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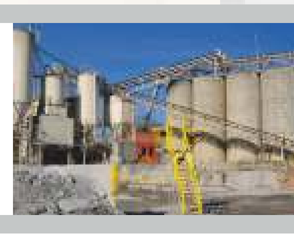


IRMA
PARTNERING HEATING SOLUTIONS
INDIAN REFRACTORY MAKERS ASSOCIATION

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MESSAGE FROM THE CHAIRMAN

Dear Colleagues,

I'm happy to inform you that we could successfully organize the first edition of Student IREFCON. They key objectives of this conference were setting a broad framework of pertinent industrial issues before the students which are not covered in academic curriculum as well as infuse critical thinking within the young minds so that they are industry ready when they take up professional assignments. For this reason, the theme of the conference was "Refractories Beyond Classroom." Professional training is an ongoing means to improve industry specific content knowledge and analytical skills that positively affect and influence the improvement of professional practice. Keeping this fact in mind and gauging the success of Student IREFCON 2025, we will continue to organize similar events in future.

As we step into another year which promises hope and sunshine for our industry, I take the opportunity to thank the Board of Directors, members and patrons of our Association. It's hard to imagine where our association would be without your unflinching support. We will continue to push forward with new ideas and a renewed dedication to our members by making our Association activities more poignant. The industry has seen phenomenal growth in the last few years boosted by palpable growth in steel, cement and other consuming industries. As per ICRA, Steel demand growth is expected to moderate to 7-8% in FY2026 as Government of India's capex drive to steel-intensive sectors witness moderation compared to the FY2021-FY2024 peaks. SPG Global opines that over fiscals 2026-28, the cement makers are expected to see healthy incremental demand of 30-40 million mt annually, prompting a strong growth in capacities. All these snippets of information suggest that 2026 will be a moderately good year for Indian refractory industry provided cheaper imports can be kept at a reasonable check.

Before signing off, I hope you continue to succeed in all frontiers and scale newer heights. Happy new year everyone.

Sunanda Sengupta
Chairman

ASSOCIATION ACTIVITIES

Student IREFCON 2025

Student IREFCON 2025 was successfull from 5-6 November 2025 at Hotel Pride Plaza, Kolkata. Detailed report features in this edition of the journal.

IREFCON 2026

IREFCON 2026 has been shifted from 28-30 October 2026 due to clash with a popular festival date. The new date will be 2-4 November 2026.

The meeting of IREFCON'26 Technical Committee were held on 15th November 2025 under the chairmanship of Dr. Saumen Sinha. The issues discussed were theme of the conference, probable Keynote Speakers and Theme Lecturers. Already a confirmation of some speakers has been received. Abstract submission for technical papers and case studies is now being received at www.irefcon.com

IN THE NEWS

Steel Demand in India

As per rating agency ICRA, the domestic steel demand is estimated to grow by around 8 per cent in FY26, but softer steel prices will keep margins under pressure for producers. In a report, ICRA projected the industry's operating margin to remain flat at about 12.5 per cent in FY26, lower than earlier expectations of an improvement.

Tata Steel

Tata Steel plans a nearly 50% capacity expansion in India to defend market share and secure raw materials, with most capex expected from internal accruals. This strategic move aims to align new capacities with anticipated demand growth post-FY29, ensuring profitability and maintaining a healthy balance sheet. This includes expanding capacity at Neelachal Ispat Nigam, setting up rolling facilities at its plant in Meramandali, buying a 50.01% stake in Thriveni Pellets and a Memorandum of Understanding with Lloyd Metals and Energy.

JSW Steel

SMS group has announced that JSW Vijayanagar Metallics Ltd. (JVML), subsidiary of Indian steel producer JSW Steel, has successfully activated the new 350 mt Ruhrstahl Heraeus (RH) vacuum degassing unit at its Vijayanagar plant in India. SMS stated that the installation includes an operational combination of an RH ladle rocker with fast vessel exchange and supports high-quality steel production with an annual capacity of three million mt.

In a significant move, JSW Steel will sell the steel business of its unit Bhushan Power and Steel to an equal-stakes joint venture with Japan's JFE Steel for 244.83 billion rupees ($2.72 billion), as it seeks to fund growth. JFE Steel will invest a total amount of 157.50 billion rupees in two tranches into the JV, JSW Steel said. The JV will aim to expand crude steel production at integrated steelworks to 10 million tons by 2030, JFE Steel said in a separate statement.

SAIL Rourkela Steel Plant

Union Steel Minister HD Kumaraswamy has announced a significant 9.8 million tonne capacity expansion plan for SAIL's Rourkela Steel Plant, aiming to double its current output. This move, following the inauguration of a modern steelmaking facility, is expected to boost supplies for critical sectors and support the nation's steel capacity vision.

Rashmi Group

Kolkata-based Rashmi Group will set up a 2.8 million tonne per annum (MTPA) integrated steel plant and 400 MW captive power plant at Purulia.The West Bengal government has allotted 938 acres of land for the projects, and the proposed investments will be Rs 1,0000 crore.

Coal acquired via auction open to any use

Govt. of India has allowed export of coal from blocks with existing linkages by tweaking its Coal (Non-Regulated Sector) Linkage Policy of 2016.The Policy for Auction of Coal Linkage for Seamless, Efficient & Transparent Utilisation (CoalSETU) will add a separate window, allowing end-use free purchase of coal. Coking coal will not be offered under this window, due to its paucity in the domestic market.

Vedanta Aluminium

Vedanta Aluminium has augmented the capacity of its Lanjigarh refinery in Odisha's Kalahandi to 5 million tonnes per annum from 2 MTPA. The expansion would boost India's total alumina refining capacity to nearly 13 MTPA and position the country as the third-largest producer globally, it said in a statement.

Monolithisch India Limited

In a development that signals growing consolidation within India's ramming mass and refractory materials sector, Monolithisch India Limited has formally completed its acquisition of Mineral India Global Private Limited (MIGPL). The move, which has now been executed across all five planned tranches, brings MIGPL entirely under the Monolithisch umbrella and expands the company's total installed capacity to 2,63,600 tonnes per annum.

OVERSEAS NEWS

Harbison Walker International

HWI, A member of Calderys, has successfully completed construction of a new lightweight monolithics production facility at its Rotary Kiln complex in Fulton, Missouri, USA. This state-of-the-art plant marks a significant investment in the Calderys Group's growth strategy for the Americas, boosting HWI's lightweight monolithics production capacity by nearly 60%. The expansion enhances product availability, shortens lead times for customers, and incorporates advanced technology and automation—including a new furnace and fully automated robotic packaging and material-handling systems.

Shinagawa

SHINAGAWA REFRA and Sheffield Hi-Tech Refractories have signed a term sheet to formalize the collaboration, working together to bring cutting edge refractories solutions. This partnership marks a major step forward in the One SHINAGAWA initiative — driving innovation, excellence, and cross-border collaboration.

Vesuvius Plc

Vesuvius Plc has reported its performance for the period from July to October 2025. Revenue was slightly ahead of the prior year on a constant currency basis. The Steel Division saw higher sales in Advanced Refractories and stable performance in Flow Control, supported by market share gains and effective price increases. The Foundry Division reported slightly lower revenue due to weaker market conditions outside India and China, partly offset by market share growth.

Guinea Bauxite Output

According to the Ministry of Finance's 2025 Mid-Year Report, Guyana's bauxite industry is estimated to have grown by 133.1 percent in the first half of this year, with total production reaching 1.7 million tonnes. This surge has been attributed primarily to ramped-up production of metallurgical grade (MAZ) bauxite by the larger of the two producers operating in the sector.

The report stated that total production from this operator – which would be Chinese operator BOSAI – reached 1,609,403 tonnes between January and June, compared with 145,335 tonnes in the first half of last year. The smaller operator, meanwhile, produced 118,914 tonnes. Despite this strong performance, the report noted that prolonged rainfall constrained full production potential during the review period.

Australian Graphite Market

According to relevant report, Australia's graphite market reaches USD 438.76 million in 2024 and is projected to grow to USD 2,257.77 million by 2033, registering a CAGR of 17.8% during 2025–2033. The strong growth reflects Australia's rising role in global critical mineral supply chains, particularly as demand for lithium-ion batteries accelerates.

