ISSN 0250- 5304

IRMA JOURNAL

(for Private Circulation Only)

Volume LVIII, No.3, September 2025

Quarterly Journal Of Indian Refractory Makers Association

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IRMA
PARTNERING HEATING SOLUTIONS
INDIAN REFRACTORY MAKERS ASSOCIATION

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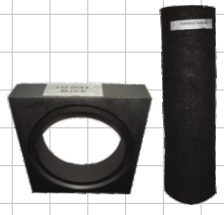

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Vol. LVIII, No.3, Sept 2025

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MESSAGE FROM THE CHAIRMAN

Dear Colleagues,

Good news continues to pour in regarding India's growth with GDP growing at 7.8% over year to year in the April to June quarter of fiscal 25 - 26. It underscores the resilience of our macroeconomic fundamentals and sets a positive tone for the months ahead. Looking forward, this is likely to be one of the strongest quarters of the year.

While higher US tariffs could weigh on exports and manufacturing in subsequent quarters, domestic demand should continue to drive growth, supported by easing inflation, GST rationalization, and continued policy support. The composition of India's exports provides some resilience. Services exports, which account for 47% of the country's exports, according to the Indian government, are less vulnerable to global trade fluctuations than goods exports. In this context we may consider intensifying our efforts to export the service components of refractories industry i.e. applications sector. I personally know few Indian companies doing great job in the Middle East and Africa.

While we are optimistic about increased steel consumption in the country, I would like to sound a word of caution. Global steel prices are falling, for which the pressure of import of cheaper steel in India is increasing. As per latest media reports, around 150 small steel mills have temporarily halted production due to excessively low steel prices. The Government is aware of this fact and has initiated measures to safeguard the domestic industry. Hence we need to keep a keen watch on the mini steel mills where refractory makers from MSME units are key suppliers.

Many of you are aware that 16th India International Refractories Congress (IREFCON 2026) will be held from 28th-30th October 2026 at Kochi, Kerala. The theme of the Congress is "Innovative Solutions for a Sustainable Tomorrow." I am confident that the Organizing Committee under Mr. Gangadharan Manari and the Technical Committee under Dr. Saumen Sinha will put up a stellar performance like yesteryears.

Sunanda Sengupta
Chairman

ASSOCIATION ACTIVITIES

IRMA Board of Directors Meeting

IRMA Board of Directors meeting was held on 12th September 2025 at Hotel Hyatt Regency, Kolkata under the chairmanship of IRMA Chairman Mr. Sunanda Sengupta. Issues discussed were PR and communication activities, Student IREFCON 2025 and IREFCON 2026.

IRMA Annual General Meeting

The 12th IRMA AGM was held on 12th September 2025 at Hotel Hyatt Regency, Kolkata under the chairmanship of Mr Sunanda Sengupta. Mr. Sandeep Acharya, Head Procurement, Process Consumables, Tata Steel Limited was the Guest of Honour of the occasion. The Chairman thanked the members for attending the AGM. He briefly discussed the present market conditions and the present challenges posed before the refractory makers. Outlining the recent initiatives of IRMA and future endeavours, he requested the members to actively take part in the association activities.

The Guest of Honour for the occasion, Mr. Sandeep Acharya pointed out the intricate relationship between the steel makers and the refractory industry. The Vote of Thanks was proposed by Mr. Anirbandip Dasgupta, Senior Executive Officer. All the normal business transactions were carried out as per the rules and regulations of the Association

IRMA Lifetime Excellence Award

This year, Mr V. Udaya Sankar has been awarded IRMA Excellence Award for his immense contribution towards promotion of the 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. BHARANITHARAN.T & AKASH KUMAR.C, Alagappa College of Technology, Anna University, Chennai for "Preparation of Sintered Mullite from Neyveli clay as a replacement for Andalusite "- undertaken by Bharanitharan. T & Akash Kumar.C.
2. PIYA PAUL & PRITY ROY, Govt. College Of Engineering & Ceramic Technology, Kolkata, for "Synthesis and characteri - zation of Refractory grade Alumina from Aluminium Dross" - undertaken by Piya Paul & Prity Roy
3. ISHIKA DUTTA & MOUSUMI GHOSH, Govt. College Of Engineering & Ceramic Technology, Kolkata, for "Evaluation of magnesium titanate as refractory aggregate" - undertaken by Ishika Dutta & Mousumi Ghosh

IRMA M R Hariharan Memorial Award

This year the Award was won by Mr. Suryadev Kumar, Department of Ceramic Engineering, National Institute of Technology, Rourkela for being the overall topper of the Ceramic Engineering Stream.

IREFCON 2026

IREFCON 2026 will be held at Grand Hyatt Kochi Bolgatty from 28th- 30th October 2026. The theme of the Congress is "Innovative Solutions for a Sustainable Tomorrow."

The Organizing Committee comprises:

Name of Members	Company
• Gangadharan Manari(Chairman)	Totale Global Pvt. Ltd
• Chinmay Basu (Co-Chairman)	Calderys India Refractories Ltd
• Krishnendu Kumar	TRL Krosaki Refractories Ltd
• Biswajit Parida	IFGL Refractories Ltd
• Rajesh B. Mukhekar	Vesuvius India Limited
• Nandan Santra	RHI Magnesita India Ltd
• Ranjan Dey	Carborundum Universal Limited
• Mayank Gugalia	Mahakoshal Refractories Pvt Ltd

The Technical Committee comprises:

Name of Members	Company
• Dr. Indra Nath Chakraborty (Advisor)	(Calderys India Refractories Ltd)
• Dr.Saumen Sinha (Chairman)	(Calderys India Refractories Ltd)
• Mr.Santanu Saha	(Tata Steel Limited)
• Dr. Debasish Sarkar	(NIT Rourkela)
• Dr. Goutam Bhattacharya	(Imerys Vizag Pvt. Ltd.)
• Mr. Ravi Kumar Periyasamy	(RHI Magnesita India Ltd)
• Dr Sathiyakumar M	(Totale Global Pvt. Ltd)
• Dr.Arup Kumar Samanta	(TRL Krosaki Refractories Ltd.)
• Dr.Premanshu Jana	(Vesuvius India Limited)
• Dr N K Mishra	(IFGL Refractories Ltd)
• Mr. Shankha Chatterjee	(Almatis Alumina Private Ltd)
• Dr.Debashis Chandra	(Refratechnik (India) Private Limited)

The meetings of IREFCON26 Technical Committee were held on 29th August 2025 and 19th September 2025 under the chairmanship of Dr. Saumen Sinha. The issues discussed were theme of the conference, probable Keynote Speakers, Theme Lecturers as well as modes of abstract and technical papers submission etc.

