International Conference on Refractories in Iron & Steel Industries

September **23-24, 2022,** Bokaro Steel City, Jharkhand, **India**

REFIS 4.0

23-24 September 2022

Bokaro Steel City Jharkhand India

SOUVENIR

In association with

Organised by :

सेल SAIL

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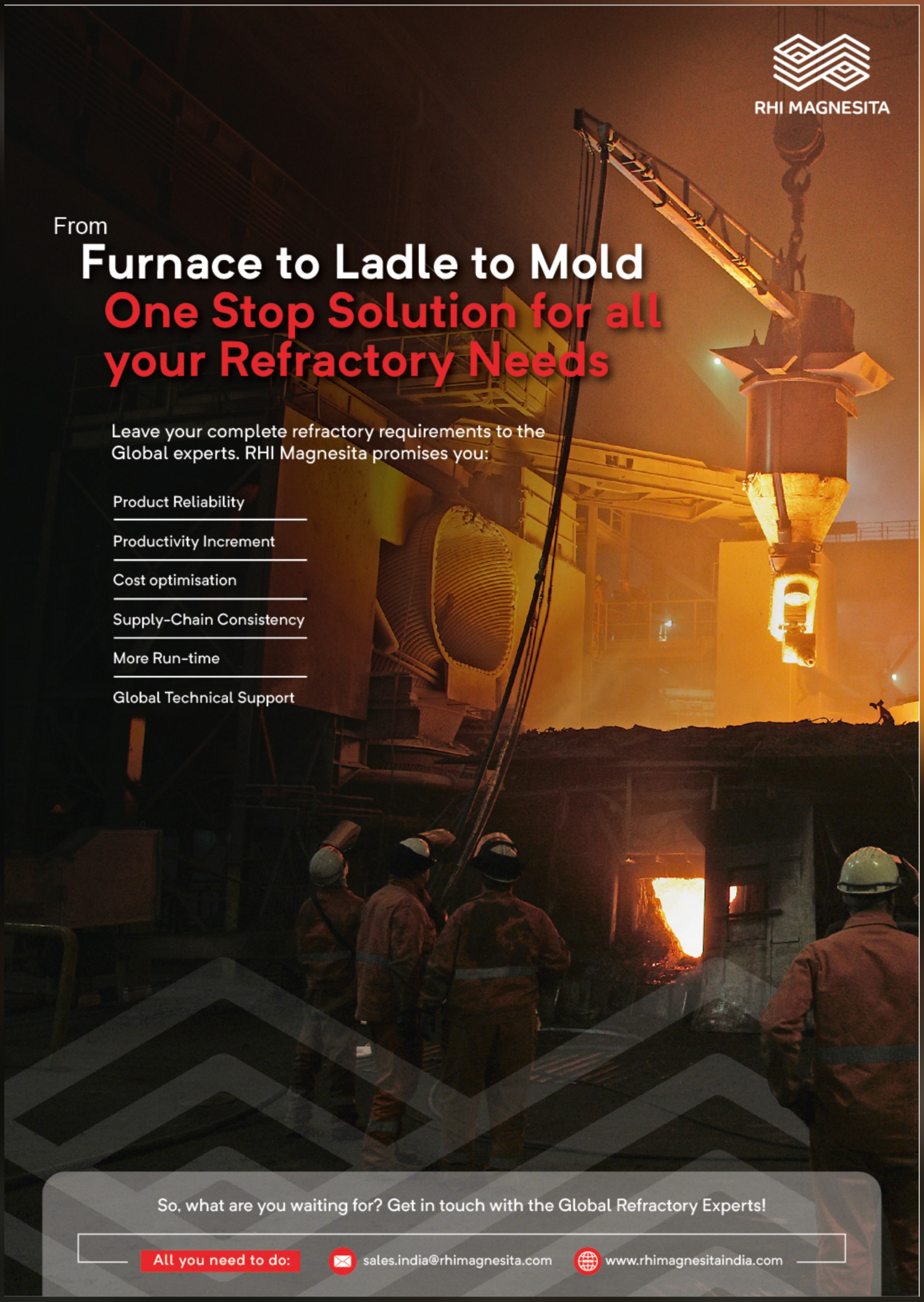
Bokaro Steel Plant

The Indian Institute of Metals

IIM Metallurgy Materials Engineering

Bokaro Chapter

Indian Ceramic Society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23-24 September 2022

Bokaro Steel City Jharkhand India

International Conference on Refractories in Iron & Steel Industries

September 23-24, 2022, Bokaro Steel City, Jharkhand

Organised by :

सेल SAIL 50 स्थापना के 50 साल 50 YEARS OF INCORPORATION स्वर्ण जयंती • SWARNA JAYANTI

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Contents

Editorial

Message

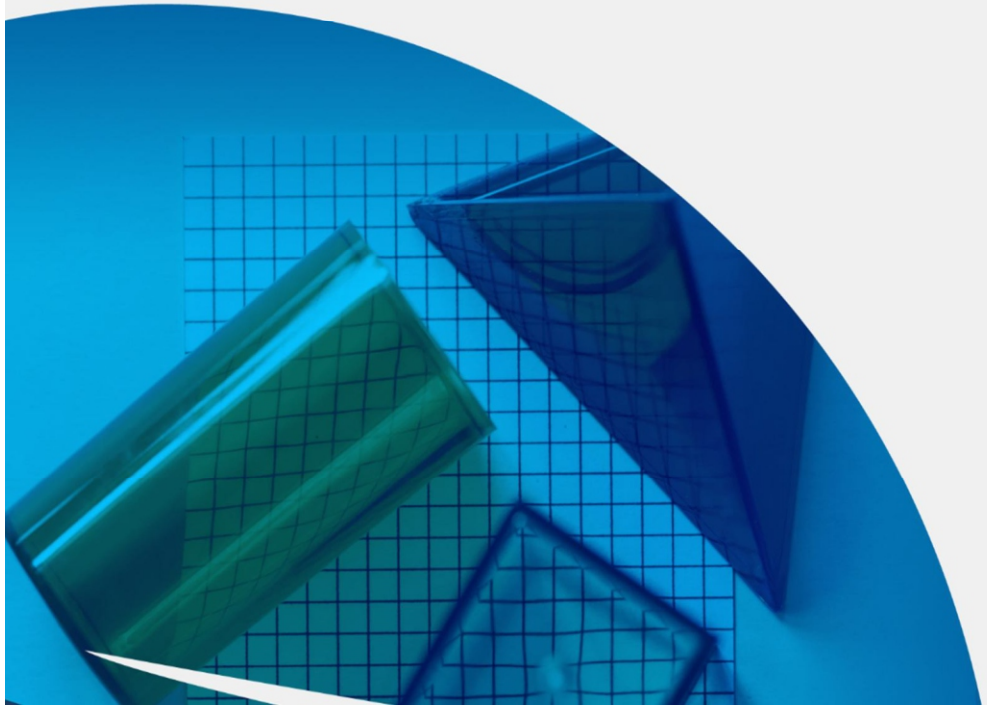
Our Team

Program Schedule

Abstracts of Technical Paper

Organizer Profile

Our well-wishers and supporter



Editorial

The International Conference on Refractories in Iron & Steel Industries encompasses the major domain of Refractory engineering and technology in the dynamic world of the present age. The Conference aims to bring together Iron & Steel Industry, Manufacturer of Refractories, Leading academic scientists, Researchers and Research scholars to exchange and share their experiences and research results on all aspects of Refractories used in Iron and Steel Industry.

It also provides a premier interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of Refractories during the current changing global scenario of Refractories and Raw materials.

Technical Program of the conference includes a plenary/ key note session and several parallel sessions devoted to future and emerging refractories technology. Altogether more than 50 papers are planned to be read by experts chosen from industry, R&D and academia spread over one and half day. A reasonable number of graduate students have also been invited to take part in the conference, present their work and interact with the peers.

Preparing a conference Souvenir and delivering the same to participants on time, prior to conference dates is a formidable challenge. Reviewing of manuscripts, communication with authors, formatting of taxes etc. within the period of a month or so was indeed a challenging task. While a very capable Technical and Publication Committee lead by Shri Rakesh Kumar Singh, CGM (SRU), SAIL, helped accomplish the task in a time bound manner, there were many behind the scene the scene who toiled hard to maintain deadline.

Towards the end of my editorial, I as a co-chairman of REFIS 4.0 would like to express my heartfelt gratitude to all committee members who have given tremendous impetus to REFIS 4.0 to sustain it with their guidance and motivation. Special thanks go to Shri Amarendu Prakash, Director In-charge Bokaro Steel Plant, who has been back bone of this conference.

And finally, I wish a grand success to REFIS 4.0 and may it become another example to follow its footsteps for other future series.

(V P Upadhyaya)
CGM (Ref), BSL &
Co-Chairman-REFIS 4.0

REFIS 4.0

Message

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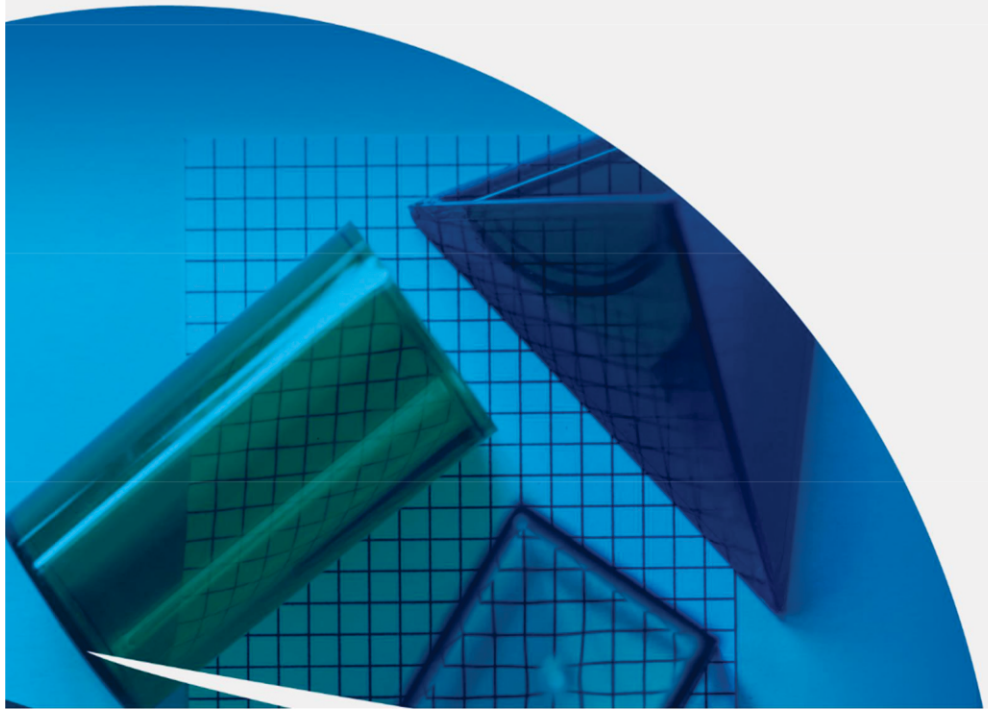


सोमा मंडल
Soma Mondal
अध्यक्ष Chairman
स्टील अथॉरिटी ऑफ इण्डिया लिमिटेड
STEEL AUTHORITY OF INDIA LIMITED
Ispat Bhavan, Lodi Road, New Delhi - 110 003

Message

I am glad to note that **International Conference on Refractories in Iron and Steel Industries (REFIS 4.0)** is being organized under the aegis of Bokaro Steel Plant, Steel Authority of India Limited (SAIL), Indian Institute of Metals (IIM), Bokaro Chapter & the Indian Ceramics Society (ICS) during the period Sept 23-24, 2022 at Bokaro Steel City.