South Africa's Chromium Ore

South Africa's mining production increased by 5.8% year-on-year in October, with the largest positive contributors having been iron-ore, platinum-group metals (PGM), manganese and chromium ore. Chromium ore production grew by 14.1% on y-o-y basis and contributed 0.8 of a percentage point.

China releases new mandatory safety standard for refractory materials production

Tata Steel Limited is planning to begin construction of its low-carbon electric arc furnace (EAF) at its Port Talbot mill in UK in July 2025 and operations scheduled to start in 2027, the company said in its annual report for the fiscal 2024-25. “Using recycled scrap, the new Port Talbot steelmaking facility will reduce the on-site carbon emissions by up to 90 percent,” the company said.

The EAF is scheduled to become fully operational by 2027, with an annual production capacity of 3.2 million mt of low-emission steel.

China unveils stricter, greener steel capacity replacement draft

China's Ministry of Emergency Management has officially issued the “Safety Specification for Refractory Materials Production” (AQ2023-2025), which will take effect on June 1, 2026 as a mandatory industry standard. The new regulation replaces the 2008 version and marks the most comprehensive upgrade to safety management requirements in the refractory industry in nearly two decades. The standard aims to strengthen risk prevention, improve operational safety, and address new technologies and processes emerging in the sector.

Key updates and changes in the new standard are:

- Stronger risk prevention and hazard control mechanisms
- Updated classification for fire-hazard zones
- Expanded safety rules covering new production processes
- Integrated environmental and safety requirements
- More detailed operational and equipment safety measures
- Strengthened public utilities and auxiliary system safety

Liaoning nears final phase of reverberatory kiln elimination

Liaoning Province has entered the final stage of its campaign to eliminate light-burned reverberatory kilns, a move that is reshaping China's magnesite industry. As the China's largest production and resource base for magnesite and caustic calcined magnesia (CCM), this multi-year industrial reform is fundamentally transforming the supply structure, market prices, and competitive landscape. The elimination initiative is driven by China's national carbon reduction goals and supported by a series of regulatory frameworks, including the Liaoning Magnesite Industry Sustainable Development Regulation, the Implementation Opinions on Advancing High-Quality Development of the Magnesite Industry, and the Air Quality Continuous Improvement Action Plan.

MEMBERSCAN

Calderys India Refractories Ltd.

Calderys has officially commissioned the basic monolithics production line at its state-of-the-art facility in Odisha, marking a major milestone in the company's expansion across India and the Asia-Pacific region. The new line enhances Calderys' Indian portfolio, strengthening its position in key process industries while building on its expertise in ironmaking refractories.

IFGL Refractories Ltd.

IFGL Refractories Limited reported earnings results for the second quarter and six months ended September 30, 2025. For the six months, sales was INR 9,426.4 million compared to INR 8,256.6 million a year ago. Revenue was INR 9,476.5 million compared to INR 8,365 million a year ago. Net income was INR 235 million compared to INR 367.3 million a year ago. sita.

RHI Magnesita India Ltd.

RHI Magnesita India Ltd has announced its audited consolidated financial results for the quarter ended 30 September 2025. The company reported a record revenue of Rs 1,035 crore, marking an 8 per cent increase quarter-on-quarter (QoQ), with shipment volumes rising 9 per cent QoQ to 141 KT.

Rath Avanee

RATH Group, together with its Indian joint venture partner RATH Avanee, has officially opened a new production site in Visakhapatnam in mid-September, after only 18 months of construction. Production in Visakhapatnam began gradually in March 2025, with around 5000 tons of fireclay produced in a bogie hearth furnace and successfully placed on the Indian market. A further tunnel kiln was commissioned at the end of July 2025. Total annual capacity has reached approximately 20,000 tons of refractory products.

Mr. Cholpadi Devadas Kamath, former Managing Director of Tata Refractories Limited and ex Chairman IRMA (2000-2002) passed away on 12th December 2025. Mr. Kamath was a visionary leader whose contributions shaped the growth and reputation of refractory industry in India. Mr. Kamath graduated from IIT Madras in 1966 as a metallurgist and began his career with Tata Steel. A recipient of the National Metallurgist Award from the Government of India, his contributions to metallurgy and refractories industry remain unparalleled.

ECONOMY AT A GLANCE

- India's GDP grew 8.2% in annual terms in July–September (Q3 FY 2025), following a 7.8% expansion in the prior quarter. July–September's growth was the sharpest since January–March 2024 and yet again overshot market expectations by a significant margin. The reading confirms that India remains the world's fastest-growing large economy.
- Nominal GDP has witnessed a growth rate of 8.7% in Q2 of FY 2025-26. Primary sector experienced the year-on-year Real GVA growth rate of 3.1% in Q2 FY 2025-26. Similarly, the Secondary (8.1%) and Tertiary Sector (9.2%) have boosted the Real GDP growth rate in Q2 of FY 2025-26.
- Compared to the previous quarter's data, readings in July–September improved for private consumption (+7.9% in annual terms vs +7.0% in April–June) and imports of goods and services (+12.8% vs +10.9% in April–June). In contrast, readings softened for government consumption (-2.7% vs +7.4% in April–June), fixed investment (+7.3% vs +7.8% in April–June) and exports of goods and services (+5.6% vs +6.3% in April–June).
- CPI eased to 0.25% in October 2025 in comparison to October 2024, is the lowest year-on-yearinflation of the current CPI series.
- IIP registered a robust growth of 4.0 % year-on-year in September 2025, driven by 4.8% growth in manufacturing sector.
- Labour Force Participation Rate climbed to a six-month high, reaching 55.4% in October 2025.
- India's cumulative exports (merchandise & services) rose by 4.84% in April-October 2025 in comparison to April-October 2024.

REVIEW OF STUDENT IREFCON 2025

Student IREFCON 2025 was held on 5th - 6th November, 2025 at Hotel Pride Plaza, New Town, Kolkata. The theme of the conference was "Refractories beyond Classroom".

The Chief Guest of the Occasion was Prof. Bikramjit Basu, Director, CSIR- Central Glass and Ceramic Research Institute.

The following were the prominent speakers at the conference:-

Sl No.	Name	Organization	Topic
01.	Mr. Gustava Franco (Keynote Speech)	RHI Magnesita	The future of the Refractory Industry
02.	Dr. Sanjay Chandra (Theme Lecture)	N.A.	Making a successful career in manufacturing Industry
03.	Mr. Ish Mohan Garg (Theme Lecture)	Calderys India Refractories Ltd	When will I become CEO
04.	Dr. Atanu Ranjan Pal (Theme Lecture)	Tata Steel Ltd	Refractories beyond Classroom

An one- hour CXO meet was organized on the first half of 05th November, 2025 to give us the benefits of their valued suggestions:-

Name	Organization
➢ Mr. Krishnendu Kumar	(TRL Krosaki Refractories Ltd)
➢ Mr. Sanat Ganguli	(RHI Magnesita India Ltd)
➢ Mr. Shankha Chatterjee	(Almatis India Pvt Ltd)
➢ Ms. Suparna Basu	(Calderys India Refractories Ltd)
➢ Ms. Paromita Sarkar	(Vesuvius India Ltd)
➢ Mr. Sujat Ali Khan	(Tata Steel Ltd)

Participating Colleges for Technical presentation by Students:-

Name of Institutes	No. Of Participants	Faculties	Total Nos.
Anna University, Chennai	53	2	55
GCECT, Kolkata	60	3	63
NIT Rourkela	30	1	31
UGIE Rourkela	22	2	24
University of Calcutta	22	2	24
Others	-	-	44
	187	10	241

There were in total 13 Technical paper presentations done by the students of the following Institutes with respective topics:-

Institutes	No. of Papers
Anna University , Chennai	2
Government College of Engineering And Ceramic Technology (GCECT),Kolkata	3
Utkalmani Gopabandhu Institute of Engineering (UGIE),Rourkela	5
University of Calcutta	3
Total	**13**

There was also a Student's interaction with the 03 recruiting member companies for 45 minute in the evening of 05th November, 2025 (RHI Magnesita India Ltd, Calderys India Refractories Ltd, Sarvesh Refractories Pvt Ltd.)