PHOTO GALLERY 12TH IRMA ANNUAL GENERAL MEETING

Welcome address by IRMA Chairman,
Mr. Sunanda Sengupta

Address by Chief Guest Shri Sandeep Acharya, Head Procurement, Process Consumables Tata Steel Limited, Bulk Commodities Procurement Division

Section of the Audience

Life Time achievement award to Mr. V Udaya Shankar
of Refractechnik India Pvt Ltd.

Award giving ceremony to students
IRMA M R Hariharan Memorial Awards

Award giving ceremony to student
IRMA N Sahoo Memorial Awards

Award giving ceremony to student
IRMA N Sahoo Memorial Awards

Award giving ceremony to student
IRMA N Sahoo Memorial Awards

IN THE NEWS

AMNS India

India's largest greenfield steel plant is set to be built in Anakapalli, Andhra Pradesh. AM/NS India secured environmental approval and land for an 8.2 million tonnes per annum facility. The project involves an initial investment of Rs 80,000 crore. Work is expected to begin within the calendar year. The plant's capacity may later expand to 24 MTPA.

JSW Steel

JSW Steel achieved its highest-ever consolidated crude steel production in Q2 FY26, reaching 7.90 million tonnes, a 17% year-on-year increase. This surge was primarily driven by strong Indian operations, which saw capacity utilization at 92%. The company also bolstered its Indian crude steel capacity to 34.2 MTPA with the commissioning of a new converter at JVML.

Per Capita Consumption of Steel in India

India's steel sector is experiencing significant growth, with production rising by over 12% despite global declines. The nation's per capita steel consumption has reached 100 kg, a key milestone as the National Steel Policy 2017 aims for 160 kg by 2030-31.

India's Green Steel Demand

As per Ernst & Young (EY)-Parthenon report, the demand for green steel in the country is expected to reach 4.49 MnT by 2030, driven by sectors like construction, infrastructure and automobiles. Although demand for green steel in India is currently negligible, it is expected to rise significantly over the coming decades, said the report titled 'Unlocking Green Steel Demand: An assessment of India's automotive, infrastructure and construction sectors.'

Coal ministry puts up 41 mines for auction

India's coal ministry is auctioning 41 mines, including 21 for underground coal gasification. This move aims to convert deep coal into syngas, reducing pollution and natural gas imports. The government targets 100 million tonnes of coal gasification by 2030. This initiative is expected to attract significant investment and create jobs, contributing to India's economic growth and a hydrogen economy. The government has set a target of 100 million tonnes of coal gassification by 2030. Last year, it approved an outlay of ₹8,500 crore for promoting coal and lignite gassification projects for both public sector undertakings and the private sector.

Ambuja Cement

Ambuja Cements will aim to increase its production capacity to 155 million tonnes by March 2028. The capacity target is 11% higher than the company's original target of 140 million tonnes. The company plans to increase capacity by 5.6 million tonnes in FY27 and 9.4 million tonnes in FY28 through debottlenecking.

JSW Cement

JSW Cement is setting up several greenfield units and one brownfield expansion, which will take capacity to 33.85 million tonne by 2028. After this phase, the company plans to push capacity to 41.85 million tonne through the second expansion at Vijaynagar and new greenfield plants at Hatta in Madhya Pradesh and in Uttar Pradesh, though no timeline has been specified.

UltraTech Cement

UltraTech Cement will cross 200 million tonne production capacity in FY26, a year ahead of the original aim as per its Chairman Mr. Kumar Mangalam Birla. UltraTech currently has a production capacity of 192.26 million tonnes for grey cement and 2.7 million tonnes for white cement.

OVERSEAS NEWS

Calderys

Calderys has announced a new partnership with Acetarc Limited, a UK-based specialist in foundry ladle design and manufacturing. This partnership, which makes Calderys the distributor of Acetarc ladles in Sweden, Denmark, Finland, and Norway, marks an important milestone in enhancing foundry operations across the region.

TIMAB Magnesium

TIMAB Magnesium, Magnesitas Navarras and Magnesium do Brasil – have officially united under a new name and identity: Terresis. This rebranding aligns with Terresis' mission: to relentlessly explore the full potential of magnesia, seamlessly integrating top-tier industrial performance with a strong commitment to environmental responsibility.

Chosun Refractories

Chosun Refractories signed a supply contract worth 41.6 billion won with Posco to provide 43 items, including core materials for Joseon Refractories' Ladle. The deal, effective through Sept. 30, 2029, accounts for 8.31% of the company's 2024 sales.

Ashapura Minechem

Ashapura Minechem has signed a long-term strategic cooperation agreement with China Railway to jointly develop the Boffa bauxite deposit in Guinea-Conakry. The agreement, finalized on September 15, was signed between China Railway and Ashapura's Guinean subsidiary, Ashapura Guinea Resources. Under the partnership, China Railway will provide expertise in mining operations, local logistics, port handling and infrastructure services. The Boffa permit covers roughly 200 km² and contains estimated reserves of over 200 million tons of bauxite.

Krosaki Group

Krosaki Middle East and Africa Ltd. (Krosaki MEA), a new subsidiary of the leading Japanese refractory company Krosaki Group, has been established. This strategic expansion aims to provide closer, more efficient, and responsive services to customers in the Middle East and Africa, strengthen regional customer relationships, and offer customized support. The refractory materials for this region will be produced in Europe by Krosaki AMR Refractarios S.A.u. and Refractaria S.A.u., both wholly - owned subsidiaries of the Krosaki Group, ensuring high - quality products and high - performance solutions.

Tata Steel

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 Industry and Information Technology (MIIT) has released a new draft revision of the “Implementation Measures for Steel Capacity Replacement” on Oct. 24, 2025, marking the latest effort to tighten control over steel production capacity and accelerate the industry's transition toward green and high-quality development. The revision follows the nationwide suspension of capacity replacement activities announced in August 2024, after regulators identified loopholes that allowed enterprises to expand capacity under the guise of replacement, leading to the phenomenon of “reducing on paper but increasing in reality.”

MEMBERSCAN

Carborundum Universal Ltd.

Carborundum Universal Ltd has recorded a dip in its consolidated net profits at Rs 60.39 crore for the April-June 2025 quarter due to a decline in its sales in the abrasives business. The consolidated total income for the quarter under review grew to Rs 1,237.75 crore, from Rs 1,204.56 crore registered in the corresponding quarter of last financial year. .

IFGL Refractories Ltd.

IFGL Refractories Limited has reported total income of Rs. 457.01 crores during the period ended June 30, 2025 as compared to Rs. 452.21 crores during the period ended March 31, 2025. The company has posted net profit / (loss) of Rs. 10.81 crores for the period ended June 30, 2025 as against net profit / (loss) of Rs. 8.43 crores for the period ended March 31, 2025..

RHI Magnesita India Ltd.

RHI Magnesita has commissioned India's first-ever robotic system for caster operations at JSW Vijayanagar Metallics (JVML), a subsidiary of JSW Steel, marking a milestone in automation for the Indian steel industry.

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.

