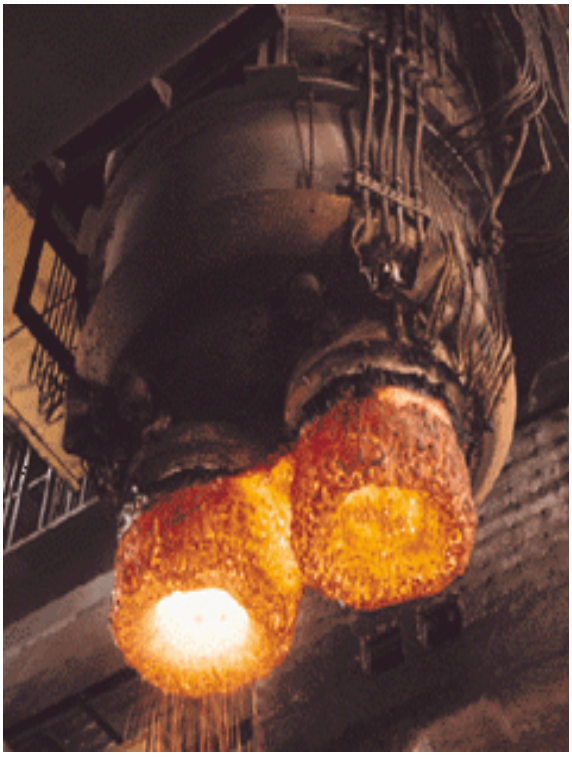
RH (Ruhrstahl – Heraeus) Process

The process is most popular because of its capacity as follows:

- Achieve low and ultra-low C(<30ppm) for extra deep drawing interstial free electrical steels, etc.
- Reduce hydrogen(<1ppm) for hydrogen sensitive products like, plates, rails, etc. and proper control of Nitrogen.
- Have a large amount of alloying scope (as for silicon steel).

RH-treatment improves the occurrence of alumina cluster and reduces surface defects as compared to other ladle treatment processes. The RH-process now-a-days is equipped with auxiliary heating facility also. The cross-sectional view of RH vessel & system are shown in **Fig. No. 4** & view of RH snorkel in hot condition after ladle degassing treatment is shown in **Fig. No. 5**.

Sectional View of RH Degasser Vessel & Snorkel Fig No. 4



RH Degasser Snorkel after Ladle Degassing Oprn. Fig No. 5

In Bhilai Steel Plant of Steel Authority of India Ltd., about 1.4 million tonnes of Rail Steels are processed through RH-Degasser and the operating parameters in BSP-SAIL are placed in **Table No. 2** for a ready reference.

RH – OB Process Operating Characteristics (Ref : BSP-SAIL)

RH-OB, a variant of RH degassing process with provision of oxygen blowing, has been quite popular for producing ultra-low carbon & interstitial free low residual very clean steels. Quality of steel is enhanced through improved stirring to remove inclusions. Total oxygen content of less than 15ppm is possible to achieve through this process and carbon level as low as 10ppm can also be attained.

With the aim of understanding the specific process parameters as prevalent during operation of RH-Degasser units in BSP, SAIL is placed in Table No 2 below:

Table No. 2
RH Degasser-(RH-1, SMS-2)
Bhilai Steel Plant, SAIL

i) Steelmaking Route: BF-LD-LF-RH-Casting (Rail Steel)

ii) Steel Qulty: Medium Carbon (Carbon-0.65%,low H_2)

iii) No. of RH Degasser: 2

iv) Capacity of RH: 130 mt

v) RH-In Temp.: 1590-1610^{0}C

vi) RH-Out Temp.: 1560-1590^{0}C

vii) Treatment Time: 15 mints. (Normal heat), 18 mints. (First heat)

viii) Vaccum Achieved during operation: 0.01 mbar or so.

ix) RH in Operation at any time: 1 Unit / 2-Units

x) Heats per day per RH : 30-35 Nos.

xi) Idle time: 15-20 mints.