Training program for students and junior level technical persons were conducted on 06th November, 2025 (2nd Day of Student IREFCON 2025)

Name	Organization	Topic
✓ Mr. Shankha Chatterjee	○ Almatis Alumina	▪ Refractory Raw Materials
✓ Mr. Biswajit Ghosh	○ TRL Krosaki Refractories Ltd	▪ Refractory Lining
✓ Dr. Indra N. Chakraborty	○ Calderys India Refractories Ltd	▪ Refractory Lining
✓ Ms. Paromita Sarkar	○ Vesuvius India Limited	▪ Flow Control Products
✓ Mr. Sourav Banerjee	○ IFGL Refractories Ltd.	▪ Flow Control Products
✓ Mr. Koushik Dasgupta	○ RHI Magnesita India Ltd.	▪ Applications Technology (Ferrous)
✓ Mr. Kartick Chandra Khan	○ TRL Krosaki Refractories Ltd	▪ Applications Technology (Non-ferrous)

PHOTO GALLERY OF STUDENT IREFCON 2025


Inaugural Session

Speech by Chief Guest Prof. Bikramjit Basu, Director, CSIR

Mr. Gustava Franco - Keynote Speaker

CXO Meet


Technical Training Programme


Technical paper presentation by Students

Felicitation of Speakers


Student’s Interaction with the Recruiters

Dr. Sanjay Chandra -Theme lecture

Cultural Programme

TECHNICAL SECTION

THE USE OF SIOXX®-FLOW AS A DISPERSANT FOR LOW-CEMENT CASTABLES IN THE MANUFACTURING OF PRECAST REFRACTORY SHAPES

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Abstract

This paper presents a case study on the use of pre-cast refractory shapes in industrial flooring applications. In recent years, pre-cast shapes have become popular due to their quick and easy installation, shorter dry-out time, and reduced number of joints compared to monolithic and brick alternatives. This case study focuses on the use of a bauxite-based low-cement castable (LCC) with the microsilica-based specialty product, SioxX®-Flow, as a dispersant to produce heavy-duty industrial floor tiles. Over 400 pieces (7 MT) of product were produced and installed, from mould design to installation, within 30 days. The use of SioxX®-Flow resulted in improved flowability of the castables, leading to a better surface finish and increased productivity related to improved consistency of the castable. The increase in green strength also improved handling of the moulded product, resulting in negligible due to chipping. The consistent setting time improved production planning and mould turn-around time, further increasing productivity. This case study showcases the practical benefits and advantages of using SioxX®-Flow as a dispersant for low-cement castables in the manufacturing of pre-cast shapes.

Keywords: Precast shapes, productivity, SioxX®-Flow

1. The Background

Standard industrial flooring made from traditional concrete is not suitable for floors where molten metal is handled. In most cases, the concrete flooring in industrial facilities handling liquid metal becomes an EHS concern due to floor damage. The concept of industrial floor tiles is popular in the western world, however, in India this concept often faces the challenge of high costs.

A working example of successful installation of such industrial flooring tiles is in the Elkem foundry alloy processing site in Nagpur, India, where the small trial installation from 2016 remains in perfect condition. During the commissioning of an induction furnace in 2023, at the same processing site, the industrial flooring was installed as part of an enhanced EHS initiative.

We accepted the challenge of installing industrial floor tiles in the new facility, all while adhering to the project completion deadline. Due to the uneven finish of the flooring tiles, two different thicknesses of the tiles were used. Orane Refractories were approached to assist with improving the consistency and surface finish challenge.

2. The Challenge

To produce and install 540 pieces of floor tiles in 2 different sizes, within a 4-week period.

While the installation and heat-up of pre-cast shapes on-site were highly efficient, the manufacturing of the pre-cast shapes presented challenges similar to the challenges encountered during the installation of castables on-site—curing, drying, and firing. Additionally, the recipe design for the refractory castable, which was to be used for manufacturing of the tiles, required thorough evaluation. Time was considered a critical issue to complete the installation.

3. Elkem Business System (EBS) in-use

The challenges that were identified during the manufacturing and installation of the flooring tiles are shown below – a systematic approach to problem solving called Elkem Business System

(EBS, derived from Toyota business system) was employed:

a) Castable recipe design to achieve high compressive strength.

b) Evaluationof properties and finaliza -tion of formulation.

c) Design and manufacturing of the moulds.

d) Casting and demoulding of the casted pieces within stipulated time and sufficient green strength for handling.

e) Minimize the drying and firing (up to 1000°C) time.

3.1. Materials and Methods

The first criterion was to determine the compressive strength requirement of this product. The tile should have a high compressive strength (CCS) - minimum 140 MPa at 110°C. The green flexural strength (GMOR) or demoulding strength should be >2 MPa and >4 MPa after 4 hours and 6 hours of casting, respectively. The above properties indicated that the density and particle packing of the mix should be at a maximum whilst the pre-cast body should have capability of short dry-out and heating times.

After a few laboratory-based trials, a low cement castable (Table 1) containing bauxite (Al_2O_3 85%), high alumina cement, calcined alumina, and Elkem Microsilica® 971U along with SioxX® Flow and EMSIL-DRY®, was used. SioxX® Flow functioned as a dispersant, enhancing the rheological properties with controlled setting and demolding time whilst aiding in early strength development of the castable. EMSIL-DRY® fibre was used to facilitate the quick dry-out and heat up of the castable to reduce the risk of spalling and explosion during heat-up. Additional evaluations as shown in Table 2 were conducted.

Table 1: Recipe used for LCC to cast flooring tilesx

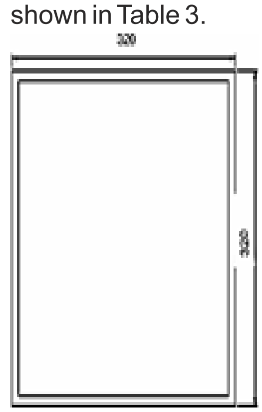
Raw Material	Quantity (%)
Calcined Bauxite (various sizes)	76
High alumina cement	7
Calcined alumina	10
Elkem Microsilica® 917U	6
SioxX® Flow	1
EMSIL-DRY®	0.1

Table 2: Characterization / properties of floor tile

Properties	Condition	Range of Values
Water demand (%)	-	4.5 – 4.7
Flowability (%)	Immediate flow_F0	130 - 140
	After 30_F30	100 - 110
Hardening time (min)	Ultrasound	200 - 250
Bulk density (gm/cc)	-	2.70 – 2.75
Green flexural strength (MPa)	After 4 hrs of casting	2 - 3
	After 6 hrs of casting	3 - 4
	After 8 hrs of casting	4 - 6
Flexural strength (MPa)	At 110°C	40 - 45
	At 600°C	30 -35
	At 800°C	25 – 30
	At 1000°C	20 - 25
Compressive strength (MPa)	At 110°C	170 - 180
	At 600°C	150 – 160
	At 800°C	120 - 130
	At 1000°C	100 - 120

3.1.1. Design and manufacturing of moulds

Mould design is a critical part of the precast refractory manufacturing process. However, in the present case, the moulds were relatively simple - wooden mould with metal liner were used. Two different mould sizes were prepared to cast two different tile shapes. Tile A (Figure 1) has dimension 320*320*75 mm and Tile B (Figure 2) has dimensions 320*320*60 mm. After receiving the mould, trial casting was performed as quality check to verify the dimensions and tolerance. There were 4 moulds prepared for each tile size. Other detail of the moulds that were prepared are shown in Table 3.



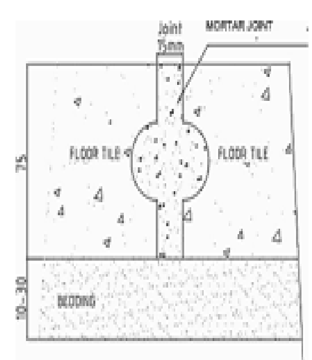
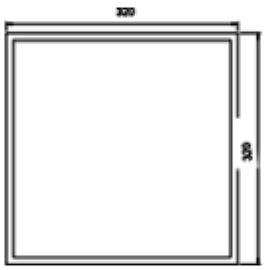


Figure 1: Section drawing of floor Tile-A



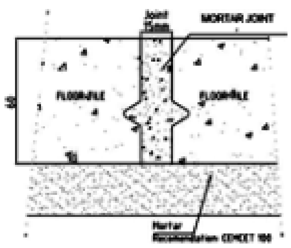


Figure 2: Section drawing of floor Tile-B

Table 3: Dimensions of tile and configuration for floor laying

	Dimension (mm)	Weight (kg)	No. of piece	Number of moulds
Tile -A*	320*320*75	21.5	198	4
Tile-B¤	320*320*60	17	342	4

*Target – 198 pieces; delivery by 25th of Dec 2022.