ECONOMY AT A GLANCE

- India's growth story is accelerating, with projections showing it will remain the world's fastest-growing major economy through 2025 and 2026. By 2030, the country is poised to surpass Germany and emerge as the world's third-largest economy, driven by strong macroeconomic fundamentals, favourable demographics, and rising consumer spending. India's nominal GDP is forecast to grow at a CAGR of 11% between FY2024 and FY2030, reaching US $7.3 trillion. Private consumption, which already contributes 60% of GDP, is projected to make India the third-largest consumer market by 2026.
- India's exports to the US plunged 37.5% between May and September 2025 as sweeping tariff hikes by the Trump administration squeezed margins across major sectors, according to a report by India-based trade think tank Global Trade Research Initiative (GTRI), ANI reported. The US, India's largest export market, saw shipments fall from $8.8 billion to $5.5 billion over the five-month period, marking one of the steepest short-term declines in recent years, GTRI said in its analysis.
- The lower GST rate is expected to support a positive demand outlook by reducing the tax burden on consumers and businesses, as per a a finance ministry report. The ministry's monthly economic report for Sept said strong performance in the industries and services sector, along with a stable labour market, will further enhance domestic demand.
- Manufacturing activity accelerated to 59.2 in October, nearly a 17-year high, driven by strong demand and the Goods and Services Tax rate reductions, according to a private sector survey. The seasonally adjusted HSBC India Manufacturing Purchasing Managers' Index in October was higher than the 57.7 in September, which it said indicated a quicker improvement in the health of the sector. October's 59.2 was just lower than the 59.3 recorded in August, which was the highest in 17-and-a-half years.
- Gross GST collection increased 4.6% to about ₹1.96 lakh crore in October driven by festive buying spree despite a cut in GST rates. The October GST collection number reflects the impact of festive season sales, and the pent up demand.
- The Centre's fiscal deficit stood at 36.5% of the full-year target at the end of the first half of FY26, according to data released by the Controller General of Accounts (CGA). In comparison, the fiscal deficit had reached 29 per cent of the Budget Estimates (BE) for 2024-25 during the same period last year.In H1FY26, capex grew at a robust 40 per cent, exhausting more than half (51.8 per cent) of the ₹11.2 trillion full-year target, compared with 37.3 per cent spent during the same period a year ago. Revenue expenditure, however, stood at 43.7 per cent of the FY26 target, compared to 45.7 per cent during the same period in the preceding year.

BUSINESS SECTION:

EXCERPTS OF IRMA CHAIRMAN, MR. SUNANDA SENGUPTA'S SPEECH AT THE 12TH ANNUAL GENERAL MEETING ON 12TH SEPTEMBER 2025

It is my proud privilege as Chairman of IRMA, to extend a warm welcome to all.

When I utter the words, “innovative”, “creative”, they are not used as mere figure of speech but rather depict real picture of the industry. We have long left the legacy of energy guzzling, smoke belching down draft kilns and transitioned to leave a cleaner and greener future for our progeny. Several companies have been switching over to natural gas as fuel, using solar energy to light their factories, developing environmentally smart products at par with global standards. You may be pleased to learn that every year Indian units of several MNCs win the coveted the annual World Refractories Association safety awards beating their overseas counterparts. In IREFCON we now discuss predictive maintenance using big data analysis, AI tools and robotics to churn the best out of our manufacturing process.

At the same time, I would like to sound some words of caution. Last year, on behalf of IRMA we undertook a detailed survey of all the major refractory clusters of India and some its findings make me believe that many of them still have a long way to travel. With my years of experience in this sector, I tend to believe that the major barrier to enter this industry is not financial but technological. If you need better realizations on your investment, you need to improve your processes, opt for energy efficient solutions and have skilled man force at your disposal. IRMA has always encouraged the growth of the MSME sector because that's where the country's employment opportunity lies. We will continue to do so but you too need to accelerate your journey to reach the next level of competence.

Meanwhile, India is the second-largest crude steel producer in the world, with a provisional production of 149.4 million tonnes in FY 2024 and a projected 152 million tonnes in FY25. This significant output is driven by strong domestic demand from infrastructure projects and government initiatives. India's cement production reached 374.55 million tonnes in FY23 and 427 million tonnes in FY24 making it the world's second-largest cement producer. While all these may sound music to our ears and we sincerely wish this dream run to continue, I would like to make few pertinent points here:

- Despite retaining its title as the world's fastest-growing major economy, India's expansion has slowed to its weakest pace in years–down from a decade-long average of 7 percent to just 5.4 percent annually. This is primarily due to a sluggish manufacturing sector, stagnant job growth, a rising trade gap, disappointing capital flows and weak urban consumption.
- India's economic growth is expected to remain modest without deeper changes till the next level of reforms are unleashed. The recent rationalization of GST rates, a much due relief can be construed in that direction.
- Over 44 percent of the workforce is engaged in agriculture, while only 31 percent work in services and 25 percent in industry. This is a skewed situation as agriculture contributes merely 16-18% of GDP. We need to skill the underemployed labour engaged in agricultural sector with industry ready skills so that they can switch over here.
- Recent core sector data show strong growth in steel and cement, but declines in coal, natural gas, and electricity. A decline in energy and fertilizer production poses risks to agriculture and power-intensive industries, while growth in steel and cement supports infrastructure and construction activity.

Given the circumstances, we refractory makers need to be aware of the factors contributing to trade volatility:

- Supply chain disruptions post-global trade tensions including trade barriers and political tensions
- Price volatility of imported raw materials for which we need to diversify our sourcing network to tide over exigencies.

Disruptions are intrinsic to any business, but the fact of the matter is Indian refractory industry is Rs 20,000 crore + industry as on date and we all who have assembled here share the same excitement.

Moving over to the recent activities of IRMA, I am happy to inform you that we have signed a MoU with Utkalmani Gopabandhu Institute of Engineering, Rourkela to provide training to the students of diploma in ceramic engineering. The faculties are drawn from the member companies located in and near Rourkela and I am happy to inform you that classes have already started, and the response has been exceptional. I must thank all the faculty members for taking out time from their busy schedule and engage the students in such a productive manner.

In line with our aim to develop the student talent and showcase before them the attractive career options Indian refractory industry offers, we are organizing the first edition of Student IREFCON from 5-6 November 2025 at Kolkata. The event specially curated for the students of diploma and degree ceramic engineering of 5 leading colleges, will have lectures by industry experts, technical presentation by students, round table meet and day long technical training programme by industry experts. The Organizing Committee under the chairmanship Mr. Jyotirmoy Bhattacherjee has done a phenomenal work in this regard and I am sure we are going to witness a great conference ahead, completely different from what we are used to see. However due to practical constraints, access is restricted to the students nominated by the participating colleges only.