xii) Temp. of RH when Idle: 900-1000^{0}C

xiii) Oxygen PPM in steel (before RH): 10-15 (Celox)

xiv) Oxygen PPM in steel (after RH):-3 (Celox)

xv) H2 in Steel (before RH): 3.0–5.0 ppm

xvi) H2 in Steel (after RH): <1.0 ppm

xvii) Argon Flow Rate (Nm^3/hr): 30–35

xviii) Argon Pressure (Kg/Sq.cm.): 8-9

xix) RH Steel Chemistry (Typical) C-0.65%, Mn-1.115%, S-0.03%, P-0.03%, etc.

xx) **Usually no chemistry adjustment is done in RH Degasser.**

xxi) RH Slag Chemistry:

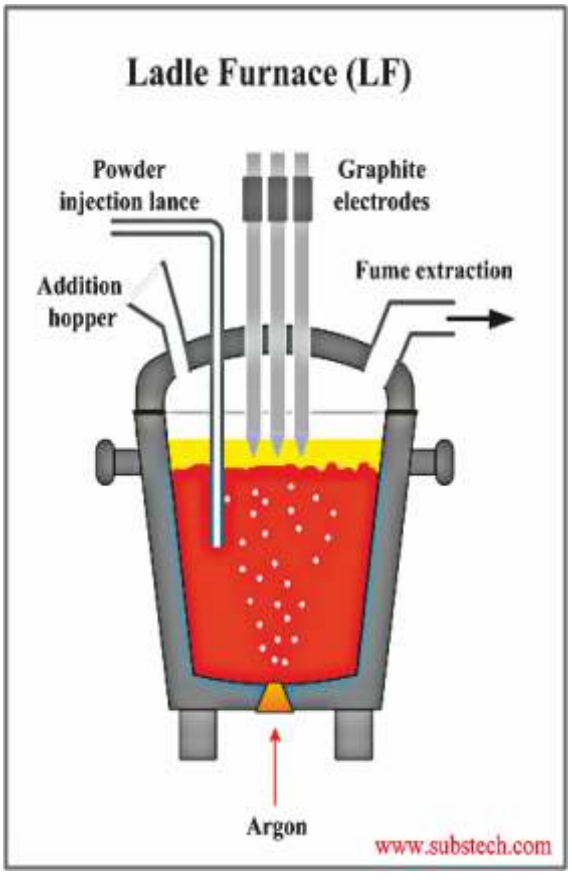
SiO_{2-}	-	12.90	MnO	-	1.26
CaO	-	45.50	P2O5	-	2.05
MgO	-	15.30	S	-	0.14
FeO	-	14.60	CaO/SiO_2:		3.5-3.6
Al_2O_3	-	0.90			

- **Pre-Heating Temp. : If idle for more than 15 mins, preheating starts at 900^{0}C**

Ladle Furnace

This furnace in SSM system, has become quite popular due to ease of operation & maintenance. It may be stated that large units of LFs are in operation in almost all PSU Steel Works and the capacity ranges from 60T to 300T size. The Figs No. 6, & 7, depict the process steps and operational regimes.

In all the plants high duty Mag.-Carbon lined steel ladles after taking & holding the tapped steel from BOF are taken to Ladle Furnace stand for secondary treatment. The lining performance of these lades shall be described in subsequent sections.



Ladle Furnace in Oprn.-Sectional view
Fig No. 6

Ladle Furnace in Oprn. – Isometric View
Fig No. 7

Secondary Steel Ladles in India

Over the years, several paradigm shift in design & technology of SSM Ladles have occurred in the steel plants of India. Of late, the metallurgists demand steel ladles to perform reliably and longer without affecting the ultimate quality of steels.

The processing ladles are, therefore, subjected to longer residence time, higher tapping temperature of steels from BOF, besides severity in operating conditions of ladles for inert gas purging from bottom & alloying of liquid steel for adherence to quality of end products. In fact, in the steel works of India, about 2-2.5 kg/tcs of refractories are consumed only in secondary steel ladles, out of total consumption of 5-69 kg / tcs of refractories consumed for maintenance / operation of the process units in modern plants with BOF, SSM & Continuous Casting systems (high speed).