Indian steel industry is poised to grow at a rapid pace in coming years and along with the consumption in volume of refractories will also increase. In addition to growth in volume, simultaneous improvement in quality of refractories will also be required. In future, Manufacturers will have to combat with stringent quality requirements and cost competitiveness of the products under environmental constraints.This will provide ample opportunities to Refractory producers to develop new of refractories with superior attributes for this sector.

I am sure the conference will provide an excellent forum for participants to discuss about the newer techniques for producing advance Refractories with improved properties for demanding applications in steel industry.

I wish the Conference a great success

(Soma Mondal)

Anirban Dasgupta

सेल SAIL

निदेशक प्रभारी / Director In-charge
भिलाई इस्पात संयंत्र
Bhilai Steel Plant
भिलाई / Bhilai

Message

The international conference on “Refractories in Iron and Steel Industries (REFIS 4.0) being organized by Bokaro Steel Plant in association with the Bokaro Chapter of the Indian Institute of Metals (IIM) and the Indian Ceramic Society (ICS) is a very welcome initiative.

Offering high- quality products at a reasonable price continues to remain a challenge for Indian refractory manufacturers. Therefore the research and academic institutes must take on a higher share of the burden for quality improvement and the production of value-added refractory at rates favorable for the Iron & Steel Industry.

I understand participants in “Refractories in Iron and Steel Industries (REFIS 4.0)” will include technologists and scientists from business, academia, research institutes will trigger insight deliberations on cutting-edge strategies that can be used to address the aforementioned challenges so as to meet the customer demand s for high productivity, exacting process standards and lower cost.

My best wishes to the organizers and participants for utilizing this opportunity for the benefit of the entire Indian Steel Industry.

(Anirban Dasgupta)

Amarendu Prakash

सेल SAIL

निदेशक प्रभारी / Director In-charge
बोकारो इस्पात संयंत्र
Bokaro Steel Plant
बोकारो / Bokaro

Message

It is heartening to note that Bokaro Steel Plant, Steel Authority of India Limited (SAIL) in association with The Indian Institute of Metals (IIM), Bokaro Chapter and Indian Ceramics Society (ICS) has taken the initiative of organizing an International Conference on **"Refractories in Iron and Steel industries (REFIS 4.0)"** at Bokaro on 23rd and 24th September 2022.

India is the 2nd largest producer of crude steel in the world today. The "Make in India" drive and the new Steel Policy of Govt. of India is to ensure high quality steel production and also enhance domestic steel consumption. India's steel industry consumes 75% of the country refractory output. The growth of refractory industry is largely dependent on the growth of the steel industry. The challenge before Indian Refractory manufacturers is to provide quality product at cost effective prices. The research/academic institutes therefore have to shoulder a greater responsibility towards improvement in quality as well as producing value-added refractory at cost effective prices for the Iron and Steel Sector.

I am sure at this conference, the technologists/scientists from industries, research/ academic institutes, consultants and manufacturers will deliberate in depth on technological solutions which can be adopted towards meeting the above challenges and meet the customer's demand for high productivity, stringent process parameters and cost economization.

I wish the organizers, participants and the conference a grand success and hope the useful solutions that emerge will benefit the Indian Steel Industry at large.

(Amarendu Prakash)

V S Chakravarthy

सेल SAIL

निदेशक (वाणिज्य)
Director (Commercial)
स्टील अथॉरिटी ऑफ़ इंडिया लिमिटेड
Steel Authority of India Limited
नई दिल्ली New Delhi

Message

I am elated to learn that SAIL-Bokaro Steel Plant is hosting its first International conference on Refractories in Iron & Steel industry at Bokaro on 23 and 24 September 2022.

As an Industry, Steel is the largest consumer of refractories and refractory is a key and strategic input that determines the quality as well as the cost of Steel Making. In these times, when the need for being cost competitive is being felt more than ever before, I hope the conference will act as a stimulant for developing low cost, world - class refractory solutions that will benefit the Steel Industry.

History proves that the most contributory factor to the development of refractory technology is the technological innovations of Iron and Steel-making processes. Today technology has touched every aspect of Steel Making.

It is heartening to note that the conference will also discuss on how Industry 4.0 has affected the Refractory industry in monolithic manufacturing and installation techniques, new developments in refractory formulations and use of nanotechnology in the field of refractories. New age simulation techniques like Artificial Intelligence, Machine Learning along with Big data in Refractory Technology needs to be explored.

I once again express my sincere appreciation to the organizing committee and send my best wishes for the success of the conference.

(V S Chakravarthy)

Atanu Bhowmick

निदेशक प्रभारी / **Director In-charge**
राउरकेला इस्पात संयंत्र
Rourkela Steel Plant
राउरकेला / **Rourkela**

Message

It is heartening to note that SAIL-Bokaro Steel Plantin collaboration with the Bokaro Chapter of the Indian Institute of Metals (IIM) and the Indian Ceramics Society (ICS), has taken the initiative to host the International Conference on "Refractories in Iron and Steel Industries (REFIS 4.0)" at Bokaro on September 23 and 24, 2022.

The domestic iron and steel industry is the largest consumer of the Indian Refractory market and accounts for more than 65% of the total refractory production. At present India is the 2nd largest steel producer of the world and is poised to grow significantly as per the National Steel Policy. Hence, the Refractory industry has to capitalize on these growth opportunities by enhancing quality and producing value-added refractory in an eco-friendly manner at competitive costs.

I am confident that at this conference, technologists and scientists from business, academia, and research institutions, consultants, and manufacturers will deliberate in-depth about the innovative approaches that can be used to address the expectations of the customers in a sustainable way.

I wish success to everyone involved in this conference and hope that the constructive solutions that are found will help the Indian Steel Industry across the board.

(Atanu Bhowmick)

Brijendra Pratap Singh

सेल SAIL

निदेशक प्रभारी / Director In-charge
बर्नपुर एवं दुर्गापुर इस्पात संयंत्र
Burnpur & Durgapur Steel Plant
पश्चिम बंगाल / West Bengal

Message

I am glad to know that SAIL-Bokaro Steel Plant will host the International Conference on "Refractories in Iron & Steel Industries (REFIS 4.0)" on September 23 and 24, 2022 in collaboration with the Bokaro Chapter of the Indian Institute of Metals (IIM) and the Indian Ceramics Society (ICS).

The primary challenge that Indian refractory manufacturers face today is providing high-quality products at competitive prices. Therefore, a larger portion of the responsibility for quality improvement and the manufacture of value-added refractory at competitive prices for the iron and steel sector must fall on research and academic organizations.

I'm sure that this conference will include in-depth discussions on cutting edge techniques that may be applied to deal with the aforementioned difficulties and satisfy customer demands for high productivity, stringent process standards and cost cutting.

I wish the conference organizers, attendees, and everyone else engaged the very best and hope that the Indian Steel Industry will wholesomely profit from the insightful ideas revealed at the conference.

(Brijendra Pratap Singh)

Anil Kumar Tulsiani

सेल SAIL

निदेशक (वित्त) / **Director (Finance)**
स्टील अथॉरिटी ऑफ़ इंडिया लिमिटेड
Steel Authority of India Limited
नई दिल्ली **New Delhi**

Message

My compliments to SAIL-Bokaro Steel Plant for taking the initiative for hosting an International Conference on Refractories in Iron & Steel industry at Bokaro on 23rd and24th September 2022.

The theme of the conference "Future of Refractories in Iron and Steel Industry" is most relevant for our industry in today's context. Refractories being one of the most widely consumed materials in the Iron and Steel sector has a substantial bearing on the overall cost of production. The need of the hour is for the refractory manufacturers and the steel sector to work in tandem for cost-optimization through use of cutting edge technologies.

I extend my best wishes to the organizers and participants of this conference and hope that the deliberations and knowledge sharing will benefit all stakeholders.

(Anil Kumar Tulsiani)

Krishna Kumar Singh

सेल SAIL

निदेशक (कार्मिक) **Director (Personnel)**
स्टील अथॉरिटी ऑफ़ इंडिया लिमिटेड
Steel Authority of India Limited
नई दिल्ली New Delhi

Message

It gives me immense pleasure to note that the SAIL team at Bokaro is organizing its first international conference on "Refractories in Steel Industry".

Refractory, as an input material has a significant impact on the cost and quality of steel making and in the current market dynamics; it is incumbent upon all of us to explore best possible solutions to minimize costs while maximizing productivity.

Considering the fact that the conference has seen such healthy participation from both industry and academic experts, I am confident that the conference will provide an appropriate platform for exchange of ideas and may become an annual event for the steel sector.

I convey my best wishes for the success of the conference.

K K Singh
Director (Personnel)

Arvind Kumar Singh

निदेशक (तकनीकी, परियोजनाएं एवं रॉ मैटेरियल)
Director (Technical, Projects and Raw Materials)
स्टील अथॉरिटी ऑफ़ इंडिया लिमिटेड
Steel Authority of India Limited
नई दिल्ली New Delhi

Message

I am very pleased to learn that Bokaro Steel Plant is organizing an international conference on "Refractories in Iron & Steel industry" at Bokaro on 23rd & 24th September 2022.

As a steel manufacturer, refractory has a significant bearing on our productivity and quality. This conference is an excellent platform to channelize inputs from industry as well as academia to explore new avenues of improving refractory related key performance indicators.

I am optimistic that the conference would be able to ponder upon the current issues and challenges such as building domestic capacities while focussing on sustainability and energy efficiency. I urge the participants to deliberate on these and attempt to create a future roadmap for our industry.

It is very heartening to know that an impressive number of entries have been received for presentation during conference which is indicative of the interest and importance of the topic.

I convey my warm greetings to all the delegates and wish the conference success.

(Arvind Kumar Singh)

Prasanna Kumar Rath

Chairman, Organizing Committee,
REFIS 4.0
&
Executive Director,
SAIL Refractory Unit
Bokaro Steel City

Message

I am delighted to know that Bokaro Steel Plant (BSL), Steel Authority of India Limited (SAIL) in association with Indian Institute of Metals (IIM) Bokaro Chapter and Indian Ceramic Society (ICS) is organizing an **International Conference on Refractories in Iron and Steel Industries (REFIS 4.0)** during the period Sept 23-24, 2022 at Bokaro Steel City (Jharkhand) to commemorate the Golden Jubilee year of production in BSL.