You might be aware that IREFCON 2026 will be organized from 28th-30th October 2026 at Hotel Grand Hyatt Kochi Bolgatty with usual enthusiasm and fanfare. Under the chairmanship of Mr Gangadharan Manari, we are eagerly waiting for grand turn of events to unfold. The Technical Committee under Dr. Saumen Sinha has started the spadework to bring before us an eclectic series of keynote speeches, theme lectures, case studies and oral presentations. Like yesteryears, I solicit your bountiful support and blessings to organize IREFCON2026 which now showcases our industry in the global scale like never before simultaneously commanding enormous brand value.

A key function of IRMA has been representing to Government and other stake-holders on issues of commonality of members. In this regard, we have been engaging the Govt periodically, but a need was always felt to generate more momentum in the process. In the past, we had engaged a PR agency but with mixed outcome. We are now exploring the idea of engaging a PR agency to strengthen our initiative keeping in mind our past experience.

At the end, I would like to gently remind you that the strength of an association lies in its members. It is the members' level of participation which makes a body like IRMA the mouthpiece of the industry. I request you all to come forward and be an active member and highlight our industry's conditions in various forums. Refractory industry is a heterogeneous and fragmented industry, and IRMA is the only common platform where we can meet and share our moments of happiness or periods of difficulty. We need to strengthen this body for our own needs.

I would like to sign off with a quote from George Bernard Shaw, "It is impossible to progress without change, and those who do not change their minds cannot change anything."

Thank you very much.

TECHNICAL SECTION

DEVELOPMENT OF SUITABLE SHOTCRETE MATERIAL TO ACHIEVE BETTER TECHNO-COMMERCIAL PERFORMANCE OF TORPEDO LADLE

Sudip Paul[1], Shankha Chatterjee[2],
[1] RHI Magnesita India Ltd, New Delhi,
[2]Almatis Alumina Pvt. Ltd., Kolkata
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ABSTRACT

Over past decades, torpedo ladle has become very common and regular transfer vessel to transport hot metal from the blast furnace to the steel shop. Other than long residence time and transfer, this whole process also involves higher metal/slag turbulence and greater chemical attack. Thus, high quality refractory lining, such as Alumina Silicon Carbide based bricks are lined in torpedo ladle which should be used for long service life. Good degree of resistances against thermal shock, abrasion, impact, and wear resistances of refractory lining are perquisite. To prolong the working refractory lining life of the torpedo ladle, a suitable selection of shotcrete castable became necessary. The present case study describes the development of right quality of shotcrete castable which not only ensures extended service life of torpedo ladle working lining but also achieves techno-commercial requirements of its performance. The development targeted to meet better abrasion resistance, volume stability and strength parameters for the shotcrete material but also ensures desired flowability and optimization of setting time during application and more importantly lowest rebound loss and lower shotcrete material consumption. Final users' references are sighted to prove superior product development using appropriate Alumina based raw materials.

Keywords: Torpedo ladle, repair castable, shotcrete mass

INTRODUCTION

Torpedo ladle is an important vessel in the integrated steel plant, performing intermediate treatment (e.g. desulfurization), homogenization and transport activities in between iron making (blast furnace) to steel making (converter). The overall productivity increase thus also depends on the performance of torpedo ladle. Few decades before, hot metal ladle was popular and that is continuing today as well but effective only for small steel plant. Majority of integrated steel plants have converted their operation to torpedo ladle in last 2 decades to achieve better operational productivity. The major advantage in torpedo ladle over hot metal ladle is primarily capacity (torpedo 200 mt to 350 mt typically) vs hot metal ladle (50 mt to 150 mt typically) and refractory life, whereasmetallurgical treatment scope and temperature loss prevention in hot metal ladle is quite minimal. This also prevents usage of hot metal ladle for long distance movement (excessive heat loss) and long waiting time (due to steel shop logistic) in integrated steel plants and thus torpedo ladle became so popular.

During refractory design development period, it was clear that torpedo lining requires better refractory than hot metal ladle (fired alumino-silicate bricks). During initiation years of torpedo ladles, a lining life of 200/300 heats was considered satisfactory. However, there was need to upgrade the service life to reduce the frequency of relining as this is completely unproductive time for the steel shop. With

time, chemically bonded alumina-silicon carbide-carbon (ASC) brick became the suitable working lining refractory in torpedo ladle and fired alumino-silicate has taken place of back-up lining in torpedo lining. And the steel shops have achieved improved torpedo refractory lining life + 500 heats life (like + 100,000 mt hot metal throughput) in early 2000s or so. Way forward, improved quality of ASC brick was developed and lined in torpedo ladles and increased service life of 800 heats or so. But extending +1000 heats with just superior quality initial ASC brick lining was not easy. Refractory researchers then came up with monolithic repair mass and lining technique which helped to extend the torpedo service life to a level of 1500+ heats.

The monolithic repair mass for torpedo ladle was of different types, based on facilities and experiences of refractory manufacturers and steel shop. There are varieties on material type as well as lining technique such as low cement or medium cement castable and cold/ hot gunning and shotcrete techniques. Based on primarily steel shops facilities and logistic scopes and refractory manufacturers experiences, the strategies for implementation of working lining refractory maintenance plan and adoption techniques are considered to increase the service life of torpedo lining finally.

Generally, in torpedo ladle maintenance, first the bottleneck areas for performance achievement/ enhancement are analyzed. These areas are generally the impact area and the spout area, whereas occasionally the trunnion area and the barrel area, based on specific steel plant torpedo ladle design and wear-out pattern. The repair monolithic performance plays a very significant role, starting from mid-campaign period to end of torpedo ladle life. The development of spout area castable is targeted to have high resistance to corrosion by hot metal & slag, good resistance to abrasion during pouring of liquid metal at elevated temperature & minimize the differential erosion between castable & ASC bricks at junction area. Whereas the development of impact area castable is targeted to have high resistance to mechanical impact, abrasion resistance from hot metal & slag during pouring of liquid metal at elevated temperature. Obviously the spout area and impact area are the most critical zones of torpedo ladle that guide final performance and hence specific consumption of refractory is mostly dependent on the performance of castable used in spout and impact areas. This case study describes the improvement process of such shotcrete castable for torpedo ladle application.

CASE STUDY

Castable technology is quite old but a complex one with continually upgrading material concepts. The choices of aggregate, matrix and binder, and additives depend on the application requirements of that castable. The torpedo ladle applicationdemand that shotcrete castable should have good properties in volume stability, abrasion resistance, thermal shock resistance and strength, whereas rheological features wise good flowability is must, in addition to quick setting time and lower rebound loss. Here in this case, sintered mullite and silicon carbide are used as aggregates and the technical understanding was not to modify these but apply changes in matrix to bring improvements in properties and performance of torpedo shotcrete castable. Originally matrix concept of medium cement castable with Tabular alumina in fines was not changed but

modification was brought in type of cement and calcined alumina concepts. Usage of 70% alumina cementgrade S70 was changed to 80% alumina cement of grade CA 25R and calcined alumina grade M4 was changed to bi-modal reactive alumina grade CL 370. The mix concepts for improvement-trials is mentioned in the table-1. The original/ base recipe is mentioned as “B” and changes are mentioned with “C” and “D”. The table-2 mentions the physical-chemical properties of components which brought key changes in castable properties and parameters.