¤Target – 202 pieces; delivery by 25th of Dec 2022.

3.1.2. Manufacturing process of tiles – Casting, demoulding, Air curing, Air Drying

For casting, 300 kg capacity pan mixer was used. 175 kg of the dry granular castable mix was charged in the mixer; water was added manually using platform weigh scale, and thoroughly mixed until a homogenous castable was obtained. Figure 3 shows the process that was followed to produce the tile samples.

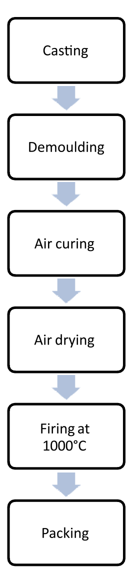


Figure 3: Flow chart for precast manufac - turing process

A demoulding target of 4 hours was set to produce 12 pieces per day – in 2 shift operations, and 400 pieces to be delivered by 25th of December 2022. The remaining 140 pieces was planned to be dispatched later. Demoulding time for the castables were set at 4 hours which led to mould rotation of 3 times in 2 shifts.

3.1.3. Dry-out and high temperature firing of tiles

The heating profile that was used for the tiles samples after demoulding is shown in Figure 4 with a total firing time of 120 hours.

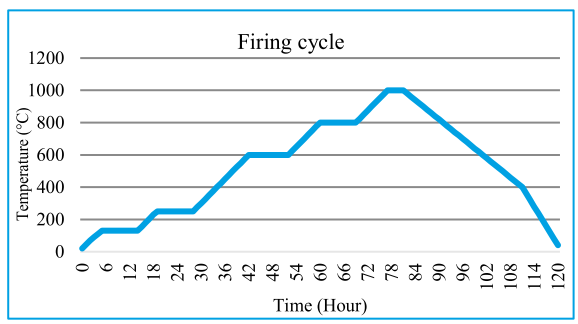


Figure 4: Firing cycle for casted flooring tiles

The timeline from the start to completion of the project is shown in Table 4. Installation of all the tiles was completed on 20th of January 2023.

15th Nov	Idea discussion
18th Nov	Lab work started and finalizing formulation
20th Nov	Mould design finalized
25th Nov	First set of completed moulds received
27th Nov	First casting trial completed
30th Nov	Start large scale casting trial
15th Dec	Completion of casting (first 400 pieces)
18th Dec	Start of firing cycle
23rd Dec	End of firing cycle
27th Dec	Dispatch from Pune
31st Dec	Goods received at Nagpur

4. Results and discussion

Results from the casting and installation practice indicated 4 hours demoulding time. The working time, where flowability was retained, was between 30-45 minutes and completed hardening by 250 minutes. Figure 5 shows an area where the existing flooring in the Nagpur foundry was present prior to installing new flooring.

Figure 5: Image of a pre-casted area in the foundry facility in Nagpur prior to installing new flooring

Manufacturing of the tiles also resulted in a low rejection rate as a result of breakage of the tiles during and after manufacturing. Figure 6 shows the consistency between tiles where thicknesses and shapes (Figure 7) are similar. The use of EMSIL-DRY® fibre in the castable also resulted in quick dry-out and heating. An example of a finished section of the flooring is shown in Figure 8 with no tile breakage.

Figure 6: Floor tile after firing and dimension inspection

Figure 7: Image showing the even shape of tiles produced during manufacturing with SioxX®-Flow

Figure 8: Image of finished section of flooring in Nagpur facility.

5. Conclusions

From the investigation of producing industrial flooring trials using a LCC with SioxX®-Flow and special drying fibre, EMSIL-DRY® the following can be concluded:

a) Planning and execution of the manufacturing process by Orane Refractories resulted in on-time delivery of the tiles.

b) Short demoulding time of 4 hours were obtained through using SioxX® Flow.

c) Retention of flowability up to 30-45 minutes of water addition and hardening time within 250 mins.

d) Low rejection rate of tile due to breakages as a results of high strength development after casting.

e) Quick dry-out and heating time by using EMSIL-DRY®.

Acknowledgement

The authors would like to thank all partners and stake holders that were involved in the successful execution of this project.

(Source: IREFCON 24 Proceeding)

TECHNICAL SECTION

DEVELOPMENT OF NEW GENERATION CEMENT-FREE, WATER BASED CASTABLE: A SUSTAINABLE APPROACH TOWARDS CARBON NEUTRALITY

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Abstract:

Now a days refractory researchers and engineers are consistently challenged by the rising demand for refractory materials, pushing them to seek sustainable solutions that maintain product performance with diminishing CO_2 emission. One approach to mitigate carbon emissions and strive for carbon neutrality involves compensating for emissions generated in one sector by decreasing them elsewhere. This can be achieved by investing in alternative technologies aimed at minimizing carbon emissions. Monolithic engineers are also working with a similar approach. One of the drawbacks of traditional calcium-aluminate cement based refractory castable system lies in the necessity of controlled drying and pre-heating to eliminate steam explosion. The major issue is the prolonged heating cycle causing emission of CO_2. To reduce the total drying cum pre-heating cycle, several works have been carried out about the product design to reduce the carbon footprint while reducing the drying and preheating time. One such approach is to sol or gel- bonded castables in low and ultra-low cement compositions replacing cement. However, certain constraints exist in this technology like longer setting time, low strength after drying, presence of free amorphous silica in the castable composition, restricting their application at elevated temperature etc. In this study, one new additive is introduced into a castable compositions to design calcium aluminate cement free system to find an alternative method of sol- gel based casting practices, which leads to considerable enhancements in drying rates. This technology not only reduce the drying cum pre-heating cycle but also improve the slag corrosion resistance which will give better performance for those areas where it is in direct contact with hot metal and slag. All relevant properties have been assessed against conventional cement bonded castables like AP, BD, CCS, PLC, slag corrosion resistance etc. Behaviour of castable against steam explosion was also studied.

Introduction:

Many efforts have been made to develop CaO-free binders for monolithic refractories. The main drawbacks related to presence of CaO in formulations containing Al_2O_3 & SiO_2 is the generation of lowmelting phase, which affects the overall thermo-mechanical behavior[1,2] of the products. Calcium-free special raw materials are increasingly used for designing cement free refractory castables associated with unique applications where the matrix plays a vital role to achieve expected performance. This special raw material can provide non- reactive protective border surrounding aggregates for controlling slag resistance[3,4], fracture toughness, residual hot strength after thermal cycling and erosion resistance[5]. The presence of special raw material reduces the formation of calcium aluminosili - cates that may provide high temperature bonds when exposed to steelmaking temperature. It is also useful in developing stable bonds for high purity metallurgical processes where Ca and Si pick-up are of great concern. Although the special raw material acts like high purity calcium aluminate cement (CAC) with respect to working time, initial and final setting time, water demand, and flow properties, they have some unique characteristics that should be considered for their use in various applications. Special raw material, unlike CAC, does not require humidity to develop strength but controlled curing is necessary to avoid surface crazing. Air drying an acceptable time under ambient conditions (>18°C, 65°F) is required to develop suitably rigid shapes ready to remove from molds. A reduced drying and pre-heating cycle is expected with the castables designed without CAC which helps for carbon neutrality[6]

Experimental Procedure:

Four castable compositions were designed for this study. The typical compositions are shown in Table-1. The aggregate consists of fused and sintered alumina along with Silicon Carbide. Existing recipe was designed with high alumina cement whereas special raw material was introduced in all other batches in different proportions. A small quantity of cement was added in T-7 & T-7B batch to control the setting time as well as swelling tendency.

Table-1: Batch formulation of castables

Components	Existing	T-7	T-7B	T-12
Aggregate	A	A	A	A
Matrix	B	B	B-b	B-a
Special RM	-	2b	b	2b
CAC Binder	3a	a	a	-
Total	100	100	100	100

In all cases 15 kg sample was prepared as per composition mentioned in table - 1. Dry mixing was carried out in high intensity Hobart mixer for five minutes followed by addition of water in two steps. 80% of total water was added in the beginning and wet mixing for two minutes followed by addition of the rest 20% water and continued to wet mix for another three minutes to achieve the required consistency.