The theme of the conference is very relevant keeping in view the rapid growth witnessed by the steel and refractory sector in recent years. This trend is likely to continue in coming years as well. There are several papers from well-known experts in India and abroad which will be presented and discussed during the conference. I am confident that the conclusions and recommendations of this conference would be very useful for the steel industry in general and SAIL in particular, which would augment India to be a self-reliant refractory hub in sync with the vision of "Atma-Nirbhar Bharat" of our respected Prime Minister.

On behalf of the organizing committee, I extend all the dignitaries, participants and delegates of the conference a very memorable and pleasant stay at Bokaro Steel City and hope this conference will serve as a useful platform for knowledge sharing on refractories particularly in Iron and Steel Industries. I specially thanks all the sponsors and advertisers of the conference souvenir. I wish the conference a grand success.

(Prasanna Kumar Rath)

Dr. S V Kamat

President,
The Indian Institute of Metals
Metal House
Kolkata
West Bengal

Message

I am delighted to learn about 'REFIS 4.0, International Conference on Refractories in Steel Industries' being organized by IIM Bokaro Chapter and Indian Ceramic Society in association with Bokaro Steel Plant of SAIL.

At this juncture, the theme of the conference being "Future of Refractories in Iron and Steel Industry" is quite apt keeping in mind the 'Industry 4.0' being implemented globally. Hence, 'REFIS 4.0' means that the Refractory industry should also match pace with the rest in monolithic manufacturing and installation techniques and new developments in this field. It will definitely throw light on this fast-emerging subject which may be considered as the key to India's infrastructure growth in the future.

The Conference aims to bring together Iron & Steel Industry, Manufacturer of Refractories, leading academicians, scientists/researchers to exchange and share their experiences and research results on all aspects of Refractories used in Iron and Steel Industry.

We at IIM pride ourselves on being associated to global Metallurgical fraternity through such endeavours.

I wish IIM Bokaro Chapter and this event a grand success!

SVkamat

(SV Kamat)

Sanjay Kumar

Chairman, Indian Institute of Metals
Bokaro Chapter &
Executive Director (P&A)
Bokaro Steel Plant
Bokaro Steel City

Message

Reviewing the transition & progress of refractory technology for iron & steel making, we realise the rapid changes that is undergoing around the world. Larger capacity blast furnaces, (as high as 6000 m^3 volume in South Korea and in India, about 4550 m^3 at JSPL Angul and 4060 m^3 in SAIL/RSP) taller coke ovens, Basic oxygen furnace replacing open hearth furnace, Vacuum degassing, continuous casting, slide gate valves, torpedo ladles that are gaining popularity are very much demanding. The service conditions to be met by refractories in iron and steel making demand for improved quality of materials.

I am pleased to know that at this verge of time when raw material resources, energy, ecological aspects, refractory-manufacturing, and R&D methodology are the core domain for discussion, Bokaro Steel Plant, Steel Authority of India Limited (SAIL), in association with Indian Ceramics Society (ICS) & the Indian Institute of Metals (IIM), Bokaro Chapter is organizing an International Conference on **"Refractories in Iron and Steel Industries (REFIS 4.0)**" during Sept 23-24, 2022 at Bokaro Steel City. I am sure the Conference will provide an excellent platform for authors and participants with backgrounds in both academia and industry to share the knowledge in the revolutionary changing scenario of refractories.

I extend my greeting to the participants and convey best wishes for the success of the Conference.

(Sanjay Kumar)

Dr Lalit Kumar Sharma

President
Indian Ceramic Society
Kolkata
West Bengal, India

Message

It gives me an immense pleasure to know that the Bokaro Steel Plant, Steel Authority of India Limited (SAIL) is organizing an International Conference on "Refractories in Iron and Steel Industries (REFIS 4.0)" at Bokaro Steel Plant, Bokaro Steel City, Jharkhand, India during 23-24th September 2022, in association with the Indian Ceramic Society (InCerS) and Indian Institute of Metals (IIM), Bokaro Chapter.

I am very happy to learn about the theme of the conference, "Future of Refractories in Iron and Steel Industry". It further expands to how Industry 4.0 has affected the refractory industry in monolithic manufacturing and installation techniques, new developments in refractory formulations and use of nanotechnology in the field of refractories.

As President of the Indian Ceramic Society, I take this opportunity to thank all the members of the conference organizing committee for their outstanding efforts in preparing for this event.

I sincerely hope that this conference will deliberate and discuss all the different facets of this exciting topic and come up with recommendations and solutions in the fields of Refractories during the current changing global scenario of Refractories and Raw materials. I strongly believe that this conference will result in concrete output in support of its topics.

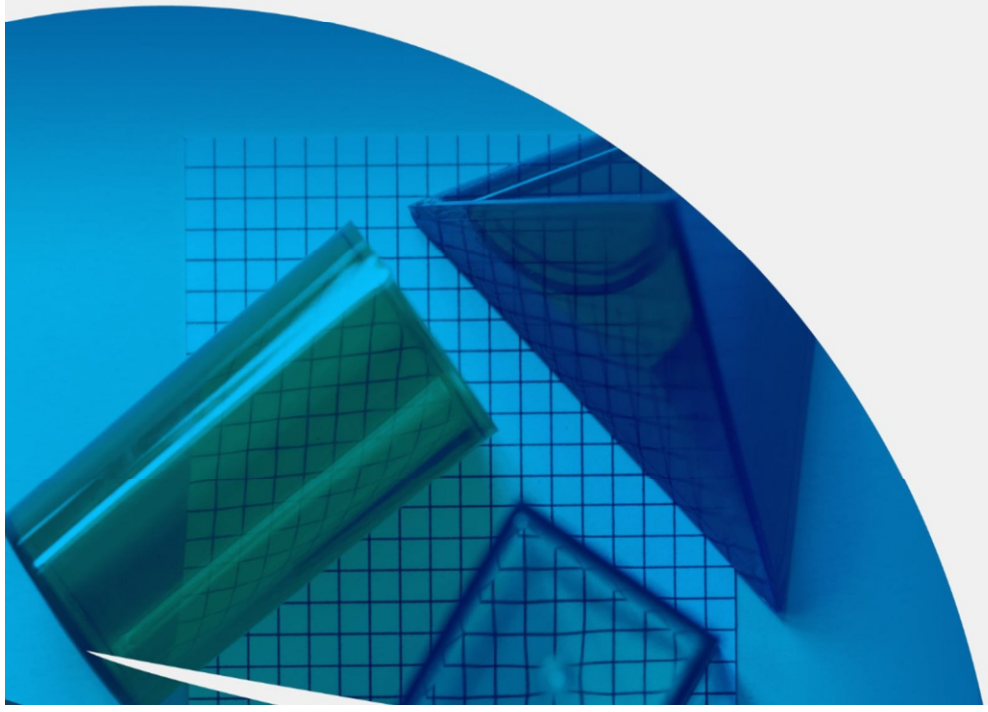
I extend my best wishes for great success of the International conference and congratulate the organizers on this timely initiative.

(Dr. L. K. Sharma)

IREFIS 4.0

Our Team

Souvenir



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3	Surendra Prasad , GM I/C (REF) , CET
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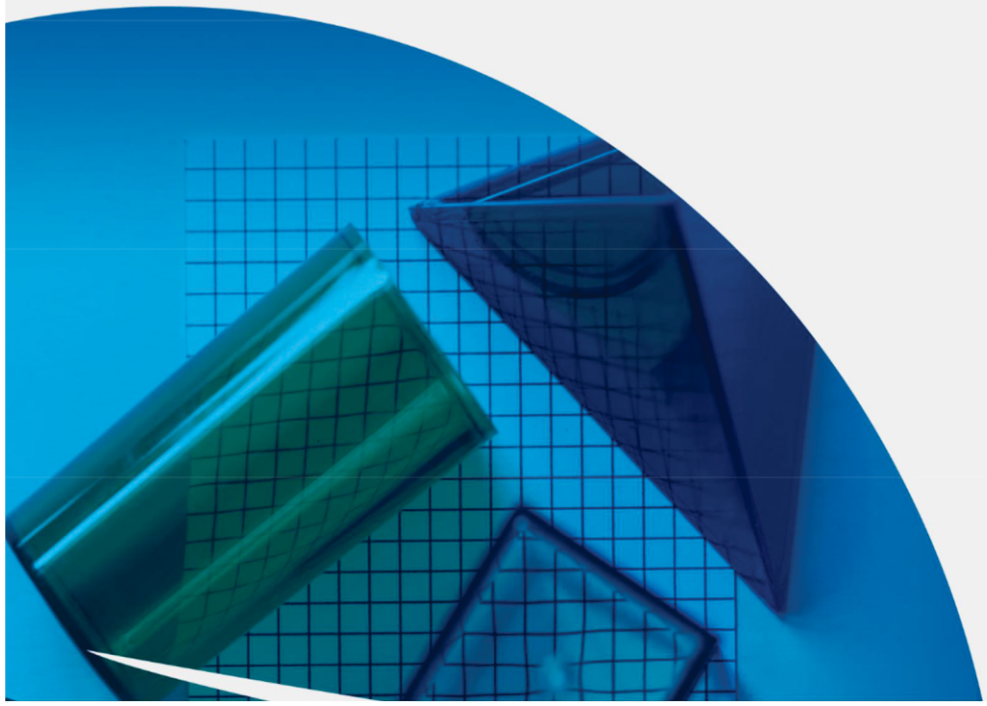
6	J Kumar , Manager (RMP)

Cultural Event	
1	Rahul Kr. Gupta , GM (RED)
2	Rishi Kant Gupta, Sr. Manager CC-Works
3	Chaudhary Ratnesh Kr Sudhanshu,GM (CSR)

REFIS 4.0

Program Schedule

Souvenir



Program Schedule	
Day-I	**Venue: HRD Building/ Auditorium**
23rd Sep'2022	8:00 AM – 13:15 PM
8:00 AM- 9:00 AM	Registration
9:00 AM-10:45 AM	Inaugural Session
10:45 AM- 11:15 AM	Inaugural Ceremony of Technical Exhibition
11:00 AM-11:30AM	High Tea
11:30 AM-13:15 PM	Plenary / Key note Session
13:15 PM- 14:15 PM	Lunch

Day-I	**Venue: Auditorium & HRD Conference-1**
23rd Sep'2022	14:15 PM-17:30 PM
Expert Opening Presentation (Auditorium)	**Safe, effective, EAF refractory maintenance via laser driven, automated, application technology** *Scott Grissinger,* MINTEQ International, Inc.
Session I-A (Auditorium) (14:45 – 16:00 PM)	Emerging Technology for Refractory
Session I-B(Conference-1) (14:45 – 16:00 PM)	Refractory for Iron making
Tea Break	
Session II-A (Auditorium) (16:00-17:30 PM)	Refractory for Steel making
Session II-B(Conference-1) (16:00-17:30 PM)	Refractory for Secondary steel refining and casting-1