Tab.1: Formulation concepts of MCC type shotcrete mass

Type	Materials \ Recipe	B	C	D
Aggregate	Sinter Mullite	XX	XX	XX
	SiC	XX	XX	XX
Matrix & Binder	Tabular Alumina	X	X	X
	Calcined Alumina M4	X	X	-
	Reactive Alumina CL 370	-	-	X
	CAC70%, S70	X	-	-
	CAC80%,CA25R	-	X	X
Additive	Silica Fume+Additives	x	x	x

Tab.2: Key features of matrix components

	S70	CA25R	M4	CL370
Al_2O_3, %	70	81	99.6	99.7
CaO, %	29	18	0.03	0.03
Na_2O, %	0.2	0.2	0.35	0.10
Fe_2O_3, %	0.1	0.1	0.03	0.03
SiO_2, %	0.2	0.2	0.03	0.03
BET, m2/g	0.42	0.55	6.0	3.0
-45µm, %	78	83	99.1	99.8
D50, µm	12	9	3.5	2.5
D90, µm	65	55	20	7

The above recipes were mixed at water demand of 7-8% and checked for rheological properties in lab conditions. Standard bars of the tried castables were casted and checked for density, porosity, compressive and flexural strengths, permanent linear change after prefiring at different firing temperatures up to 1400ºC. Bars prefired at 1400ºC/5 hrs were tested for hot modulus of rupture (HMOR) at 1400°C with 30 minutes soaking time. Bars prefired at 1400ºC/5 hrs were tested abrasion resistance test as per ASTM C704. Initial and final setting time of castables are mentioned in table.3 along with water demand and wet-out time.The other results of the conducted tests are mentioned in figures 1-7 below.

Tab.3: Casting rheologyin standard castables

Parameters	B	C	D
Water demand, %	8.0	8.0	7.0
Wet-out time, sec	70	68	58
Initial setting time,mint	195	135	115
Final setting time,mint	250	170	155

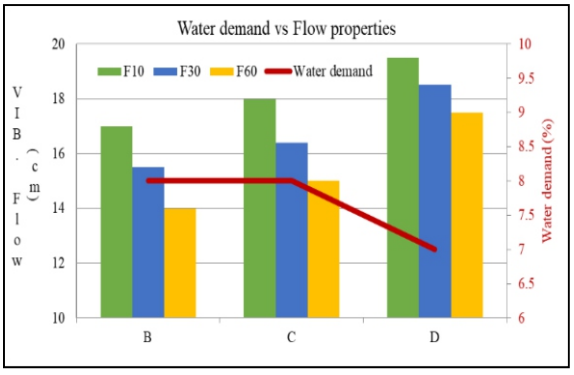

Fig.1. Water demand and flowability

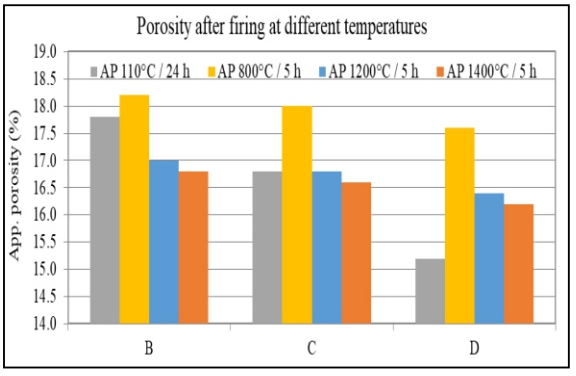

Fig.2. Apparent porosity of prefired castable bars

The change from 70% CAC to 80% CAC caused drastic reduction in setting time in set-C and set-D whereas presence of microfines-aluminas from bi-modal reactive alumina CL 370 facilitates better hydration reaction in set-D. Castable water demand also was less in set-3 due to better packing. The flowability was also better in set-D due to better packing with bi-modal reactive alumina.