Free flow (FF) and tap flow (TF) were measured with flowmeter. TF was measured as per TRL Krosaki in- house standard. Three different sizes sample were made for evaluation of different properties. For measurement of CCS, CMOR, AP, BD and PLC, sample size was 160mm X 40mm X 40mm and for measurement of thermal spalling resistance cube samples of 65mm X 65mm X 65mm were prepared. For measurement of induction slag corrosion behaviour, the sample size was 115mm X 115mm X 50mm. The slag corrosion test in induction furnace was carried out at 1550^{0}C with blast furnace slag.

For measurement of CMOR, CCS, AP, BD and PLC at different temperatures, firing of samples was carried out at 800^{0}C in oxidizing atmosphere whereas at 1100^{0}C and 1500^{0}C firing was carried out in reducing atmosphere. XRD was carried out to understand about the presence of different mineralogical phases and identify the formation of any new phases after firing at 1100^{0}C and 1500^{0}C.

Results & Discussions:

Both free flow (FF) and tap flow (TF) for all four batches were measured by keeping water percentage fixed at 6.5%. The appearance of samples after free flow and tap flow is shown in fig.1. The flow values are mentioned in table – 2. Setting time was also measured for all batches and it is almost similar except T-7 where the setting time is low compared to other batches.

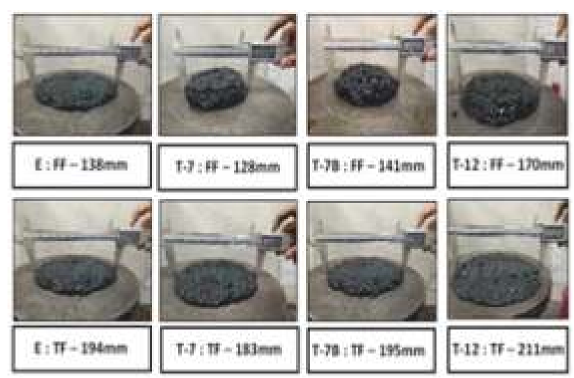


Fig.1 Appearance of castable after Free flow (FF) and tap flow (TF)

Table-2: Flow Properties of Castable Batches

Properties	Existing (E)	T-7	T-7B	T-12
Casting water (%)	6.5	6.5	6.5	6.5
Free Flow (mm)	138	128	141	170
Tap Flow (mm)	194	183	195	211
Setting Time (Hrs:mins)	2:00	0:50	1:55	1:55

Properties of Samples after Drying & Firing:

All physical properties like AP, BD, CCS, CMOR, PLC etc. were measured after drying the samples at 110^{0}C for 24 hrs. and after firing at different temperatures.

The variation in AP is shown in fig.2. There is increasing in AP while firing the samples at 800°C and above against the AP measured after drying at 110°C for 24 hrs. This is quite normal as the removal of both physically and chemically combined water takes place with increasing temperature creating pores in the body. In all cases, measurement of AP at 1100°C is maximum and this has happened due to total remnant structural water.

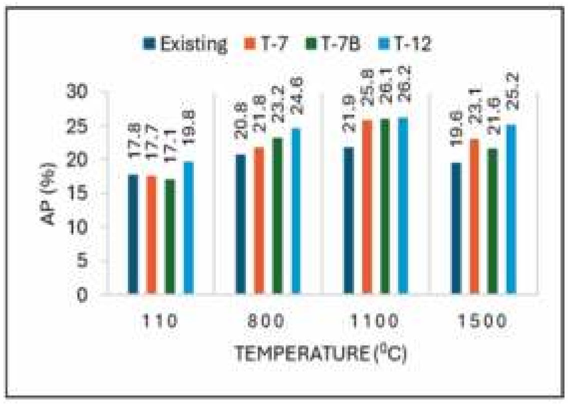


Fig.2: Variation of AP at different temperatures

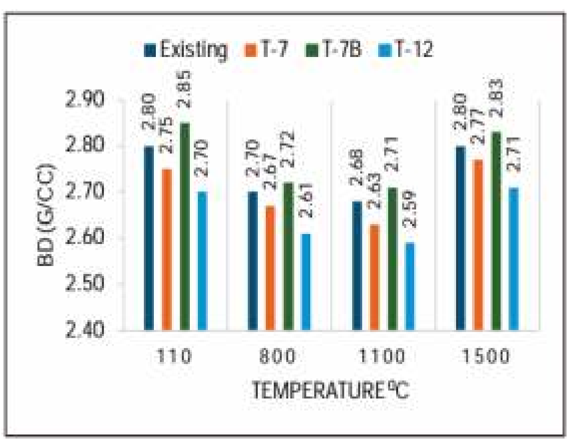


Fig.3: Variation of BD at different temperatures

The maximum BD is observed for all samples after drying which is expected followed by reduction in BD with increasing firing temperature (Fig.3). BD is lowest at 800°C & 1100°C due to total remnant structural water. While firing at 1500°C, BD is increasing again due to sintering

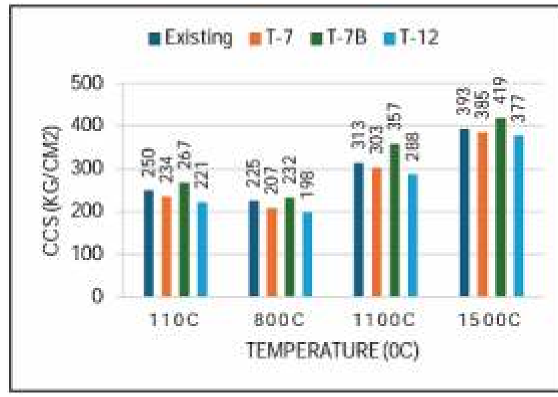


Fig.4: Measurement of CCS at different temperatures

While analyzing CCS & CMOR, it is observed that there are similar values for all the samples till 1100°C. However, a significant increase in CCS and CMOR is observed while firing at 1500°C. This is due to sintering of the samples (Fig.4 & 5). Sample T-7B having both special RM & CA-Binder is showing highest CCS at all temperatures. Sample T-12 shows the lowest CCS as it doesn't have any CAC binder.

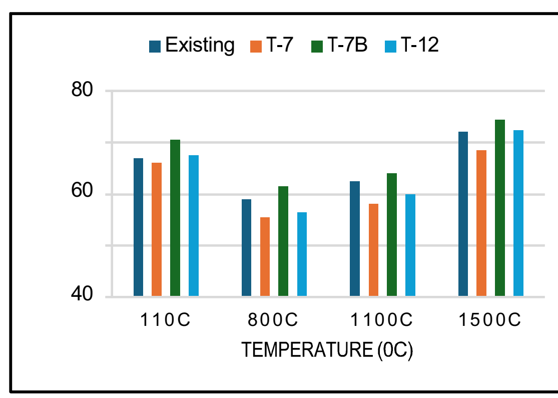


Fig.5: Measurement of CMOR at different temperatures

In fig.6, PLC values are shown after firing at 800°C, 1100°C & 1500°C. The PLC values till 1100°C is negligible. However, positive PLC is observed for all samples while firing at 1500°C. Existing sample having CAC is showing more positive PLC than others. This may be due to presence of CAC which forms CA_6 after firing at 1500°C.

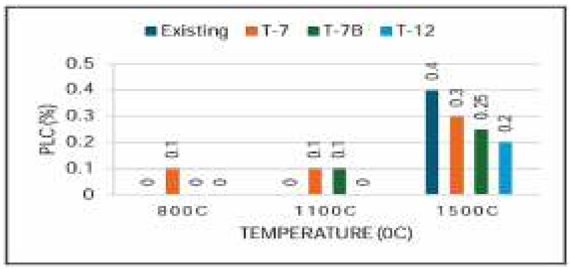
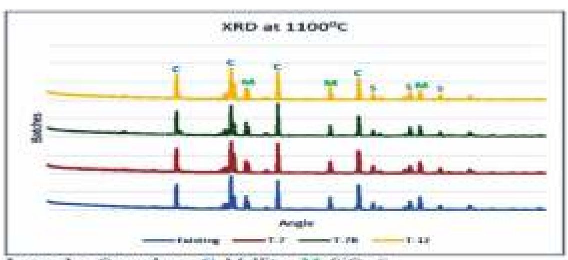


Fig.6: Measurement of PLC at different temperatures

XRD Analysis:

The presence of different mineralogical phases is identified by XRD analysis after firing at 1100°C (Fig.7A) and 1500°C (Fig.7B).