Cultural Program & Dinner	
	Venue: Bokaro Club
	19:30 PM onward

Day-II	**Venue: Auditorium & HRD Conference-1**
24th Sep'2022	9:00 AM – 13:00 AM
Session III A (Auditorium)	Refractory for Mill Zone
Session III B(Conference-1)	Refractory for Secondary steel refining and casting-1
Tea Break	
Session IV A (Auditorium)	New Product & Advance Refractory Solution
Session IV B(Conference-1)	Quality assurance & Refractory Maintenance

Day-II	**Venue: HRD Retreat**
24th Sep'2022	13:15 PM- 14:15 PM
Lunch	

Day-II	**Venue: HRD Auditorium**
23rd Sep'2022	14:15 PM-15:30 PM
14:15 PM-15:30PM	Valedictory session

Registration	
Day-I	**Venue: HRD Building**
23rd Sep'2022	8:00 AM – 9:00 AM

Inaugural Session	
Day-I	**Venue: HRD Auditorium**
23rd Sep'2022	9:00 AM – 10:45 AM
9:10 -9:15 AM	Lighting of Lamp & invitation of dignitaries to Dias
9:15 -9:20 AM	Welcome addresses *Shri P K Rath, ED(SRU), SAIL/ Chairman REFIS 4.0*
9:20-9:25 AM	Program Introduction Shri *V P Upadhyaya, CGM (Ref), BSL, SAIL &* *Vice Chairman, REFIS 4.0*
9:25-9:35 AM	Address *Shri B K Tiwari, ED (W), BSL*
9:35-9:45 AM	Address by Guest of Honour CEO, Dalmia Bharat Refractories Ltd
9:45-9:55 AM	Address by Guest of Honour Prof. Rajiv Shekhar, IIT (ISM), Dhanbad
9:55-10:15 AM	Inaugural Address by Chief Guest (online) *Shri Amarendu Prakash, Dir I/c, BSL*
10:15 – 10:30 AM	Video Message & Release of Souvenir & Proceeding
10:30-10:40 AM	Vote of Thanks *Shri Sandeep S Lall, Convener, REFIS 4.0*
10:40 AM	National Anthem

10:45-11:15 AM	Inaugural Ceremony of Technical Exhibition

11:00-11:30 AM	**High Tea**

Plenary / Keynote Session	
Day-I	**Venue: HRD Auditorium**
23rd Sep'2022	11:30 AM-13:15 PM
Global Scenario and future of Refractories *Dr. Arup Kumar Chattopadhyay, Ex MD, TRL Krosaki Refractories Limited*	
Describing global current trend and scenario of Refractories *Mr. Sunanda Sengupta,EVP(Sales, Marketing and Customer Care) TRL Krosaki Refractories Limited*	
Digital Transformation in refractory sector (online) *Pawan Raj, Founder & CEO, Sparrow RMS, New Delhi*	
Some Aspects of Refractory Research in India *Prof. Bharat Bhushan Jha, Visiting Faculty, NIT Jamshedpur*	

Expert Opening Presentation	
Day-I	**Venue: HRD Auditorium**
23rd Sep'2022	14:15 PM-14:45 PM
Safe, effective, EAF refractory maintenance via laser driven, automated, application technology *Scott Grissinger,* MINTEQ International, Inc.	

Session: I-A(Parallel Session): Emerging Technology for Refractory	
Day-I	**Venue: HRD Auditorium**
23rd Sep'2022	14:45 PM-16:00 PM
Use of Artificial Intelligence, Machine Learning & Big data in Refractory Technology *Prakash Bharati, José María Domínguez, José Torres Alemany, Margarita Álvarez, Alfran-Nrl, Alfran*	
Refractory raw materials: Problems and prospects *S. Sinhamahapatra, V.P. Reddy, S. Pasari, K. Dana, H.S. Tripathi, CSIR-CGCRI Kolkata*	
Innovative solutions and trends of high alumina refractories for modern iron and steel applications *Shankha Chatterjee, Andreas Buhr, Almatis Alumina Pvt. Ltd. India/ Almatis GmbH*	
Challenges & Opportunities for Refractory Industry *H.L. Rai, Zircar Refractories Ltd*	
Adaption of a Corundum Refractory lining Technology in Lime Dolomite Calcination plant and Major capital repair technique through top-down approach at SAIL-ISP *Prasanta Baidya , B K Sinhamahapatra, Tarun Misra , V K Rai, M. Bose SAIL-IISCO Steel Plant*	

Session: I-B (Parallel Session): Refractory for Iron making	
Day-I	**Venue: HRD Conference-1**
23rd Sep'2022	14:45 PM-16:00 PM
Introduction of Slide Gate System for drainage of Trough Hot Metal in Iron Making *Suchit Kr Mahanta*, Gautam Kr. Choudhary, Shubhashis Paul, Sahin Ali, Utpal Chakraborty, Ujjwal Kumar, Deepak Kumar, Sunanda Sengupta, P.B Panda, ** Dinesh Vishwakarma &** Mousom Bag, **Avick Ghosh* *TRL Krosaki Refractories Ltd. **Tata Steel Ltd.	
Development of a New Refractory Repair Technology in Hot Blast Stove in pressurized condition at SAIL-IISCO Steel Plant *B K Sinhamahapatra, Tarun Misra, V K Rai, M. Bose, C L Gaikowad, Shaubhik Roy, SAIL-IISCO Steel Plant, Burnpur*	
Development of Alumina Zirconia Castable for refractory coating in the bore of Double Chambered Copper Tuyers in high productive Blast Furnaces *R.K. Pradhan*, P. Singh, S. Kundu, B.Mahata, S. Sarkar, SAIL Refractory Unit IFICO*	
Advancements in Fused Silica Refractory Technology for Coke Oven wall rebuilding *K.G.Venkatesan, Fosbel India Private Ltd.*	
A Novel approach to reduce Torpedo ladle preheating time by introducing no cement bonded spout castable *Biswajit Sahu, Manoranjan Kumar Singh, Avinash Singh, Prasanta Panigrahi, Tushar Agrawal, Sujat Ali Khan, Brijender Singh, TATA STEEL, Jamshedpur, India*	
Refractory design developments & application for stoves of blast furnaces in SAIL plants *Surendra Prasad, A.C.Goyal, A.Dewangan, T.C.Joshi & S.Manna, CET, SAIL, Ranchi*	

16:00-16:10 PM	Tea Break

Session: II-A (Parallel Session): Refractory for Steel making	
Day-I	**Venue: HRD Auditorium**
23rd Sep'2022	16:10 PM-17:30 PM
Cost effective refractory handling manipulator for safe & better ergonomics *Gaurav Pandey*, Suchit Kr Mahanta, Gautam Kr. Choudhary, S. Paul, Ujjwal Kumar, Deepak Kumar Hiroshi Nagata, Sunanda Sengupta, P.B Panda, **Navneet Sinha, **Rajeev Ranjan; *TRL Krosaki Refractories Ltd.. **Tata Steel Ltd.*	
Study on Recycling of Used Mag-Carbon Brick in production of Mag carbon Bricks *Pallavi Singh, Anjali Bharti, Amit Charit, Sandeep Srivastava, SAIL Refractory Unit Bhilai*	
Insight into BOF bottom purging *Kaushik Dasgupta, RHI Magnesita India Limited*	
A case study - use of recycled material in rh degasser lower vessel magnesia chrome brick *Avishek Mitra, Sanat Hazra, Dalmia Bharat Refractories Ltd, Rajgangpur*	
Optimization of EAF Tap weight by Improving the Refractory Design In SMS-1 & Best Operation Practices *Argha Ghosal , Deepak Chaudhary & Asis Kumar Sarkar, JSW Odisha*	
Improvement in lining life of 300t converter in BSL / SAIL *R. Pandey*, K. Nandan*, MK Kujur**, R.K. Gupta***, A. Mohanty*, *SRU, **RDCIS, *** BSL, SAIL*	
A Discussion on Importance of Spinel Bricks in Steel Making Processes *Deepak Mane, Maithan Ceramics Ltd*	

Session: II-B (Parallel Session): Refractory for Secondary steel refining and casting-1	
Day-I	**Venue: HRD Conference-1**
23rd Sep'2022	16:10 PM-17:30 PM
Effect of fume silica reduction on the properties of alumina magnesia castable for steel ladles *Satyam Kumar, Ritwik Sarkar, NIT Rourkela, Odisha*	
Alumina Rich Spinel Refractories for Steel Ladle Application – A Complete Solution by TRL Krosaki *J. P. Nayak*, R. Dutta, B. Ghosh, P. B. Panda, TRL Krosaki Refractories Limited*	
Co-relation of various refractory & operational parameters on the steel ladle life of ISP *M. Bose, B K Sinhamahapatra, Tarun Misra, V K Rai, Prasanta Baidya, SAIL-IISCO Steel Plant, Burnpur*	
A case study - life enhancement of alumina spinel burnt bricks for slag dumping area of ladle metal zone *Avishek Mitra, Sanat Hazra, Dalmia Bharat Refractories Ltd, Rajgangpur*	
Performance improvement of Steel ladle life by modelling operating parameters *Goutam Ghosh, Nabid Anjum Khan, Santanu Saha, Prasanta Panigrahi, Sujat Ali Khan, Brijender Singh, Tata Steel*	
Implementation of Double Porous Plug Gas Stirring in Steel Ladles to Improve Gas Stirring Efficiency and Increase Ladle Lining Life *Rajeev Kumar Singh, Kiran Kr. Keshari, RDCIS, SAIL*	
Interaction between Refractory and Liquid Steel Regarding Steel Cleanliness: A Review *Santosh Kumar, B Sunita Minz, Smita Toppo, Snehanshu Roy, Somnath Kumar and N Mondal, RDCIS, SAIL*	

Session: III-A (Parallel Session): Refractory for Mill Zone	
Day-II	**Venue: HRD Auditorium**
24th Sep'2022	9:00 AM-10:45 AM
How can endoscopic inspection enhance industrial monitoring especially focusing on refractory lining status? Today and tomorrow *Michel Julien VREYSEN, ADI-Industrial Services*	
High performance alternate quality refractory for hearth of reheating furnace I*.Roy#, M.K.Kujur#, S.Aman#, A.Paul#, R.K.Pradhan*, R.K.Singh* # RDCIS, SAIL , * SRU, SAIL*	
Total Refractory Management in Re-heating Furnace in Bokaro Steel- A new experiment and new experience. *Subhash Singh and P.Sengupta, SKG Refractories Ltd*	
Development of a New Refractory Repair Technology in Roof Area of Reheating Furnaces in hot condition at SAIL-Bokaro Steel Plant *RK Gupta, I Majumdar, J Kerketta, BSL, SAIL*	
Development of a New Refractory Repair Technology in Ceramic Module Area of Reheating Furnaces in hot condition at SAIL-Bokaro Steel Plant *PK Sengupta, I Majumdar, J Kerketta, BSL, SAIL*	
Replacement of Module Area with High Alumina Refractory Bricks in Recuperative Zones of Reheating Furnace#2,4 *S C Mohapatra, A K Rajak, Sabir Ali, BSL, SAIL*	