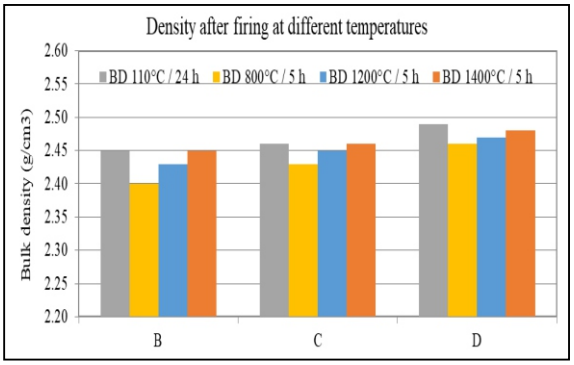

Fig.3. Bulk density of prefired castable bars

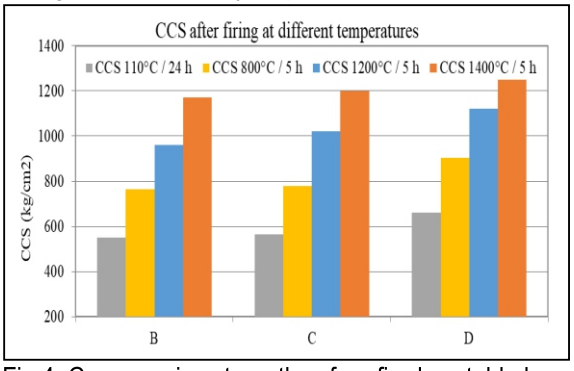

Fig.4. Compressive strengths of prefired castable bars

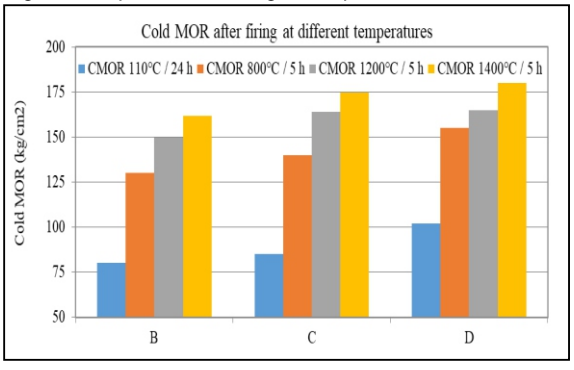

Fig.5. Tensile strengths of prefired castable bars

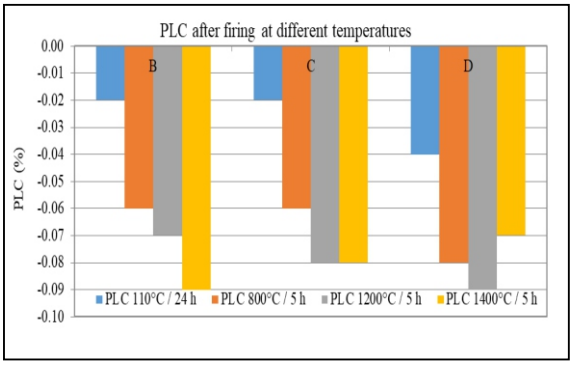

Fig.6. Permanent liner change of prefired castable bars

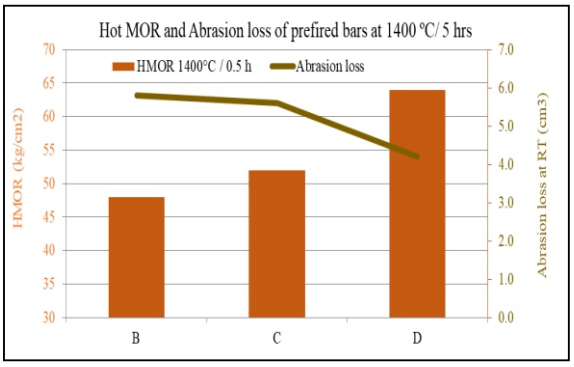

Fig.7. HMOR, abrasion resistance of prefired castable bars

Bi-modal reactive alumina CL 370 enhanced particle packing. This altogether worked for reduction in porosity and improvement in density and strengths parameters in final set-D.The better sinter reactivity of reactive alumina, in presence of silica fume helped for secondary mullite formation and further strength development in set-D. Volume stability can be linked to PLC and was under control. Hot MOR was found to be maximum in set-D whereas abrasion loss was minimum among all sets in set-D.

INDUSTRIAL APPLICATION BENEFITS

The improved shotcrete mass of set-D was applied in application along with special additive which accelerates to set the castable quicker after pumping to the working lining. In actual field application, the water demand was 6% and having only 5% rebound loss. Each shotcrete

repair used to build up 2-3 inch castable thickness over eroded ASC working brick lining. After each cold repair, 24 hrs curing was maintained and then put in preheating before taking the ladles into circulation. The usage of such improvement shotcrete mass are tabulated in table.2 below with plant and torpedo capacities and overall torpedo life and shotcrete mass consumption. Normally 1st shotcrete repair starts after 450-500 heats life and continues repeated cold repairs with shotcrete mass at a gap of 250-300 heats. Thus totally 4-5 times cold repair are done in full torpedo life. It was observed that there is average 200 heats improvement in overall torpedo life and shotcrete castable consumption has significantly reduced by 5-10 mt in quantity which clearly signifies better performance of the improved shotcrete castable.

Tab.3: Successful application details

	Plant-1	Plant-2
Plant capacity	12 mtpa	10 mtpa
Torpedo capacity	350 mt 380mt	200 mt 380 mt
Earlier torpedo life	1500-1600 heats	
Improved torpedo life	1600-1800 heats	
Earlier shotcrete consumption	50-60 mt, 12-15 mt per repair	
Improved shotcrete consumption	45-50 mt, 10-12 mt per repair	

CONCLUSIONS

- Selection of proper 80% high alumina cement is essential for achieving proper rheology as well as desired setting behaviour. CA25R cement plays vital role here having quicker setting time to 70% purity alumina cement used before.
- Castable water demand control is very essential to reduce porosity and provide stronger matrix to achieve volume stability with sufficient strengths after firing. Bi-modal reactive alumina CL 370 plays essential role here.
- Right choice of right matrix with bi-modal reactive alumina CL 370 developed secondary mullite formation in presence of silica fume and provide best hot tensile strength and lowest abrasion loss.
- With developed improved shotcrete mass, castable consumption reduced significantly and overall life of torpedo ladle increased.

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Source: IREFCON 24 proceedings

TECHNICAL SECTION

HOLISTIC APPROACH FOR PROLONGED TAPHOLE LENGTH THROUGHOUT THE FURNACE CAMPAIGN

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Shubhashis Kundu, M K Ghosh Choudhury, Ravi Shankar, Sujat Ali Khan, Tushar Agarwal TATA STEEL LIMITED

Abstract

Normally, the performance and longevity of the blast furnace is intimately linked to the performance of the Taphole. Taphole clay plays a critical role in stable operations and achievement of longer furnace life by protection of hearth side wall with longer taphole length. With the increase in furnace campaign, the need for clay quality modifications arises due to continuous corrosion and erosion by hot metal and slag.

Established in 1907, Tata Steel is the world's 6th largest steel company with an existing annual crude steel capacity of 28 million tones. The G-Blast furnace commissioned in November 1992, was upgraded to an Inner Volume of 2643 m^3 and blown on 6th April 2005. Initially, Krosaki Harima, Japan, started furnace operations monitoring from 2010 onwards, which was again jointly supervised by TRL Krosaki along with Tata Steel. Since then, the performance of taphole clay has been reviewed on regular basis with continual clay modifications as per the furnace requirements. With the prime objective of achievement of longer furnace life, the focus was to maintain or improve the taphole length without impacting the other KPIs like Cast duration, Drillability, Taphole side wall temperature control etc. A thorough study has been conducted on taphole clay developments, improvement in cast house operational practices and its effects on the furnace health as well as productivity. The present paper illustrates the clay quality changes along with the persistent improvements in cast house practices. With the increase in the Furnace age, time to time modifications were done in clay plasticity, setting behaviour and manufacturing control of the refractory. Along with changes in taphole clay quality, improvement in cast house practices viz. usage of Trough cover, Mudgun water- cooling arrangement, Clay temperature monitoring, Taphole face preparation, Laser sensor taphole centering helped to achieve consistent taphole length throughout the furnace campaign. With a joint collaborative approach by the user and manufacturer, optimized clay quality and advanced cast house practices, G-BF is running for ~19 years with 2.43 MT/m3 (IV-wise) productivity. The current Taphole length is as per target (3.6 meter) and the Taphole side wall and Hearth temperature are within the controllable limits.

1. Introduction

The blast furnace is the most familiar furnace type that is used for iron production. The design and operation of these furnaces differ between manufacturers and each design is unique from another. With the development of iron making, new techniques such as high-top pressure, high air pressure, high smelting strength, high wind flux and oxygen enriched blowing are used in large scale blast furnaces which expect more from taphole clay.[1]

Good health and reliable operation of the tap hole are essential for smooth functioning as well as achieving the desired lifespan of blast furnace. The expectation of furnace operators, from taphole clay, are plugging without any leakage and back flushing, smooth taphole opening, i.e. only with drill bit without hammering or oxygen lancing, no increase in taphole diameter during slag as well as metal casting, consistent taphole length, no slag delay and no spitting during casting. Achieving these targets requires correct taphole clay formulation as well as its quality consistency. The factors that determine the correct selection of taphole clay include ensuring the clay plasticity, mechanical strength and refractoriness. The clay needs to be refractory at high temperatures as well as have sufficient plasticity to be able to work the clay in

the mud gun, to be able to plug the tap hole and ensure a proper seal of the tap hole to prevent the liquid pig iron and slag in the furnace to run out of the taphole. Table 1. depicts the various functions and property matrix for taphole clay.