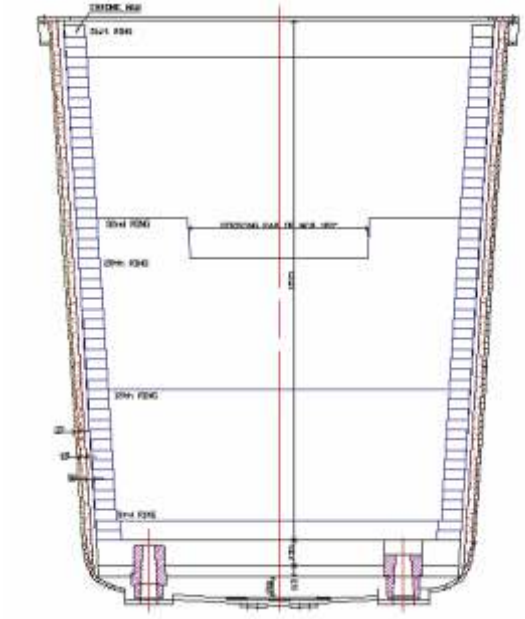
Studies on SSM Ladle Lining Wear

Ladle lining is divided into four zones such as, bottom, metal zone, slag zone and free board area. Ladles are generally rejected due to erosion in certain areas, most common being slag zone, lower metal zone and bottom impact areas. Wearout pattern also indicates higher erosion in purging plug side of slag zone.

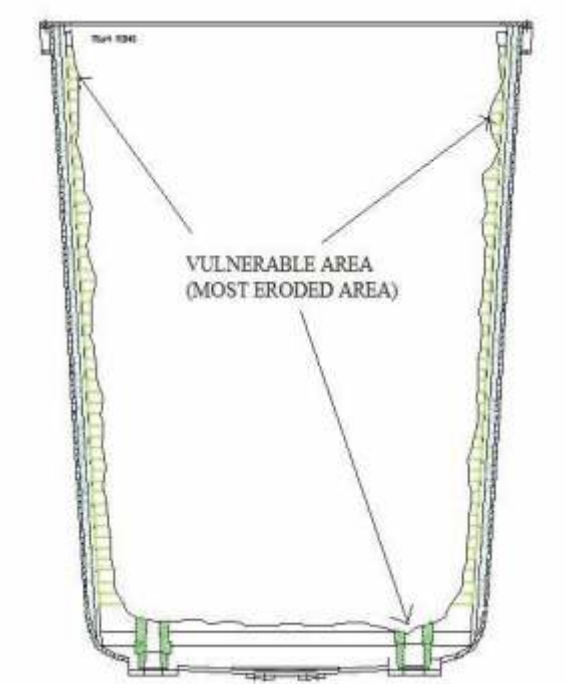
This section deliberates on the process regimes, zoned lining designs, lining life and wear patterns of the SSM Ladles, namely 300T SSM Ladle of SMS-2, Bokaro Steel Plant - SAIL, and 160T SSM Ladle of SMS-2 Vishakhapatnam Steel Plant (RINL), Vizag.

300T SSM Steel Ladle of BSL (SAIL)

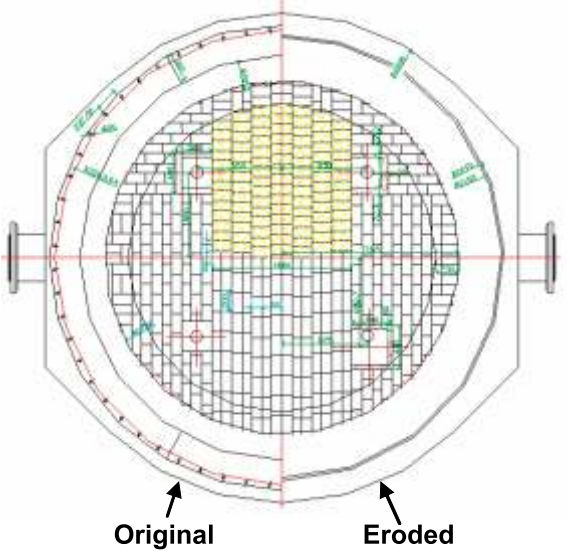
Steel Melting Shop No. 2 of Bokaro Steel Plant is equipped with 2 nos. of 300T BOF and 15 nos. of steel ladles. For secondary refining there are 2-nos. of LF and 1-no. of Ladle Rinsing Station. There has been gradual changes in lining configuration w.r.t. quality & zoning with $A1_2O_3$ – MgO-C and MgO-C combination. The lining details & profiles are shown in **Fig. No.8, 9 & 10.**