Session: III-B (Parallel Session): Refractory for Secondary steel refining and casting-2	
Day-II	**Venue: HRD Conference-1**
24th Sep'2022	9:00 AM-10:45 AM
Bottom Purging Improvement of Steel Ladle at LD#3 (TSL JSR) *Amit Banerjee, Monoj Halder, Prasanta Panigrahi, Navneet Sinha, Brijender Singh Tata Steel*	
Modern Techniques In Improving Steel Quality In Tundish *Ashish Gadre (Director) Allied Metallurgical Products Pvt Ltd*	
Refractory Design Modification and improvement of Steel Ladle life in SMS-III BSP *Amit Roy, Prasanta Saha, BSP, SAIL*	
An overview of steel ladle at Durgapur Steel Plant *Niral Topno (SMS), Sandipan Sen (Refractory) DSP, SAIL*	
Design of the State-of-Art Technology of RH Snorkel and its Performance *Soumen Jana*, S. Satpathy, A. K. Samanta, H. Nagata. S. Sengupta, P. B. Panda, TRL Krosaki Ref.Ltd*	
BSP, SMS-III RH Degasser Refractory Design Modification *Jitendra kumar , Amit Roy , Pronab Roy, BSP, SAIL*	
Automatic Mould Level Control With Eddy Current Sensor, Automatic Surface Inspection System and Wireless Continuous Temperature Measurement System *Arpan Chakraborty and Hannu Suopajärvi, Vesuvius India Limited*	

10:45-11:00 AM	**Tea Break**

Session: IV-A (Parallel Session): New Product & Advance Refractory Solution	
Day-II	**Venue: HRD Auditorium**
24th Sep'2022	11:00 AM-13:00 PM
Technologies for preventive maintenance for the extension of the lifetime of coke ovens and hot blast stoves *Matthieu LEHEUT, FIB-Services International S.A. Luxembourg*	
Laser Contouring System – Scanner (Refractory Thickness Measurement)-online *Xavier Rabec, Xavier Rabec, Ramalakshmanan & Ravishankar Kundu, Vesuvius India Ltd*	
Advanced Tundish Outlet Modifier - online *Paromita Sarkar, Vesuvius India Limited*	
Leveraging Digital Technology in Managing Torpedo Ladle Lining *Bhukya Kiran *, Biswajit Sahu*, Biswajit Pal, Manoranjan Kr. Singh, Bankim Chandra Tripathy, Sujat Ali Khan, TATA STEEL, Meramandali, India*	
A comparative investigation of the physio-mechanical characteristics of amorphous and crystalline silica extracted from rice husk ash *Ashutosh Gupta, Abhishek Kumar Singh, Manish Kumar, Vaibhav Kumar Singh, V.K Singh& M.R Majhi, IIT BHU*	
Effect of thermal treatment on phase and microstructural evolution of magnesium borate ($Mg_2B_2O_5$) nanorod whiskers prepared via hydrothermal cum reaction sintering process *Vaibhav Singh, Ashutosh Gupta, Abhishek Kumar Singh, Manish Kumar, V.K Singh, M.R Majhi, IIT BHU*	
Thermo-Mechanical Modelling and Simulation for effective Refractory Design in Iron & Steel Industries *Kushal Agarwal1, G S Debasisha1, Pranoy Ku. Dubey1, Tapas Shyamal1, Debasish Sarkar2, 1 Sarvesh Ref Pvt. Ltd., 2 NIT Rourkela, Odisha*	

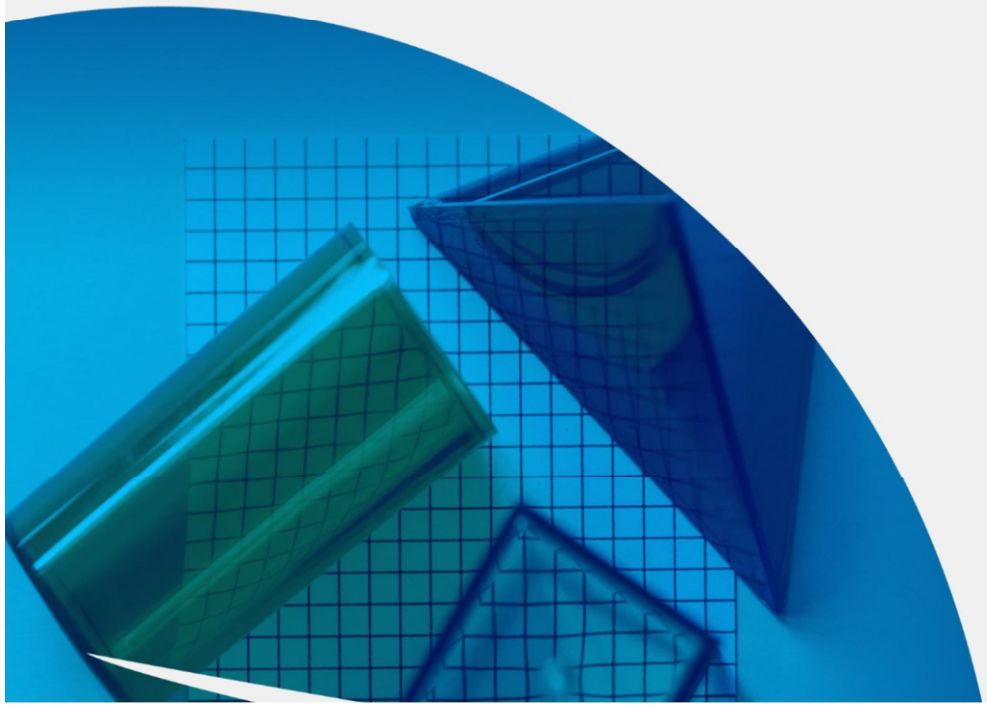
Session: IV-B (Parallel Session): Quality assurance & Refractory Maintenance	
Day-II	**Venue: HRD Conference-1**
24th Sep'2022	11:00 AM-13:00 PM
Quality assessment of critical shaped structural refractory blocks using novel NDT technique *Saumita Gangopadhyay*, Monoj Halder, Prasanta Panigrahi, Navneet Sinha, TATA STEEL*	
Intelligent technologies for refractory spend management *Debesh halder & Avijit Pandit, Mjunction services Limited*	
Advancements in Refractory Maintenance practices at RINL-Visakhapatnam Steel Plant *L. Srinivasa Rao, V.Venkateswara Rao, Sandipan Roy, A.Pratik Priyank, RINL, Vizag*	
Introduction of newly designed ladle heating system to reduce the arcing time for improved performance of refractory *Md. Sharique Aman, Shyam Jee, INP Gupta, I. Roy , M. K. Kujur, RDCIS, SAIL*	
New Generation Ladle Slide Gates With Enhanced Ergonomics & Safety, and new generation high performance purging plug *Sudip Banerjee & Jayanta Gupta, Vesuvius India Ltd*	

Valedictory Session with Panel Discussion	
Day-II	**Venue: HRD Auditorium**
24.09.2022	14:15-15:30 PM
14:15-14:20 PM	Welcome of Guest
14:20-14:45 PM	Synopsys of the conference Shri V P Upadhyaya, CGM (Ref), BSL
14:45-14:55 PM	Opening Remarks Shri P K Rath, ED (SRU), SAIL,
14:55-15:15 PM	Panel Discussion: Future of Refractories in Iron and Steel Industry • Shri V K Pandey, ED I/c, Salem Steel Plant, SAIL • Shri B K Tiwari, ED (Works), Bokaro Steel Plant, SAIL
15:15-15:20 PM	Concluding Remarks Shri P K Rath, ED (SRU), SAIL
15:20-15:30 PM	Vote of Thanks Shri Sandeep S Lall, Convener, REFIS 4.0

REFIS 4.0

Abstracts

Souvenir



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23-24 September

Bokaro Steel City
Jharkhand
India

2022

Plenary/Key Note Address

Global Current Trend and Scenario of Refractories

Sunanda Sengupta

TRL Krosaki Refractories Limited, India

Abstract

Refractory plays an important role in development of the economy, as this is the fundamental requirement for production of any kinds of building materials like Steel, Cement, Glass, Non-Ferrous etc. It is expected that the current geo-political imbalance across the globe shall be overcome in next 1-2 years and India will play a major role in driving the demand of refractory due to upscaling of production by user industries like Steel and Cement.

The Global trend of refractories promise a remarkable growth in coming five years which is getting backed by a high-class research and innovative work. The major challenges associated with the growth of refractories industries are turbulence in global supply chain management and limited sources of raw materials & energy. Overcoming this challenge is very much essential to maintain the safety, trust & commitment with the user industries.

Now refractories Industries are mainly focusing to meet the global requirements with capacity expansion, new technologies, recycling and beneficiation of used materials along with moving towards digitization for enhancement in customer services.

Plenary/Key Note Address

Some Aspects of Refractory Research in India

Prof. Bharat Bhushan Jha

Visiting Faculty, NIT Jamshedpur

Abstract

Refractories are the backbone of all high temperature processing industries which include Iron and Steel, Cement, Aluminium, Copper, Glass & Ceramic etc. Stringent quality and tight specifications of various products made through high temperature processing combined with maximum productivity and flexibility has put tremendous pressure on Indian Refractory Industries for supplying quality products. Also, India's steel production capacity is targeted at 300 MT by the year 2030 from 118 MT in FY 2022. The cement industry is expected to grow by 12% against cumulative annual growth rate (CAGR) of ~6%. Therefore, unprecedented need gap is waiting to be addressed by Indian Refractory Industries. In India to fulfil the demand of refractory industries various research and development activities is being conducted by different groups. The refractory research mostly adhered to up gradation of natural raw materials/value addition to refractory raw materials and development of various synthetic refractory aggregates, synthetic refractory materials and high-performance refractory products.

The present paper is an overview of the refractory research scenario in India towards value addition to available raw materials and synthetization techniques. In a changing scenario, post COVID, challenges and opportunities for Indian Refractory Industries shall also be discussed. Indigenization of quality refractory production to support Government's initiative of ATMANIRBHAR BHARAT will also be described and finally reprocessing of refractory waste towards wealth creation shall be dealt with.

Safe, effective, EAF refractory maintenance via laser driven, automated, application technology

Scott Grissinger

MINTEQ International, Inc.

Abstract

Traditional EAF refractory maintenance with hand gunning is ineffective and dangerous from a work task environment and ergonomic point of view. Traditional hot fettling installations require crane use and are inefficient due to lack of sintering of the entire installed material. We present an updated, automated refractory system that substantially improves the effective gunning and fettling material applied to the furnace through a laser driven maintenance robot. Automated material applications (both gunning and fettling) are performed based off the difference between desired refractory lining thickness and actual lining thickness obtained through laser measurement. Advances in laser head technology allow for faster more accurate measurements of the furnace lining. Software technology interprets the laser and determines the furnace areas in need of maintenance and provides the operator a material installation plan based off predetermined parameters. Operators can visualize and monitor the automated maintenance through high temperature video cameras located on the gunning robot in the center of the furnace. The latest generation automated gunning system with its integrated cameras partnered with the fifth-generation laser has the technology to reduce the safety risk to operators, increase the overall furnace campaign lining life, and through increasing the knowledge of bank and bottom contour and wear patterns, allow for more precise bank and bottom material additions to improve overall melt efficiency.