Legends : Corundum : C, Mullite : M, SiC : S

Fig.7A: XRD Analysis after firing at 1100°C

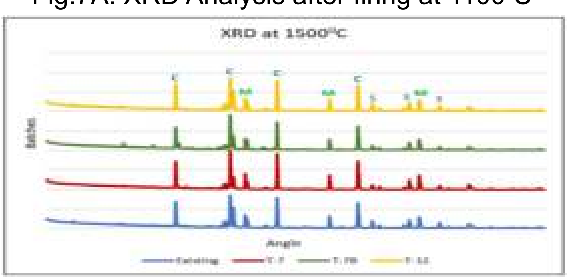


Fig.7B: XRD Analysis after firing at 1500°C

While observing the XRD analysis the major phases are identified as corundum, mullite and silicon carbide (SiC). The peak intensity of mullite is increased while firing at 1500°C indicates in-situmullite formation.

Behavior against steam explosion:

One of the main advantages to eliminate CAC binder from castable formulations is to reduce the drying and pre-heating schedule and thus reduce carbon footprint. For hydraulic (CAC) bonded castables it is essential to follow the longer pre-heating cycle to remove the physically and chemically combined water carefully without any steam explosion. In case of castables designed with special raw material without CAC binder, the formation of different calcium aluminate hydrates will be not there which are responsible for steam explosion if proper drying and pre-heating schedule is not followed. To understand the behaviour of castable with special raw material regrading steam explosion against existing one with hydraulic bonded, one in- house test was carried out. In this test, the cube samples (65mm X 65mm X 65mm) after demoulding and with ~ 2 hours air drying were placed inside the furnace of temperature 1000°C and 1300°C and kept there 5 minutes. Later, it was observed about the physical condition of the samples after cooling down the furnace. For individual sample the same cycle was followed. The appearance of samples is shown in Fig. 8.

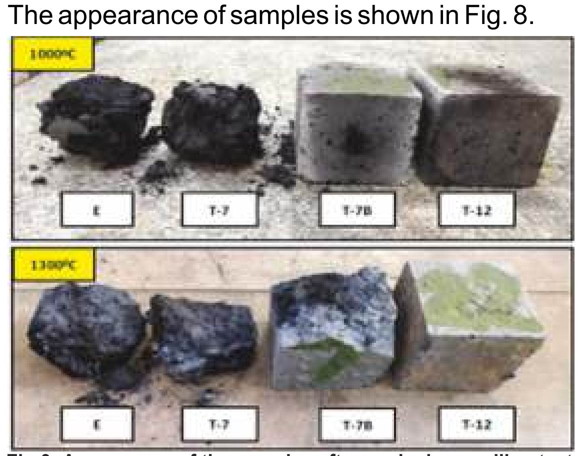


Fig.8: Appearance of the samples after explosion spalling test

Steam explosion is observed for sample "E" and "T-7" at 1000°C and 1300°C and both the samples are having CAC binder. At 1000°C, T-7B and T-12 are perfect whereas other two samples were badly damaged. On the other hand, at 1300°C, sample T-12 is in good condition but slight damage is observed for T-7B. This observation clearly indicates that samples without CAC having better steam explosion resistance property and therefore drying and pre-heating schedule can be reduced without any steam explosion.

Slag Corrosion Test:

Other important advantage for castables without CAC is the improvement in slag corrosion resistance. Most of the high end castables are in direct contact with molten metal and slag where slag corrosion resistance is a key property to get better performance in terms of hot metal throughput or heats. The slag corrosion resistance was conducted in an induction furnace at a temperature of 1550°C using a blast furnace slag which was collected from an integrated steel plant. The chemical composition of slag is shown in Table-3.

Table-3: Chemical Composition of Slag

Component	Weight (%)
SiO_2	36.50
Al_2O_3	18.79
Fe_2O_3	0.28
TiO_2	0.82
CaO	35.53
MgO	7.54

After slag corrosion test, samples were cut in two pieces to observe the corrosion depth and slag penetration. The appearance of cross-section is shown in Fig.9. Based on corrosion depth measurement, a comparison in slag corrosion behaviour is calculated and represents as percentage corrosion (Fig.10). Lower in slag corrosion is better in performance.

Fig.9: Cross-section view after slag corrosion test

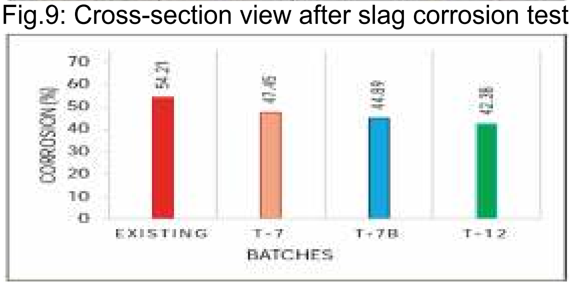


Fig.10: Measurement of slag corrosion

The existing sample is showing maximum corrosion followed by T-7, T-7B and T-12. In case of T-12, CAC was zero and in other two samples (T-7 & T-7B) it was 1/3rd of existing sample. The improvement in corrosion resistance is due to less/zero amount of CaO present in the samples.

Conclusion:

Prolong drying and pre-heating schedule is unavoidable for CAC based castable and it requires longer shutdown time. At the same time more generation of CO_2 is there causing carbon footprint. Castables without CAC cement is showing better in slag corrosion resistance and steam explosion. However, a longer setting time may associates without CAC and therefore a small amount of CAC along with special raw material is the best choice to design castables having optimum drying and pre- heating schedule along with better slag corrosion resistance. Based on the laboratory trials, this castable must give better performance in terms of hot metal throughput or heats while using as such or in PCPF shape in different applications where molten metal and slag are in direct contact with the castable lining.

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(Source: IREFCON 24 Proceeding)

TECHNICAL SECTION

CAC PRODUCTION WITH LNG

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Abstract:

Calcium Aluminate Cements are usually produced in Rotary Kiln route by solid or liquid fossil fuels or synthetic gas like producer gas. Using natural gas in CAC production in rotary kiln route and its impact both in product quality and environment have been explained in this case study in collaboration with INOX, the OEM for LNG storage and handling system. Being a Cryogenic liquid, the challenge of handling and storage of Liquified Natural Gas (LNG) was huge as it has to be transported by Bullets unlike pipeline networks. Hence safety, using efficient equipment associated with storage, handling & final combustion and involvement of trained & competent people were the key.

The existing fuels that were used in producing CAC were high in Sulphur content and poor heat value due to their certain properties, constituents and nature of processing before use. In this case study we have evaluated the impact of fuel constituents on the quality parameters of CAC and environment. A comparative study of CAC production with different fuels and storage and handling issues of LNG at site have also been demonstrated.

Keywords: Calcium Aluminate Cement, Green Fuel, Cryogenic Liquid.

A. Introduction

Furnace oil was used to produce 70% alumina cement at Katni plant. Due to lack of automation and manual control on the combustion system, fuel consumption used to be at higher side .The specific thermal energy consumption was on the higher side – around 1400 kcal/kg clinker (ref the thermal energy consumed per unit of cement with Furnace oil). High SOx and NOx emissions were observed due to high sulphur content in the fuel oil (Sulphur content was as high as 4 %). Higher carbon footprint (Avg 410 kg CO2 emitted/ 1000 T of clinker) was also recorded. Frequent stoppages due to ring formation (uncontrolled fusion) inside the kiln was experienced resulting in inconsistency in product quality – setting time, flow characteristics and phase concentration.

Change of fuel type to a cleaner one became necessary to reduce emissions and carbon footprint , meet stricter environmental regulations and corporate sustainability goals. Along with the fuel type improvement of combustion control was also required to minimize kiln stoppages, to reduce energy consumption and enhance product quality.

Proposed Solution

Transition to LNG: Commissioning LNG as a greener, more efficient fuel alternative to address the current issues and achieve sustainability objectives.

About LNG (liquified natural gas) :

Natural gas is a naturally occurring hydrocarbon mixture consisting primarily methane. LNG is natural gas that has been cooled down to the liquid form at -161 Deg C (refer other characteristics in table 1). It is environmental friendly fuel as compare to other liquid hydrocarbons (refer other components in table 2).