Profile of 300T Ladle (New Lining) BSL-SMS-2
Fig.No.8



300T SSM Ladle (BSL) – Erosion of Wall Lining at Campaign End (Vertical Section)
Fig No. 9



300T SSM Ladle (BSL) – Original Bottom Lining vs. Eroded Lining at the Campaign End (View from top)
Fig. No. 10

The **Table No. 3 & 4** give the operating regime & MCB brick properties, while the batch composition of high-duty MgO-C brick of the A-Class Company is placed in Table No. 5 and these categories of brick are in use in critical Slag Zone area of SSM Ladles.

Table No. 3
Operating Regime of 300T- BOF & 300T- SSM Ladle
Plant: BSL, Shop: SMS -2 (BOF –CCD), Yr.: 2023-24

Parameter	Data
BOF Cap.	300 T
BOF Tap Temp.(1660 - 1700°C)	99.8%
Slag Splashing of Heats (BOF)	>95% heats
On Line Purging (Ar)/% heat	100
SSM Route	LF
LF – Treatment (% heats)	100
Casting Time (minutes)(Blooms/slab)	56
Metal Holding time in Ladle(Avg.)	120 – 150 , minutes
Ladle Return Time (minutes) (Casting end to tap start)	40 - 60
Ladles in circulation / Day	8 – 9 Nos.
Slag Basicity	1.8 – 1.9
Steel Killing	Al/ Si
Ladle Life (Heats) – Avg.	99.5

Lining & Life	
Bottom Working Face	Al2O3 – MgO-C + MgO-C
Metal Line (WF)	MgO-C (8-9% FC)
Slag Zone (WF)	MgO-C (10-11% FC)
Ladle Life (Heats)	85-100

Table No. 4
Characteristics of Slag Zone brick (300T Ladle - BSL)

Parameters	Source – A Class Co.
Chemical (Loss Free) – wt%	
MgO	95.10
SiO_2	0.60
Al_2O_3	1.80
Physical:	
(As received)	
AP (Vol%)	3.42
BD (gm/cc)	3.10
LOI (wt%)	12.80
FC (wt%)	11.60
After Coking:	
AP (Vol%)	8.00
BD (gm/cc)	3.10
App. Sp. Gr.	3.40

Table No.5
MgO-C brick – Batch Composition (wt %), with no addition of salvaged MCB (Slag zone use)

Sl.No.	Items	Grain Size(mm)	(% in batch)
1.0	High Purity DBM (MgO- 96/97%)	3 – 4	25.0
2.0	-do-	1 – 3	45.0
3.0	-do-	0 – 1	16.0
Total			86.0%
4.0	Flaky Graphite (FC-92/94%)	Fines	9.0
5.0	Extra –hard Pitch	-do-	1.0
6.0	Metallic Al-Powder	Atomised	1.5
7.0	Phenolic Resin (Bonding)	Liquid +Powder	3.0
Total			100.5
Formed MCB bricks baked at 180-200°C (reducing atmosphere)			

Micro-structural Study of MgO-C brick of Slag-Zone (300 T Ladle-BSL-SMS-2)

After laboratory scale evaluation of MgO-C brick (Slag Zone) of 300T steel ladles of BSL, micro-structural studies have been carried out on the brick samples of Source-A(1) for understanding of the internal matrix. The findings are summarised below:

Microstructure of brick: Source – A(1)-BSL use

Base Material Identified:

a) Fused magnesia: Normal type.

b) Dead burnt magnesia: high purity, sea-water type

c) Flaky nature of graphite

d) Metalic A1-powder

Texture:

Maximum coarse DBM and fused magnesia grain upto 3mm are found to be present in the brick. Mostly fused magnesia and DBM grains are found in the coarse fraction of the brick in a ratio of 1:1 approx. The matrix contained graphite flake, fused magnesia and metallic A1-powder.