Table 1. Function vs. Property Matrix of Blast Furnace Taphole Clay

Closing Hole	Easy plugging and drilling	=> Plasticity of fireclay. => Good gas permeability => Proper sintering
Hearth Protection	Constant Length	=> Resistance to hot metal and slag. => High stickiness to the furnace wall.
Constant Delivery	Erosion Resistance	=> Expansive nature. => Resistance to hot metal and slag.

It is also important to mention that blast furnaces operate differently from each other, according to the raw materials used (iron ore and pellets rate, coke reactivity, etc.), to the fuel composition (coke and pulverized coal balance), to its daily production, to its inner volume, to the equipment used during pushing and drilling, and to many other factors associated with the pig iron production process.[2]

The present case study deals with the development and detailed approach for smooth running of furnace with timely changes in the taphole clay as well as cast house practices. The G-Blast furnace commissioned in November 1992, was upgraded to an Inner Volume of 2643 m^3 and blown on 6th April 2005. To design a suitable clay for G BF, thorough study has been done on the furnace operating conditions in Table.2, casting practices in Figure.1, specification of the machinery and cast house practices.

Table.2 Furnace Parameters

Top pressure (bar)	1.5
Hot blast pressure (bar)	3.04
Oxygen vol. (Nm^3/hr /%)	20K / 6.5%
Hot Blast temp (°C)	1170-1190
Coke rate (kg/THM)	290~320
Coal rate (Kg/THM)	180~210
Hot Metal Temperature (°C)	1490-1510
Hot Metal Analysis Si (10-2)	70~85
S (10-3)	50~60
Slag Basicity	1.05
Slag Volume (Kg/Ton)	270

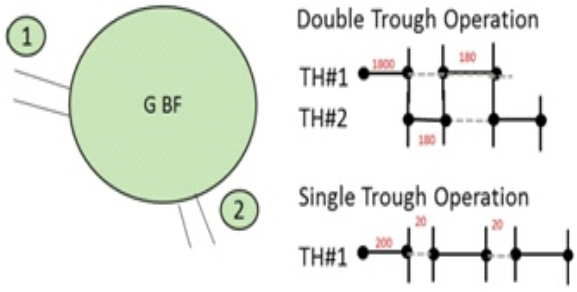

Fig 1: Cast House design and Casting Practice

The present work addresses the gradual development of taphole clay, which can attain long and stable taphole lengths, guaranteeing reliable protection of the blast furnace hearth walls.

2. Case Study Discussion

2.1 Evolution of Clay quality

As the blast furnace campaign life goes on, the clay quality requirement also changes due to continuous wear and tear mechanism by hot metal and slag to the Carbon block refractories. Thus, the clay design concept varies with the blast furnace age which are as follows

- In initial 5 years of the campaign the clay design is basically Al_2O_3-SiO_2-SiC-C as focus is on faster drainage.
- Between 5~10 Yrs of the campaign, SiO_2-Al_2O_3-SiC-C based clay with good plasticity, adhesion to the old clay and bigger mushroom volume
- For 10~20 Years of the campaign: High Corrosion resistance, higher plasticity, good adhesion (SiO_2-Al_2O_3-SiC-C), mushroom protection as well as hearth side wall protection (worn out C-block area replacement with clay)

TRL Krosaki joined with the Tata Steel G BF Team from 2010 onwards for monitoring of furnace operations along with timely improvements of taphole clay and cast house practices. The current case study emphasizes the different approaches taken for maintaining a good furnace campaign.

2.1.1 Phase 1 – (2010 – 2017)

Clay Quality

After the initial campaign life of ~ 5 years, the furnace requirements are reduction in initial spitting, increase in cast duration and quick sintering. Resin bonded clay having superior thermosetting characteristics along with high corrosion resistance was used in Phase 1 campaign. The change in resin bonded clay was also an attempt to increase and control the curing speed of the clay.

Cast House Practice Improvement:

A. Usage of Trough Cover:

Trough cover as shown in Fig.2 keeps the tap hole area warmer and makes removal of skull easy. This also protects the mudgun from excess heat and helps to maintain lower temperature of taphole clay and this benefits in clay leakage control and optimum plasticity of taphole clay.

Fig 2: Trough Cover

B. Water Cooling System:

External water-cooling system for barrel and nozzle helps to maintain the clay temperature within 60~80^{0}C. Continuous Nozzle temperature monitoring, as shown in Fig.3 is maintained throughout the tapping and cooling is adjusted as per requirements.

Fig 3: Clay Temperature Monitoring

C. Drilling Practice:

For using higher corrosion resistant clay drilling practice has been standardized, with lot of brainstorming and hit and trial method, Fig.4. The Drill bit quality has been optimized with tungsten carbide tip and the mist cooling has been increased to 3~5Ltr/Min.

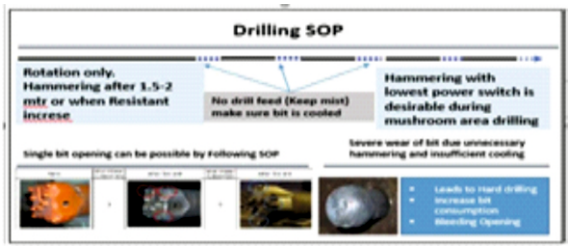

Fig 4: Drilling SOP

D. Model Based Drill bit selection:

One model has been designed based on GUTKO, Production rate, HMT, Slag Volume etc. for proper drainage and Optimum Cast duration.

2.1.2 Phase 2 – (2017 – 2021)

Clay Quality

As the furnace ages, the need for longer Taphole Length to sustain cast duration increases. In this scenario, composite bonded clay with higher plasticity and different polymerization speed was used for better mushroom build up. Blue line in Fig.5.shows better plasticity behavior due to thermoplastic nature of tar in composite clay when compared to resin bonded clay. Apart from this, some nano carbonaceous materials were added to strengthen the clay matrix to enhance the corrosion and erosion resistance.

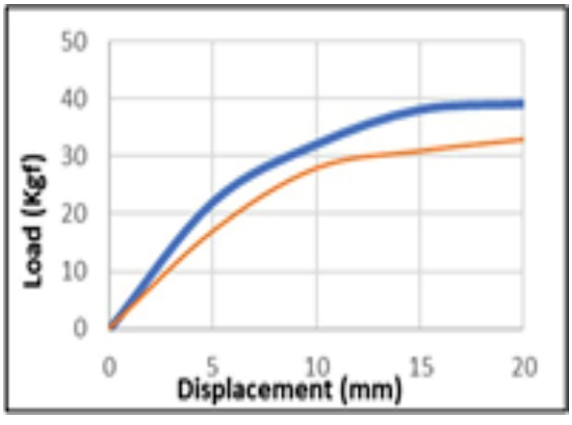

Fig 5: Plasticity behaviour of Composite vs Resin Bonded Clay

Cast House Practice Improvement

A. Tap hole face reamer:

Previously tap hole faced reamer attached with drill machine was being used for cleaning of adhesion material. But sometimes the sealing between Mud gun nose and Taphole face was improper. A self-rotating Reamer attached with Mud Gun Nose as shown in Fig.6 has been adopted and the clay leakage frequency has been reduced drastically.