LNG – basic properties : Table 1

Chemical Name	Methane (CH_4)
Gross Calorific Value	51500 Btu/Kg or 12990 Kcal/Kg Approx.
Molecular Weight	16.042
Melting Point @1atm	-182.2 C (-296 F)
Boiling Point @1atm	-161 C (-258.7 F)
Auto Ignition temperature	537.2 C
Expansion Ratio	1 to 627
Liquid density	430 to 470 kg/m3
Flammable Limits in Air by Volume	5 to 15%
Toxicity	Non Toxic
Appearance, Odor and State	Colorless, Odorless Cyrogenic Liquid

Typical composition : Table 2

Component	Percentage
Methane	>85 mol%
Ethane	<11 mol%
Propane	<3 mol%
Butanes	<2 mol%
Pentanes	<0.10 mol%
Nitrogen	<1 mol%

LNG supply chain :

LNG is extracted from gas fields and treated thereafter to remove the impurities. The nit is liquified to transfer and store to tanks. The liquified LNG is loaded for sea shipment for inland storage to different dépôts. From the dépôts the LNG is directly transferred to user's end through tanker or vapourised to transfer through pipeline network.

Construction of LNG tanker :

For inland transportation in liquid form, Cryogenic containers are used which are double walled pressure vehicles. Inner vessel is made out of SS 304 with working pressure of 7-12 bar, operating temp range is - 197 to +50 C, whereas outer vessel made with Carbon steel. Multilayer vacuum insulation is present between the vessel wall. LNG storage tanks are manufactured as per IS standard like ISO 20421 etc. In India, the vessels should comply with the PESO regulations of static and mobile pressure vessel (unfired) rules (SMPV) 2016.

Main challenges of handling and storage of LNG :

- Extremely Cold
- LNG pool formation /spillage
- Fog clouds
- Rapid phase transition (RPT)
- Boiling Liquid Expanding Vapour Explosion (BLEVE)
- Frostbite or freeze burn to Skin & Eyes
- Ingestion/ Inhalation
- Fire and explosion

Suitable actions to be taken as per the guidelines of IOCL and SOP during the following emergency situations.

- Minor leakage
- Handling of sick tanker
- Accident / overturning of tanker
- Fire breakout

B. Steps for Implementation:

1. Process Study with Consultant

Calculation of energy requirement of High Alumina Cement :

Total heat requirement is calculated to transform raw material to clinker considering heat of transformation in each phases mentioned in below table (table no.3) for HAC. Also the heat required to remove the moisture in the raw mix and finally the energy required for grain growth and sintering of the mix.

Total heat of transformation = Total sensible heat of finish product from 25°C to Tsinter - Total sensible heat of raw material from Traw to 25°C + Total heat of reaction at 25°C

Total heat = (Sensible heat outlet - Sensible heat inlet + Reaction heat) x Correction from actual conversion factor (dry basis)

o **70% Alumina Cement (Al_2O_3 : 69%,**

CaO : 27%, others : 4%)

Mass and mole balance : Basis 100 g

Proportion of Al_2O_3 γ over total Al2O3 = 80%

Major phases : CA, CA2

Minor phases : C2AS, C12 A7 & others
Conversion factor from raw material to clinker : 1.12 (dry) and 1.15 (wet)

Moisture in raw mix : 1%

Table 3

70% CAC composition	
CA	61%
CA2	33%
C2AS	3%
Others	3%

Table 4

Sinter temperature (°C) :	1600
Green nodules temperature (°C) :	30
Green nodules moisture :	24%
Moisture of raw material mix :	1%
Proportion of Al2O3? in raw Al2O3 :	80%
Actual conversion factor (wet) :	1.15

Heat of transformation : 505 kcal /kg clinker
Heat of water evaporation : 224 kcal /kg clinker
Total heat requirement : 729 kcal/ kg clinker
Actual heat used in earlier used fossil fuel (furnace oil) : 0.140 kg FO x 10000 kcal = 1400 kcal/kg clinker.

Similarly the heat requirement is calculated for 45% Alumina Cement also.

○ **45% Alumina Cement (Al2O3 : 46%, CaO : 36%, others : 19%)**

Mass and mole balance : Basis 100 g
Proportion of Gibbsite over Boehemite in Bauxite = 80%
Major phases : CA, Ca2, C2AS
Minor phases : C12 A7 , CT & others
Conversion factor from raw material to clinker : 1.49 (dry) and 1.55 (wet)
Moisture in raw mix : 3%
Heat of transformation : 705 kcal /kg clinker
Heat of water evaporation : 106 kcal /kg clinker

Total heat requirement : 811 kcal/ kg clinker

Based on the above theoretical heat requirement for both 70% and 45% alumina based cement production and considering the thermal energy losses (around 35%) in rotary kiln route the capacity of burner is determined.

2. CER (Center for Energy Regulation) Approval

- Obtain necessary permissions and regulatory approvals.

3. Local Administration & PESO Approval

- Secure approval from local authorities and Petroleum and Explosives Safety Organization (PESO).

4. Procurement, Erection and Commi - ssioning

- Acquire the required burner and LNG storage system.
- Install and commission the LNG storage plant and new burner.
- Check list for installing LNG storage tank inside plant
- Finalizing the location and layout of the storage plant and installing the handling and storage facility as per below schematic diagram shown in Fig 1.

Schematic diagram of LNG storage handling and regasification facility :

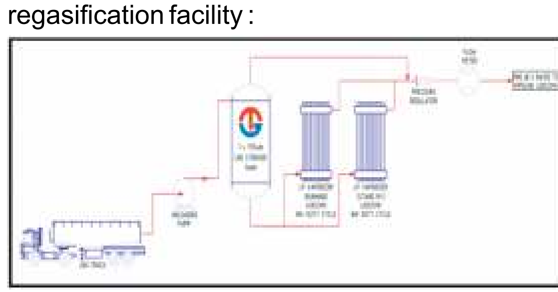


Fig. 1

5. Employee Training and Safety measures

- Conduct training sessions led by the vendor for handling cryogenic liquids and operating the new combustion system.

- Implement nitrogen injection in the storage tank and supply line to ensure zero leakage.
- Manage the unloading of LNG bullets with trained employees, supported by the vendor.

6. Commissioning

- Commission the burner and all related accessories for green fuel usage
- The contribution of the key vendors like IOCL and INOX were important to make the commissioning a smooth sailing.
- IOCL representatives were on site to impart training on how to unload LNG tanker at site.
- INOX supported throughout the commi-ssioning period to store the cryogenic liquid and operate the vapouriser to achieve optimum pressure at the user end.
- Difficulties faced to achieve required pressure at burner end of the rotary kiln by minor adjustment in the PRV and few modifications in the pipeline to achieve zero leakage.

C. Results and benefits :

Reduction in CO_2 Emissions

- Achieved a reduction of CO2 emission by approximately 46%. Please refer to Fig 2 and Fig 3 where the trend of CO2 emission is shown since last few years.

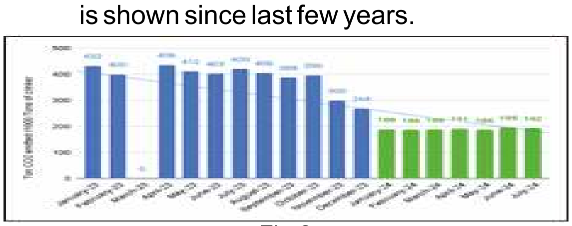


Fig 2

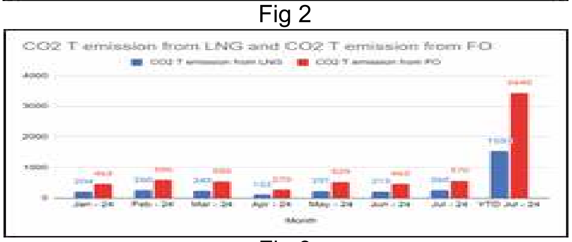


Fig 3

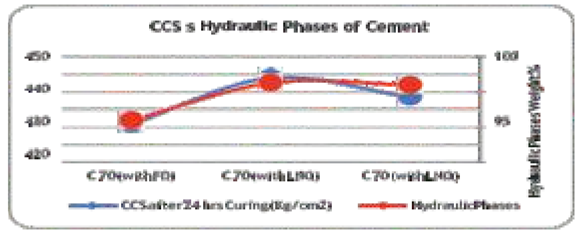


Fig 4

Improved Efficiency

- Reduced kiln preheating time by 40%
- Lower thermal energy consumption, reduced by 18.3

Operational Stability

- Stable flame trajectory and length
- Significantly reduced downtime due to ring formation

Quality Improvement

- Consistent and improved quality of clinker
  - The Cold crushing strength and Hydraulic phases increased sub-stantially. Please refer Fig 4
  - Reduced sulphur-bearing phases in the final product

D. Conclusion :

Replacing existing fossil fuel with alternate green fuel for end product like cement is always challenging in terms of evaluating it's suitability from thermal energy requirement and system adaptation point of view. Here Liquified Petroleum Gas being a cryogenic in nature and having price volatility, it's always being difficult to take a final strategic and technical decision. Right from the thermal study to getting the statutory approval and thereafter installation challenges, Calderys, Katni plant has successfully overcome all the hurdles. The end results were really satisfying when the quality of the product improves in terms of consistency & specifications and also meeting the sustainability commitment towards climate change. The reduction level in Sulphur bearing phases is as high as 65% in the final product and Carbon footprint reduced by 46%. This reduction substantially contributed in product quality improvement and commitment of Calderys to environment sustainability.