Keywords: EAF gunning, automated, robotic, laser measurement

Use of Artificial Intelligence, Machine Learning & Big data in Refractory Maintenance Technology

Prakash Bharati[1, a], Jose Maria Dominguez[2], Jose Torres Alemany[2] and Margarita Alvarez[2]

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Abstract

Refractory maintenance is an integral part of core industries such as Aluminium, Cement, Foundry, Iron & Steel, Petro-chemical and thermal power plants. In the era of Industry 4.0, the maintenance landscape is taking a new shape which is primarily driven by the Industrial Internet of things (IIOT). Industry 4.0 promises significant efficiency gains as well as trigger changes - especially harsh and dangerous working environments of refractory operations [1]. Fourth industrial revolution has gained significant momentum in the recent past mostly driven by rapid development in the field of Artificial Intelligence (AI) and Machine Learning (ML) which are being used for prescriptive rather than preventive maintenance. Prescriptive refractory maintenance is assisted by smart technology where decision making involves massive input data on a real time basis, analytics, machine learning and artificial intelligence. It takes predictive maintenance a step further by implementing an action to solve the issue rather than recommending an action. It helps to reduce the equipment downtime, cost & improve the control & quality of production. Development of the digital twins has completely transformed the way maintenance works are carried out. In this paper, we explain the workings of Artificial intelligence & machine learning. We also focus on how digital twin systems and artificial intelligence are poised to change the way refractory materials are installed and repaired during the maintenance.

Keywords: Artificial Intelligence; Machine Learning; Big Data; Digital Twins; Prescriptive maintenance; Refractory technology

Refractory Raw Materials: Problems and Prospects

S. Sinhamahapatra[a], V. P. Reddy, S. Pasari, K. Dana, H. S. Tripathi

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Abstract

India is endowed with large reserve of major refractory raw materials namely magnesite, sillimanite and bauxite. However, refractory grade good quality bauxite is nearly exhausted in India and existing Indian bauxite contains impurities such as SiO2, Fe2O3, TiO2, and CaO. These impurities can form low melting phases such as iron aluminum titanate (FeAlTiO5) along with the vitreous phases at high temperatures, which restrict their use for refractory applications at high temperatures. On the other hand, Indian magnesite is associated with CaO, Fe2O3 and SiO2 and these impurities may form low melting phase merwinite [Ca3Mg(SiO4)2] and monticellite (CaMgSiO4). Additionally, the impurity content also varies with location. Therefore, a single strategy of beneficiation will not be useful for all the materials and this warrants a multipronged approach to solve this problem. In this paper, the problem associated with the Indian raw materials and their up-gradation is explained.

Keywords – Bauxite; Sillimanite; Magnesite; Refractory; Mullite

Innovative solutions and trends of high alumina refractories for modern iron and steel applications

Shankha Chatterjee*, Andreas Buhr

** Almatis Alumina Pvt. Ltd. India, Global Technical Director, Almatis GmbH.*

Abstract

The continual development of steel producing technology is a main driver for the development of new high alumina refractories. The paper briefly discusses the trends in steel secondary metallurgy and how modern alumina refractories provide innovative solutions for challenging conditions in the steel making process. Examples are given how refractories contribute to steel quality and economical improvements in the process

Challenges & Opportunities for Refractory Industry

H.L. Rai
Zircar Refractories Ltd.

Abstract

Steel Industry being major consumer of refractory, future of refractory Industry is totally dependent on the size and health of Steel Industry.

Luckily, Government of India has long vision for Steel sector growth. As you all know, the National Steel Policy (NSP) – 2017 was given Cabinet approval by Government of India. This policy was designed to give fillip to growth to our economy to 5 Trillion $. Our Country is working very hard to implement this target of 300 million tons by 2030 .It is expected to achieve this target almost as scheduled. While our Country is in the process of achieving this target, Government of India is working towards creating a Vision for India @ 2047 when India will be celebrating its 100 years of Independence. Strategy is being devised first to reach target of 300 million tonnes by 2030 and then 500 million tonnes by 2047. All stakeholders are expected to offer their inputs which can provide basis for plan of action towards achieving the goals of Vision @ 2047.

We all know Men, Materials and Machines are key to run a successful and growing industry. Refractory industry is already facing big problems on these fronts and this problem is likely to intensify, if timely corrective actions are not taken. One can put up plant with money but how will that plant run in absence of above??

This paper will touch upon these issues to bring all relevant matters for all to address.

Adaption of a Corundum Refractory lining Technology in Lime Dolomite Calcination plant and Major capital repair technique through top-down approach at SAIL-IISCO Steel Plant

Prasanta Baidya[1], B K Sinhamahapatra[1], Tarun Misra[1], V K Rai[1], M. Bose[1],
[1]. Refractories Department, Burnpur – 713325, W.B.
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Abstract

Lime Dolomite Calcination Plant is an integral and crucial part of any integrated steel plant as Lime & Dolomite play very important role for maintaining healthy balance sheet of that respective steel plant. ISP-SAIL is having total four shaft kilns for producing calcined lime & Dolomite. Three shaft kilns having capacity of 330 TPD are operation for lime production and one single shaft kiln having capacity 200 TPD is dedicated for dolomite production. All the shaft kilns consume mixed gas (Blast Furnace gas & Coke Oven Gas) as a fuel for the calcination process. However due to inconsistency in quality of gas, choking of combustion system occurs frequently and abnormally high numbers of shutdown become regular phenomenon at LDCP kilns and ultimately it leads to high thermal shock for the refractory used in LDCP lining which is primarily consists of Magnesite bricks. During last few years it has been observed that falling of refractory arch at shaft kiln dilutes reliability of LDCP production. Refractory department of ISP has made various changes in quality and design parameters in existing lining practices, like implementation of Corundum arch which is primarily α-Alumina and is extremely thermal shock resistance compared to earlier Magnesite bricks even in that harsh condition. ISP have already installed this type of arch in shaft kiln-2&4 and planning to extend it to rest two kilns also as downtime due to refractory reason has become minimal now.

ISP Refractory team has also adapted new lining technique to fasten the capital relining work in minimum time frame by installing retainer, Tie-rod system and top-down lining approach without emptying the burden at a time. This type of practice has not only expedited the capital relining work speed but also taken care of maximum safety at that time. It has also minimized the job volume and maximized reuses of old bricks which directly reflected in financial data and leads to major cost saving.

Introduction of slide gate system for drainage of hot metal from Trough in Iron Making

Suchit Kr Mahanta*, Gautam Kr. Choudhary, Shubhashis Paul, Sahin Ali, Utpal Chakraborty, Soumyadipta Das, Ujjwal Kumar, Deepak Kumar, Sunanda Sengupta, P.B Panda,
***Dinesh Chandra Vishwakarma, **Mousom Bag & **Avick Ghosh*
*TRL Krosaki Refractories Ltd., **Tata Steel Ltd.*

Abstract

In an integrated steel plant, raw materials are processed in blast furnace (BF) to produce hot metal. From BF hot metal (liquid iron) is tapped through tap holes & is transferred to a refractory lined vessel called as torpedo ladle for transfer to further processing stations which involves conversion of hot metal to steel. Transfer from tap hole to torpedo vessel takes place through a refractory lined drain called Trough. Separation of liquid iron & slag is carried away in Trough by principle of difference in density with the help of Skimmer block. Metal drains through metal runner & slag through slag runner. Trough needs to be relined or repaired at regular intervals for continuity of operation as refractory has a certain life limitation. Before repair drainage of remaining hot metal from Trough is a pre-requisite. This is being done in a conventional process which has various associated challenges related to process and safety.

To overcome those challenges, a concept of slide gate like ladle slide gate system was developed. This system comprises of mechanism, refractory components & an actuator. This paper covers, conventional process of hot metal drainage & challenges associated with it, approach of developing a new concept of slide gate system for this application, design, trial details & merits of slide gate system over existing conventional system.

KEYWORDS: Trough, Slide gate system, hot metal, lancing

Development of a New Refractory Repair Technology in Hot Blast Stove in pressurized condition at SAIL-IISCO Steel Plant

B K Sinhamahapatra[1,a], Tarun Misra[1], V K Rai[1], M. Bose[1], C. L. Gaikowad[2],Shaubhik Roy[2]
[1]Refractories Department, SAIL-IISCO Steel Plant, Burnpur – 713325, W.B., India
[2]Blast Furnace, SAIL-IISCO Steel Plant, Burnpur – 713325, W.B., India
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Abstract

Hot blast stove is one of the most important apparatus for blowing hot air inside the blast furnace which is a very important step in increasing efficiency of iron making and reducing specific consumption of coke. Reliability of the hot blast stoves is of great concern to all blast furnace iron makers. During the course of operation, the stoves go through off-blast and on-blast modes cyclically. The refractory linings inside the stoves are subjected to repeated exposure of thermal shock and thrust of air which leads to degradation of vulnerable parts of the linings. Repair of lining defects are carried out by injecting refractory mortars or various pumpable refractories. But to carry out injection work, the system should have negative pressure inside so that hot gases does not come out when holes are cut/drilled for injection. But in case of ISP's stoves, the situation is opposite. The design does not have provision of connecting the stoves to chimneys having sufficient draft to create suction at the dome of the stoves. Therefore, hot gases started to come out when opening is created at the dome of the stoves, and the area becomes red-hot. The dome temperature of the stoves was reduced and water spraying was adopted for cooling of the shell from outside to prevent shell failure.

A new repair method has been developed in drilling, fixing nozzles and use of valves of specific design with specific tools. All material, tools and tackles sourced indigenously. Nozzles and valves have been installed at the hot spot areas pre-identified with the help of infra-red thermal scanner. A ceramic fiber based pumpable refractory was used to carry out the repair. The material was injected at required depth and at the predicted defect-zones of the refractory lining of the dome. After refractory injection, the hot spots disappeared and water spraying not required. Steel shell surface temperature reduced below 100^{o}c from earlier above 300^{o}c at hot spots. Normal refractory operating parameters of the stoves were restored.

Keywords - Hot Blast Stove; Refractory Injection; Ceramic Fiber; Hot Spot

Development of Alumina Zirconia Castable for refractory coating in the bore of Double Chambered Copper Tuyers in high productive Blast Furnaces

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Corresponding author; email: rkpradhan@sailsru.co.in

Abstract

Tuyeres are devices that permit hot air from the bustle pipe to enter the blast furnace. They are special shaped nozzles through which hot air blast is injected into the blast furnace. Tuyeres are made of copper, located all around the blast furnace and are usually water cooled since they are directly exposed to the furnace temperature. There are four types of tuyeres used in blast furnaces. They are (i) single chamber tuyeres, (ii) double chamber tuyeres, (iii) multiple chamber tuyeres, and (iv) spiral chamber tuyeres. Double chamber tuyeres are the most widely used tuyeres. Being exposed to a harsh and turbulent operating environment, the tuyere region is dynamic and complex, containing combustion gases, liquid oxides (slags), liquid iron, coke, pulverized coal, char and temperatures frequently exceeding 2,200 deg C. Due to above reasons, bore of tuyere is coated with refractory materials to protect from burn-out and abrasion at the outer surface. Considering the operating conditions, the refractory materials used for coating in the bore of tuyer, should have high volume stability, strength and abrasion resistance at elevated temperature. Initially, the bore of tuyer was casted with 70% Al2O3 Low Moisture based castable which gave an average life of 3 months only. The poor life of tuyer is due to frequent erosion and poor spalling resistance of refractory coating. As a result of this, high-pressure water, which cools the tuyere, is allowed to enter the blast furnace causing furnace instability, increased fuel and material costs, lost productivity, and increased safety and environmental risks.