Fig 6: Taphole face Reamer

B. Casting Sequence based on Liquid level monitoring system, Fig.7: This helps to improve the Slag tap ratio, Casting duration, Proper drainage of furnace, Proper GUTKO has been achieved. This improves the overall performance of clay.

***Fig 7**: Liquid Level Monitoring*

2.1.3 Phase 3 – (2021 – Till date) Clay Quality

As the furnace becomes old, and it is between 10 ~20 years, the carbon block wear out is more and it gets replaced by clay. Here the need for longer taphole length and reduction in taphole side wall temperature is essential to protect the mushroom as well as hearth. The stability of mushroom depends on several factors, like clay formulation, binder system as well as mixing process during its production and taphole clay workability. To ensure targeted taphole length in every cast, stringent manufacturing norms were implemented for reduction in binder along with optimization of clay temperature at the manufacturers end. Fig 8 & 9 presents comparative data, wherein the percentage of binder and the mix temperature during clay manufacturing have been narrowed down to minimize the fluctuations during usage at furnace.

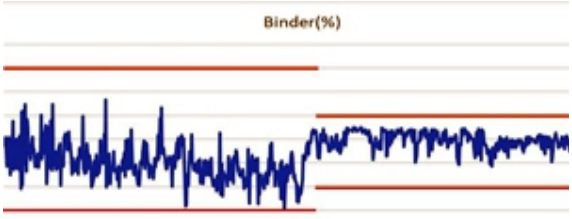

Fig 8: Binder Analysis during manufacturing

Fig 9: Mix temperature Analysis during manufacturing

Many a times, due to high erosion impact the side wall temperature overshoots to ~ 35^{0}C. Localized solutions like addition of TiO_2 added clay into the system reduces the temperature drastically due to the formation of Ti-C-N4 in the mushroom and side hearth area. Initial trials with TiO_2 added

Cast House Practice Improvement

A. Laser sensor-based tap hole centering has further eliminated the issue of off-centering drilling, thus further improvement in clay leakage has been achieved.

B. Drilling assistance model, Fig.10, has been designed to predict the clay push qty, bit size etc, which helped to eliminate human error and improve the clay performance further.

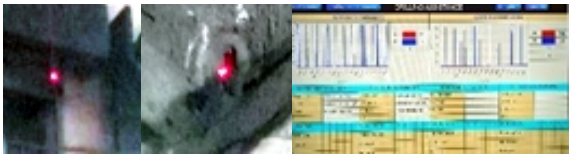

Fig 10: Drilling Assistance Model

Conclusions

Every furnace THC is different even if the same raw materials are used, as furnaces are unique and accordingly THC formulations must also be tailor made for each furnace and its specific operational parameters. The performance of this product is highly dependent on the BF operational parameters and its application. The design and development of a THC is a continuous process because the formulation usually requires small changes until it operates satisfactorily according to a certain blast furnace process. Fig.11 & 12 shows the trend of taphole length, cast duration and hearth temperature for the entire furnace campaign of G-BF

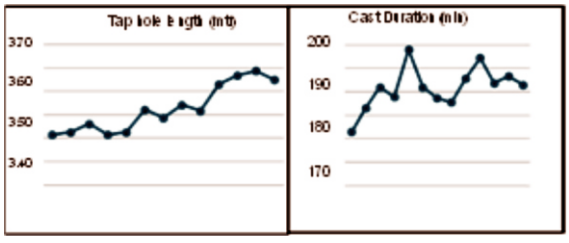

Fig 11: Trend of Taphole Length and Cast Duration

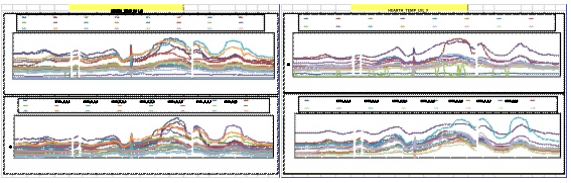

Fig 12: Hearth Temp Trend

With this collaborative approach by the user and the manufacturer, the current Taphole length is as per target (3.6 meter), Cast duration is >180 Min and the Taphole side wall and Hearth temperature are within the controllable limits

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Source: IREFCON24 proceedings

STATISTICS

EXPORT & IMPORT OF REFRACTORY ITEMS

EXPORT OF REFRACTORY ITEMS	2023-24	2024-25
	Rs. Crores	Rs. Crores
FIRE CLAY BRICKS & SHAPES	176.70	172.16
HIGH ALUMINA BRICKS & SHAPES	1423.45	1451.46
SILICA BRICKS & SHAPES	24.17	19.89
BASIC BRICKS & SHAPES	218.71	229.61
MONOLITHICS/CASTABLES	597.63	681.05
SPECIAL PRODUCTS	459.92	471.71
CERAMIC FIBRES ETC	218.62	232.71
OTHERS	219.60	222.74
TOTAL	3338.80	3481.33

IMPORT OF REFRACTORY ITEMS	2023-24	2024-25
	Rs. Crores	Rs. Crores
FIRE CLAY BRICKS & SHAPES	22.44	20.62
HIGH ALUMINA BRICKS & SHAPES	1219.83	1166.40
SILICA BRICKS & SHAPES	169.49	173.56
BASIC BRICKS & SHAPES	1807.28	1463.78
MONOLITHICS/CASTABLES	1299.30	1315.53
SPECIAL PRODUCTS	35.76	28.02
CERAAMIC FIBRES & OTHERS	406.30	380.24
OTHERS	405.75	728.16
TOTAL	5366.15	5276.31

(Source: Ministry of Commerce & Industry, 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.

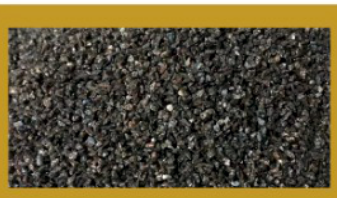
MISSION

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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Printed and published by Mr. Anirbandip Dasgupta, on behalf of Indian Refractory Makers Association and printed at Quality Supply Syndicate, 219C, Old China Bazar Street, 2nd Floor, Room No. C - 10, Kolkata - 700 001 and published at, IRMA, 41, Shakespeare Sarani, Kolkata - 700017, Editor : Dr. I. N. Chakraborty • R.N.I. Regd. Number 34845/79