Fig. No. 11 (A & B) are showing the matrix details as mentioned above.

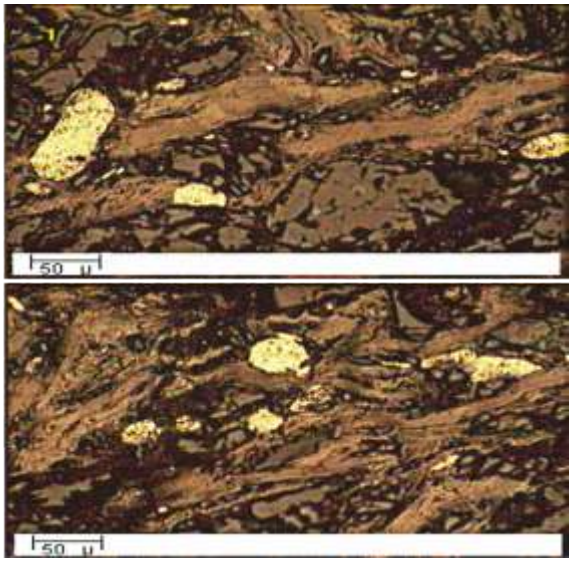


Photo-micrograph (A) : Showing Graphite Flake, Fine Fused MgO grains and metalic Al-powder

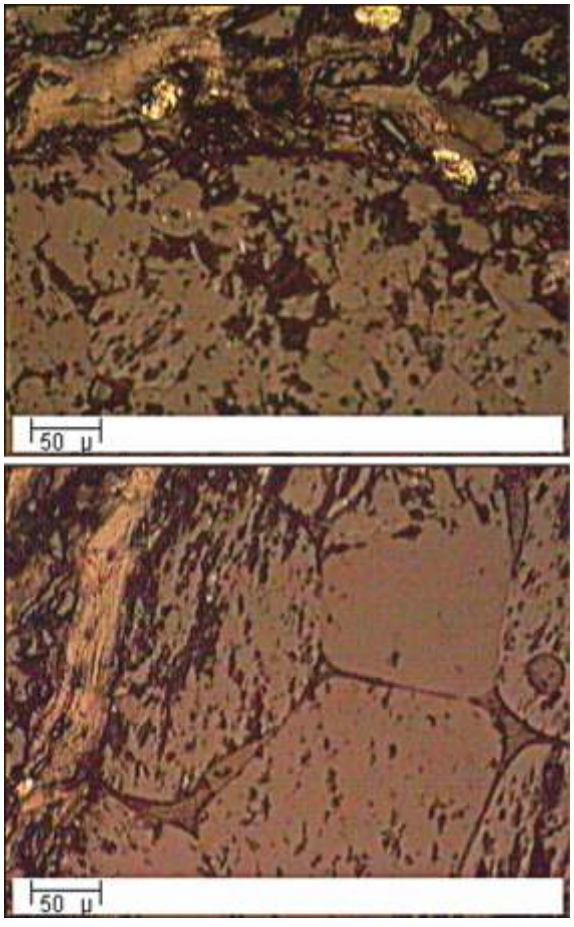


Photo micrograph (B) : Showing Dead Burnt MgO grain in contact with Matrix.
Fig. No. 11 (A & B)

STUDIES ON 160T SSM LADLE, SMS-2, VSP(RINL)

In SMS-2 of VSP, ladles are usually rejected due to erosion in certain areas, like slag zone & lower metal zone. Wear out pattern also indicates higher erosion in porous plug side of slag zone. In this section, the process details and the zoned lining design as practiced, characteristics and micro-structure of MgO-C refractories used in critical slag lines of 160T-SSM ladles.

Table No. 6 summarizes the process parameter of 160T SSM Ladles operating at VSP. The superior quality MCB bricks of another Source of A-Class Company(A-2) are being used for the Slag Line of subject ladle, while the brick was developed by analyzing the slag chemistry and process parameters of VSP, are detailed in **Table No. 7**.