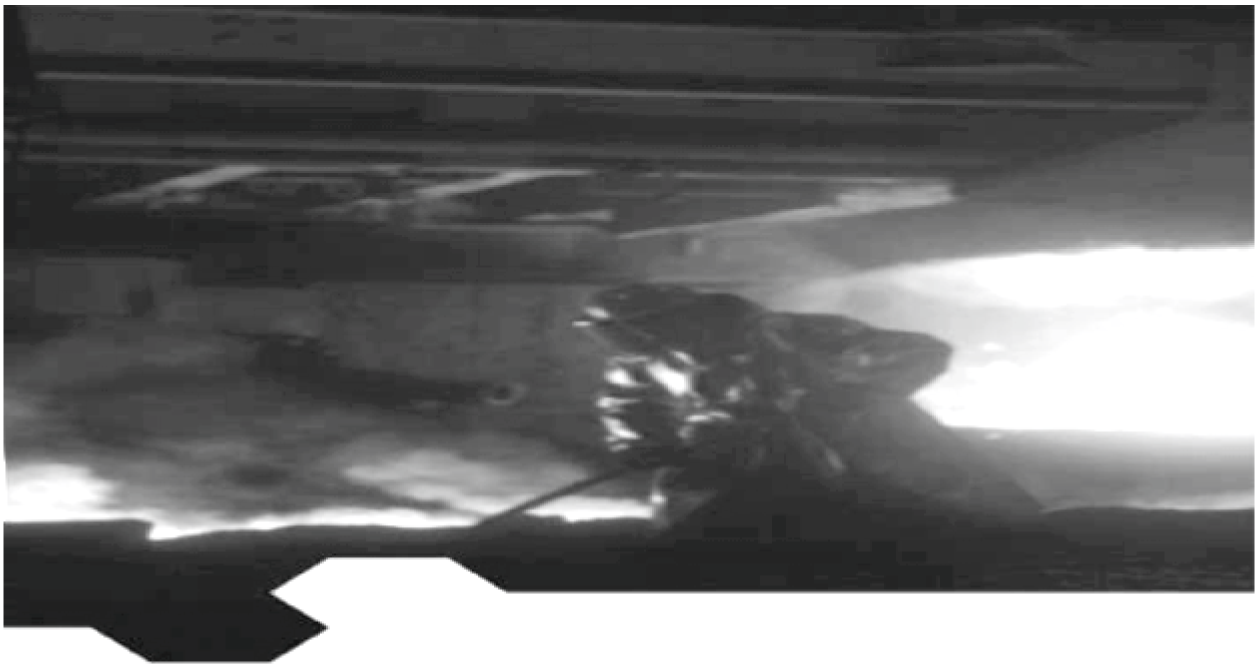
(Source: IREFCON 24 Proceeding)

STATISTICS

China's output of refractories' downstream industries for the
Calendar Year 2025 (Provisional)

Industry	Production (Million tonnes)	YoY Growth Rate (%)
Pig iron	845	-2.3
Crude steel	973	-4
Cement	1690	-6.9
Ferroalloy	40	5.8
Alumina	92	8.4
Coke	501	3.2

(Source: Internet platform Govt. of India)



SHREE SADASHIV REFRACTORIES PVT LTD

ABOUT US

Shree Sadashiv Refractories Pvt Ltd is an emerging company in the business of Mining and Processing of Refractory Raw Materials in Jamnagar, Gujarat in India. We are engaged in producing Refractory Raw Materials like Calcined Bauxite, Calcined Clay & Chamotte.

MISSION

SSRPL's core business mission hinges on its' commitment quality and service and offering raw material products consistent in size, chemistry & physicality. Our Laboratory is equiped with latest equipment for testing as per the industry standard.

KEY PRODUCTS

CALCINED BAUXITE

Refractory Bauxite, also known as Calcined Bauxite is produced by sintering high alumina bauxite in rotary kilns at high temperatures.

BROWN FUSED ALUMINA

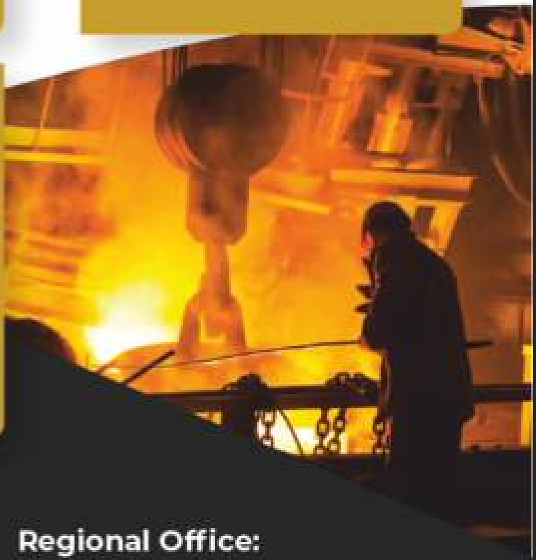
Calcined Bauxite is heated to Temperatures above 2000°C through smelting process in Arc Furnaces. Then slow solidification process is followed to get blocky crystals, which in other words is known as Brown Fused Alumina.

CALCINED CLAY

Calcined clay is obtained by calcining (heating) superior grade clay at high temperature in Rotary Kiln.

WHITE FUSED ALUMINA

White Fused Alumina is manufactured by the Fusion of Pure Quality Calcined Alumina in Arc Furnaces with Temperatures greater than 2000°C. After Slow solidification, a high purity synthetic material is obtained.



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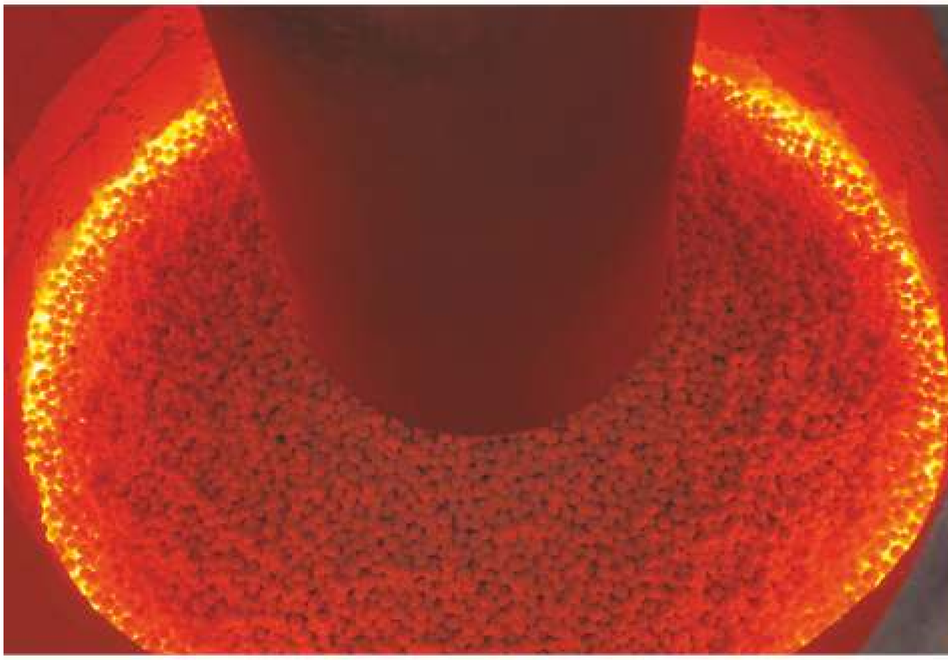

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