For reducing the tuyere wear, it was decided to use Alumina Zirconia castable for refractory coating **in** the bore of Copper Tuyers. Due to very high volume stability, hardness and abrasion resistance at high temperature, Calcia Stabilized Zirconia(CSZ) was used as the major input to obtain the desired properties of end products. Accordingly, composition using very high purity Aluminas in combination with CSZ after optimization of its quantity was designed in laboratory through several trials to obtain desired properties considering area of application. Based on lab studies, Alumina Zirconia castable was manufactured with the developed composition and casted in the bore of two nos. of Double Chambered Copper Tuyers manufactured in SGW, Kulti for trial in BF#2, BSL. The tuyres achieved a life of nine months against existing average life of three months. After this successful trial, the developed castable is regularly supplied to in SGW, Kulti for refractory coating in the bore of two nos. of Double Chambered Copper Tuyers for all productive BFs of BSL, DSP, BSP and RSP.

The development of AZ castable, its manufacturing process along with trial results to achieve higher life will be discussed in this paper.

A Novel approach to reduce Torpedo ladle preheating time by introducing no cement bonded spout castable

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Abstract

The steel industry contributes to about 5-8% of global emission and considered to be a 'hard to abate sector' since carbon is used as a reductant in the steelmaking processes. Preheating of refractories consumes significant amount of CO gas and time to achieve desired refractory quality. Considering the amount of energy consumption, effort been made to use no cemented bonded castable. Torpedo ladle is critical for hot metal transportation from Blast furnaces to LD/SMS Shops. Considering the limited fleet, which is required for daily production; Low torpedo availability can lead to low Hot metal buffer & interruption in Hot metal supply to LD/SMS Shops. Relining is a major activity (longest downtime) of torpedo maintenance. In this work, the performance of CAC based castable and newly developed no cement bonded castable (NCC) compared and analysed. The new torpedo spout castable exhibits higher drying speed with better high temp. properties like strength, HMOR, Slag corrosion resistance, abrasion resistance and lower thermal conductivity compared to existing low cement based castable. By using this new torpedo spout castable, preheating period reduced by 34hrs at our Tatasteel , Jamshpedur works, which caused in considerable reduction of CO gas consumption by ~30% and resulted in lower carbon footprint. Improved torpedo spout performance also contributes economical benefits by lowering the repairing material consumption like hot gunning.

Keywords: Refractory, Torpedo ladle, no cement bonded castable, Preheating period, Carbon footprint

Refractory design developments & application for stoves of blast furnaces in SAIL plants

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Abstract

Stoves used in the world up to the end of the 1960's were primarily based on the use of material to withstand temperature. Little attention was paid to the movement of Refractory lining within the stove while designing. It was an accepted fact that stove repairs would be required every time the Blast Furnace goes down for major repair.

Steel companies through out the world were eager to improve furnace efficiency and reduce coke rates. One of the key areas to achieve lower coke rates is "Higher Hot Blast Temperature" from the stoves. This in turn not only required improved refractory quality but also improvements in the construction design.

In the present market scenario, there is a continuous pressure to lower production costs in the steel industry. Therefore any reduction in the production cost of hot metal contributes significantly to the cost indices of the company.

Hot blast stove is an integral part of blast furnace complex and contributes significantly towards blast furnace productivity and cost effectiveness. In general, every 100oC rise in hot blast temperature contributes to ~1.75 % increase in production and a reduction in coke rate by 12 to 24 kg per ton of hot metal. Thus increase in hot blast temperature will not only help to increase output but also reduce production cost from existing blast furnaces. This emphasises the need for up-gradation of existing stoves which were generally designed to give hot blast temperature of 850 oC to 900 oC

This paper deals in "An approach to refractory design developments and application for stoves of blast furnaces in SAIL plants".

Cost effective refractory handling manipulator for safe & better ergonomics

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Abstract

During ladle preparation at tilter, time involved plays a crucial role in shop productivity. In ladle preparation, slide gate refractory changing is a time taking & exhaustive process as it involves changing of refractories like upper nozzle, slide plate & lower nozzle. Changing of these refractories is human exhaustive process as these are heavy in weight and executed in heat & dusty environment and the entire process is done manually in every steel plant of India.

Refractory arrangement in slide gate system is in such a way that firstly upper nozzle is fixed in ladle well block (it is part of ladle lining) then slide plate and lower nozzle. One of the highly exhaustive processes is changing and fixing of upper nozzle its weight is around 17 Kgs and after applying mortar its weight increases to 25-30 Kgs and operator has to lift and fix manually. Upper nozzle fixing process requires more time, human effort leading to fatigue to operators and sometimes delay in preparation of ladle. This is a controlled and precise operation, deviations can lead to failure. To eliminate these problems a mechanized manipulator was designed to reduce the human effort, better ergonomics and to make the process more easier and operator friendly. This mechanized manipulator consists of some mechanical & pneumatic components which allows operator to lift and handle such heavy load without any effort. Manipulator is provided with an air balancing system which carries the load of refractory which helps in lifting and fixing of nozzle with all degree of freedom. This system works completely with pneumatic, with this system operator has to give only 1-2 kgs of force for lifting 25-30 kgs of load as complete load is being nullified by the air balancing system. A special type of gripper was also provided to grip the refractory components without damaging it. This type of system can be seen in automobile and other industries for handling load but for steel plants this was a bit challenging task as in steel plant there are lot of constraints like heat, dust, area etc. This type of solution can serve to solve various weight handling issues across steel industry.

Keywords: Nozzle fixing, Manipulator, Mechanization

Study on Recycling of Used Mag-Carbon Brick in production of Mag carbon Bricks

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Abstract

Mag-Carbon bricks are extensively used in steel ladle, converters, VAD vessel and EAF as working lining. After the campaign of the refractory lining is completed, approx. 30-35% of the working lining is dismantled which is of no use to the steel makers. In congruence with the zero waste management principle and also keeping in view the scarcity of the virgin materials, study has been conducted for recycling of these used Mag-Carbon bricks as grog for manufacturing of Mag Carbon bricks.

The primary objective behind this study is economical and environment friendly utilization of waste Mag carbon refractories, the scarcity of virgin raw material (Sea Water magnesia, Dead Burnt Magnesia), its rising cost, environmental aspects associated with production and depletion of high purity Magnesia based raw materials, reduction in specific cost of refractory in steel making.

The samples of used Magnesia Carbon Bricks were collected from our sister steel plant. After cleaning of the metal and slag from the surfaces of the remaining bricks, size reduction was carried out to usable fractions (coarse, medium and fines). Chemical and physical properties (Residual carbon, MgO, SiO_2, Fe_2O_3 content, BD etc.) of different fractions were studied for their respective use in making Magnesia Carbon Bricks replacing virgin material by optimum quantity. Study on suitability of recycling with optimum utilization of used Mag Carbon Bricks in as it is and calcined form in final product is done in detail. Comparison of Physical and Chemical properties of Magnesia Carbon Bricks manufactured by recycling grog in different ratio with magnesia carbon bricks manufactured by virgin raw material is carried out.

The study reveals that used Magnesia Carbon Bricks may be used in making fresh bricks in both calcined and non-calcined form for replacement of virgin raw material to a certain extent, without any adverse effect on the end properties of the bricks. Moreover, recycling of Magnesia and Carbon saves the energy required to produce it and thus the carbon emission.

This study enabled us to reduce the cost of production of Magnesia Carbon Bricks thus reducing the specific cost of refractory in steel making, but without compromising much on the quality of the Magnesia Carbon Bricks.

Insight into BOF bottom purging

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Abstract

A bottom purging element in a BOF is not just another piece of magnesia carbon brick that one builds slots into and watch it delivering the gas!

An inadequately developed element will fail under thermomechanical stress and result in excessive wear and/blockage of slots at a very early stage of converter campaign, so that metallurgical benefits associated with purging are achievable only for a meagre part of the campaign.

The wear is typically concentrated around the gas blowing elements and the most frequented two reasons are attributed to erosion and thermo-mechanical spalling.

Much has been discussed about the erosion aspect, like there is a correlation between maximum erosive wear and the gas flow rate and that maximum wear occurs at flow rates corresponding to the bubbling-jetting transition point of the gas stream in the bath.

Not much has been discussed about the thermo-mechanical wear aspect. To this effect, this paper tries to explain the fundamentals of the critical material properties and design aspects that go into improving the bottom performance. As no discussion on bottom purging element is complete without a mention of the dynamics of the gas flow the system handles, basics of fluid dynamics that upholds an efficient BOF bottom purging have also been discussed in brief.

A case study - life enhancement of RH lower vessel through improved quality of re-bonded magnesia chrome bricks

Avishek Mitra, Sanat Hazra

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Abstract

As the demand of clean steel has increased particularly with very low carbon and hydrogen content, RH degassing process is gaining popularity among steel manufacturers. RH Degasser is one of the best among various secondary refining process due to its high refining efficiency and productivity. Usually, various types of MgO-Cr_2O_3 bricks are used in different areas of the vessel because of their excellent resistance to erosion and corrosion, high temperature stability, low thermal expansion and high hot strength.

This case study speaks about the development of a new quality brick with special additive to counter faster corrosion resulting in higher life. The physico-chemical properties of the developed brick along with its improved corrosion and spalling resistance are also discussed. The objective of the present work is also to investigate the causes of damage in RH lower vessel brick and then to improve the life with a newly developed re-bonded magnesia chrome brick.

Optimization of EAF Tap weight by Improving the Refractory Design In SMS-1 & Best Operation Practices JSW Odisha

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Abstract

As the Indian Steel Industry has grown up and matured EAF route steel production getting popularize day by day & EAF steel production participated in an ever more competitive market , off late after stabilizing the JSW Vijaynagar plant in BF- BOF route , JSW Steel has entered in the EAF route steel making by the acquisition of Ispat – Dolvi 2007 ,M/s BHUSAN Steel Jharsugda 2021 & Monnet Ispat 2017 Creating new facility in Vijaynagar [SMS-III] 2016 , this competition has led to a continuous search for lower cost alternative for energy input materials ,Optimize / Increase the Tap weight and reducing the processing time by increasing the Hot metal pouring rate by redesign the Launder & time and Oxygen flow and operation excellence.