Table No. 6
Operating Regime of 160T – BOF & 160T - SSM Ladle Plant: VSP (SMS-2),Yr.: 2023-24

Parameter	Data
BOF Cap.	160 T
BOF Tap –to-Tap Time (minutes)	40
BOF Tap Temp.(°C)	> 1700°C (10%) 1660 - 1700°C (70%)
Slag Splashing of Heats (BOF)	100%
On Line Purging (Ar)	100%
SSM Route	LF – RH
LF – Treatment	100% of Heat
Casting Time (minutes)	60
Ladle Return Time (minutes)	45
Metal Holding time in Ladle	120 minutes
Heats/Ladle/Day (Nos.)	6
Slag Basicity	1.8
Steel Killing	Al/ Si
Ladle Life (Heats)	71.7

Table No. 7
Quality of MgO-C bricks – Source-A(2)-(Slag Zone)

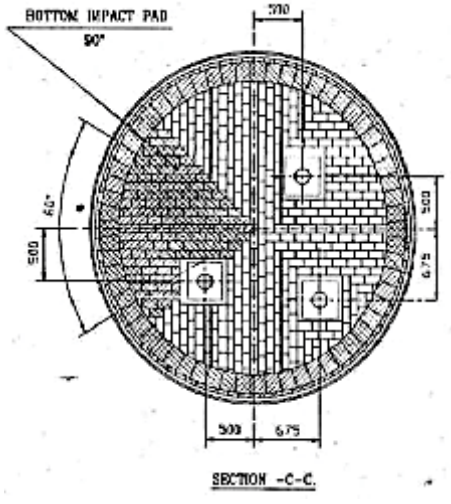
Parameters	Value
MgO (wt%), min	97.0 (ignited basis)
FC (wt%), min	11.0-12.0
AP (v%), max	3.0-4.0
BD (gm/cc), min	3.1-3.2
CCS (kg.cm2), min	350-380

The **Figure No.11** is depicting the lining profile of the subject ladle and the pattern of residual lining at the campaign end is indicating an uniform pattern of erosion both for metal and slag line. This was the optimized lining pattern

with quality zoning in 160T ladle of VSP. The **Fig. No. 12** gives an overview of the zoned bottom lining using Al_2O_3-MgO-C/AMC brick in the steel impact segment.

Lining Profile vs. Erosion

Original Lining vs. Eroded Lining
of 160T SSM Ladle of VSP (RINL)
Fig. No. 11



Zoned Lining of Ladle Bottom with the
Impact Pad (160T SSM Ladle of VSP-RINL)
Fig. No. 12

Fig. No.13 depicts photomicrographs of composite fused magnesia used in MgO-C brick making (Slag Line 160T SSM Ladle VSP)

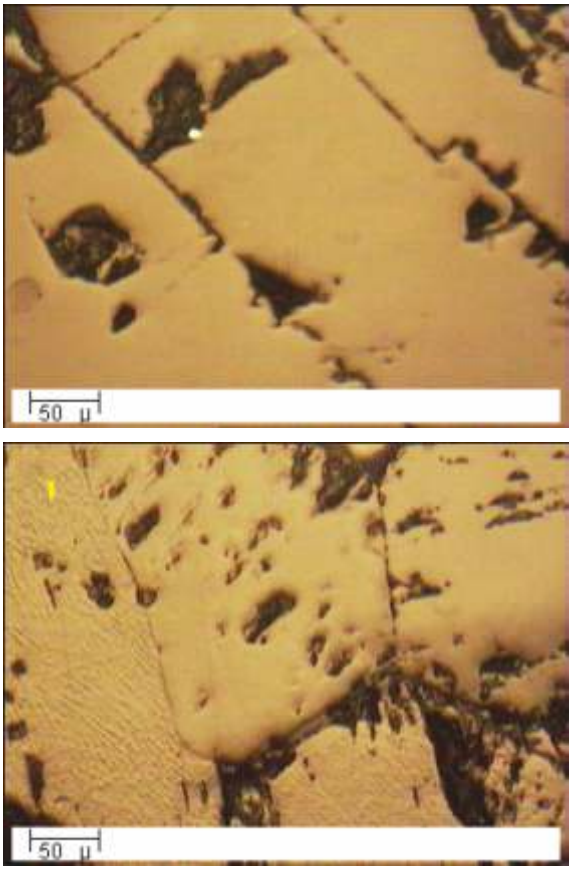


Photo-Micrographs of Composite Fused Magnesia grain showing Direct bonded Periclase Crystals.
Fig No. 13

Conclusions:

1. Clean steelmaking necessitates adoption of state of the art secondary steelmaking processes, coupled with vacuum degassing & arcing in newer steel plants having BOF, Tundish & Continuous Casting systems for varied carbon steels & SS steelmaking with lower & lower impurities.
2. In steel plants of SAIL & VSP (RINL), there

is increasing usage of secondary refining processes for the ultimate end products for different customers.

Currently BSL, SAIL & VSP (RINL) are operating with On-Line Purging, Argon Rinsing Station, LF, VAD, IRUT systems, etc. depending on the qualities of end steel products.

3. Secondary Steel Making Ladles in most of the Steel Plants of India are having zoned lining with varying qualities of high duty Alumina-Magnesia-Carbon and Magnesia - Carbon bricks, made of fused-high purity MgO grains of different origins of import.

4. SSM ladles in the subject plants are under Total Refractory Management and the lining life ranges from 80-120 heats with tailor-made plant specific intermediate repairs for ladle slag zone, working bottom and well block areas.

5. Steel Plants are having challenges in augmenting the average life of SSM ladles to a level of 180-220 heats, which is currently prevalent is international bench making for modern steel plants.

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The authors sincerely thank Mr. Anirbandip Dasgupta, Sr. Executive Officer, IRMA for his continued encouragement in the developmental activities for clean steel making.

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References

1. Advances in Lining of Secondary steel Ladles in India, etc. Dasgupta, Kr. Ajay & Chattopadhyay, Kr. Arup, Proceedings of IRMA-IREFCON-08. Intrl. Reft. Conf. PP. 84-88, Kolkata (Feb, 2008)

2. Process Technologies & Products of SAIL Plants, Tech. Proceedings of RDCIS, SAIL, Ranchi (Feb, 2018).

3. Plant Process Parameters & BOF/SSM Ladle Reft. Inputs, Operating Committee Meeting on Refts., Bhilai (6–7th March,2024)

4. Dasgupta, Kr. Ajay & Ganguly, Kr. Ashim- "Engg. of Products with Reft. Arising from Steel Making Furnaces for Cost Benefits & Sustainability", IRMA Tech. Jr. (June, '24)

5. Pvt. Communications with Mr. Ashim Kr. Ganguly, Sr. Tech. Consultant (Reft.), Kolkata, (Sep. 2024)

Corresponding Author (E-mail):
Mr. Susanta Sarkar
sarkar.sru@gmail.com)

STATISTICS

Item	Performance of Indian steel industry		
	2023-24 (mt)	2022-23 (mt)	% change
Crude Steel			
Production	144.30	127.20	13.4
Capacity	179.51	161.30	11.3
Utilisation	80	79	-
Hot Metal Production	87.04	81.16	7.2
Pig Iron Production	7.36	5.86	25.6
Pellets Production	96.52	79.33	21.7
Sponge Iron			
Overall Production	51.56	43.62	18.2
Coal Based Production	41.78	35.61	17.3
%share of Coal Based	81	82	-
Total Finished Steel (alloy/stainless + non-alloy)			
Production	139.15	123.20	13.0
Import	8.32	6.02	38.2
Export	7.49	6.72	11.5
Consumption	136.29	119.89	13.7
Per Capita Consumption	97.7 kg	86.7 kg	12.7

Source: JPC; mt=million tonnes

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7. The body typing should be 10 point "Arial" Normal, e.g. The factor affecting the lining life

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Raw Material Elucidation

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marketing@sadashivarefractories.com
info@sadashivarefractories.com

Mr. Krunal Dalal : +91 90541 16583
Mr. Nandlal Samani : +91 95588 23340

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