Over the year electric steel furnace community of the operation has develop a variety of Technological Improvement geared to increasing the EAF productivity , operators has emphasized the lowering of the operation cost per mt of steel produced by increasing the Tap Weight , reducing the Tap to TAP TIME improving the quality of Inputs like Hot metal , lime , pet coke , Dolomite and DRI etc .

Depending on the market condition , JSW Steel may run with different goal and goal of Maximizing the cost effective use of resources , When the market demand is high the goal may be to maximize EAF through put and number of Heat taped in day , the objective of work is to optimize the Tap to Tap time by adopting the best operating Practices .In considering the very high demand of HR Coil , JSW Steel have decided to Increase the through put of four EAF of SMS-1 of JSW – Odisha of originally designed capacity 95 mt Tap weight with 70 minutes processing time to 105 mt Tap weight & 60 minutes processing time by reengineering the Bottom shell and upgrading the quality of Refractory & pattern and Increasing the Hot metal pouring rate [3 mt/min to 6 mt/ min] and operation excellence .The Job was undertaken immediately after taken over Bhushan by JSW Management and Idea conceptualization to projects completion time is less than 6 month , all the 4 EAF [Eight Number of Bottom Shell] redesign , In house modification of Bottom Six number Bottom shell , discarding two old shell by new shell , up gradation of quality of Bottom shell lining and modification of Steel Ladle and Hot metal ladle & modification of loco Car of EAF Processing the Project was take up simultaneously and completed in six month from OCT-21 March 22 .The work was successful and completed in 31st March 22 resulting 10-20 %increase of the capacity of SMS-1 & Quality of steel also improved as hot heel was improved .

Key word – Productivity , Foaming Slag , Tap to Tap Time , Hot Heel .

Improvement in lining life of 300t converter in BSL / SAIL

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Abstract

The performance of converter lining with Magnesia Carbon (MgO-C) refractory depends on quality of raw materials along with binders being used, its running maintenance and largely on operational practices. The basic raw material for manufacturing of MgO-C refractory is high purity sea water magnesia with addition of crystalline graphite and anti-oxidants. Resins / and pitch are used as a binder.

MgO-C with different compositions and masses are manufactured in SAIL Refractory Unit (SRU) a sister unit of Steel Authority of India Limited (SAIL). The various compositions were developed based on erosion pattern of previous performances of converter linings.

SRU Ranchi Road unit, a well-known refractory manufacturer of MgO-C refractory, along with SAIL plant have developed a modified lining pattern with improved quality bricks for its 300t converter at BSL with tuyere bricks for **CBT** at its Steel Melting Shop-II.

The paper will describe the various actions taken to improve lining life of 300t capacity converter at BSL / SAIL with in-house MgO-C refractories.

A Discussion on Importance of Spinel Bricks in Steel Making Processes

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Abstract

Refractories an integral part of steel making, as Iron & steel Industry is the largest refractory consumer. Since long time refractory industry has undergone many vital changes in terms of technological developments like various manufacturing processes and raw material combinations. On the other hand refractory industry has always evolved with superior products to cope with the requirements of advanced steel making practices. This study evaluated journey on development and application of Spinel Bricks used in Steel Ladles for secondary refining of liquid steel in steel melt shops.

Technological advancements in steel making, like Ultra-Low Carbon Steels (like IF grade steel) manufacturing, creates an extraordinary demand for requirement of less/no Carbon refractories for secondary refining vessels like Steel Ladles. Also, it is today's demand on possibilities for alternate solutions to an environmentally harmful chrome containing refractories. It is anticipated that an importance of Spinel bricks will continue to grow in coming years to meet challenging requirements of steel making processes.

Effect of fume silica reduction on the properties of alumina magnesia castable for steel ladles

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Abstract

This paper focuses on the properties of alumina magnesia based castable considering two different particle size distributions with q values 0.21 and 0.29 and fume silica content of 4 and 1 wt.%. Alumina magnesia based castable compositions were processed as per the conventional processing technique and further evaluated for physical, mechanical, and thermo-mechanical properties at 110, 1000, and 1550 ℃ temperatures. The result showed that in comparison to 4 wt.% fume silica content, 1wt.% fume silica addition leads to an improvement in castable mechanical and hot strength properties, which is due to the absence of anorthite phase and formation of hibonite phase in 1 wt.% fume silica-containing compositions. Microstructural and energy dispersive x-ray analysis of the castables fired at 1550 °C show that the glassy phase is present in 4 wt.% fume silica addition however well compact microstructure with needle-shaped hibonite grains are observed for 1 wt.% fume silica content.

Keywords: Alumina magnesia castable, Fume silica content, Hot strength; Properties, Calcium hexa aluminate.

Alumina Rich Spinel Refractories for Steel Ladle Application – A Complete Solution by TRL Krosaki

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Abstract

Demand and uses of alumina rich spinel bricks for steel ladle application is increasing day by day because, demand of ultra-low carbon Interstitial-Free (IF) grade steel increases extremely in the market. Till date, with the technological evolution, alumina rich spinel fired bricks are found suitable in metal zone application of steel ladle for IF grade steel production.

Currently, fired spinel brick is being preferred by steel manufacturer to use in place of alumina-magnesia-carbon (AMC) for bottom application of steel ladle due to carbon footprint issue. However, magnesia-carbon (MgO-C) brick has retained its position for slag band of steel ladle due to its special characteristics, and moreover unavailability of any alternative refractory solutions till now. Due to heterogeneous refractory lining system, operational severity; performance of steel ladle puts a great challenge before steel manufacturer with respect to campaign life, cost, and time.

However, TRL Krosaki (TRLK) has already mitigated these challenges related with steel ladle by developing zone wise different suitable grade of refractories for steel ladle application. All these products are performing well at different customer end with enhancement of ladle life.

Keywords: steel ladle, refractory brick, alumina, spinel, carbon

Co-relation of various refractory & operational parameters on the steel ladle life of ISP.

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Abstract

ISP is an integrated steel plant in SAIL family with a production capacity of 2.5 million tons of crude steel which comes from 3 converters with a capacity of 150 MT each. Liquid Steel is poured from BOF, refined in secondary refinery unit and finally transported to the casting units via steel ladles. Currently ISP has fleet of total 23 steel ladles with a capacity of 150 MT each out of which 10 ladles remain in circulation on an average. Steel ladle performance plays an important role as production of steel is directly dependent on its performance. 48% of total annual cost of refractory spent on steel ladle in the year 2021-22. The only way to reduce the cost is to increase the life of steel ladle. Refractory team of ISP has studied the scopes of various refractories in its steel ladles like MgO-C bricks, Dolomite bricks, Spinel Bricks etc. to maximize its ladle life. Apart from that Refractory team has also analyzed the operational parameters like Slag chemistry, Shell temperature, LF holding time, Arcing time, number of heats per day etc. for adapting best practices to get maximum output from its steel ladles. Modified relining practices along with suitable unshaped refractory selection have played a critical role for enhancing steel ladle life at ISP.

ISP is also known for its various product ranges, starting from low carbon to high carbon steel, Si/Al killed grade steel in open/closed mode of casting and to maintain this product range different types of addition and treatments are done in LHF, even Casting time-frame also changes as per its requirement to successfully cast those various grade. However ISP Refractory team is able to maintain a healthy steel ladle average instead of all those above mentioned fluctuating parameters by co-relating along with analyzing those operational data and adapting new relining techniques, zonal lining, and proper refractory selection.

A case study - life enhancement of alumina spinel burnt bricks for slag dumping area of ladle metal zone

Avishek Mitra, Sanat Hazra

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Abstract

In the present scenario, mostly magnesia carbon bricks are being used in the metal zone of steel ladle. But, the problem of these conventional resin bonded refractories are higher thermal conductivity, higher thermal expansion, carbon pick up in steel and heat loss/skulling. To achieve higher life, minimize carbon pick up in steel and to make the lining cost competitive, burnt Alumina--magnesia spinel brick is one of the best alternative material to magnesia carbon brick.

In an integrated steel plant in India, Dalmia Bharat Refractories Limited was supplying Alumina Spinel bricks in ladle metal zone for sometimes. The quality supplied was performing in all areas but the main issue was high erosion in the slag dumping area. Bricks of this area of Metal Zone were eroded faster then the rest area bricks for which pocket repairing of Slag dumping area is almost a regular practice which is the main constraint to achieve higher life.

This case study speaks about the development of a new quality brick with special additive to counter faster corrosion resulting in higher life of bricks at slag dumping area of metal zone. The physico-chemical properties of the developed brick along with its improved corrosion and spalling resistance are also discussed.

Performance improvement of Steel ladle life by modelling operating parameters

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Tata Steel

Abstract

Operating parameters have enormous influence on the performance of the steel ladle refractory. Critical operating parameters had been used for the model building for steel ladle refractory life in TSK SMS shop. Optimising the operating parameters through the digital model building will help us to enhance the performance of the steel ladle. We have conducted technical understanding of all the critical and non-critical operating parameters for the steel melting shop for steel ladle applications. We have taken few assumptions such as quality of refractory variation is very low among the various suppliers. Various parameters study is performed to get the insights of the operating parameters. The suitable model was built with the help of various analytics tools with the inhouse analytics team. We would able to predict the steel ladle life with the operating parameters.

The objective with the study finally leads to the performance improvement of the steel ladle life by 5 to 10 heats. The financial benefits along with the insight's generation will be the outcome of the model. The further study will be conducted to deploy the model in other shops of the Tata Steel.

Implementation of Double Porous Plug Gas Stirring in Steel Ladles to Improve Gas Stirring Efficiency and Increase Ladle Lining Life

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Abstract

Gas stirring through porous plugs located in the bottom of the ladle is an effective method employed in today's metallurgical industries to enhance melting of alloys and improving its homogenization in steel melt. It is also utilised for improving the slag metal interaction in the ladle furnace. The efficiency of alloy dissolution and slag metal interaction is intricately related to the melting and mixing phenomena in steel ladles. The present study focuses on mathematical and physical modeling of gas stirring of liquid melt for mixing of slag and metal in a steel ladle. The effect of stirring the vessel using single porous plug was compared against a double porous plug system. Based on the results of the mathematical and physical modeling studies, steel ladles at Durgapur Steel Plant, SAIL were converted from single plug system to double porous plug system. The objective for the implementation was to reduce ladle lining erosion and improve lining life. As a demonstration trial one ladle was converted from single to double porous plug arrangement. Mixing characteristics of the slag and metal, thermal homogenization of the steel melt and refractory lining erosion pattern were used as parameters to evaluate the process efficiency. Results from the plant trial showed better homogenization of the steel melt and increase in lining life from 45 to 55 heats. Encouraged with the results, plant gradually converted all steel ladles from single porous plug to double porous plug. At present the average ladle life in the shop is around heats, wherein a major contribution to improvement has come from implementation of the double porous plug gas stirring.

Keywords – Gas Stirring, Steel Ladles, Double Porous Plug, Secondary Refining

Interaction between Refractory and Liquid Steel Regarding Steel Cleanliness: A Review

Santosh Kumar[1,a], Biswasi Sunita Minz[2], Smita Toppo[1], Snehanshu Roy[1], Somnath Kumar[1] and Nityananda Mondal[1]

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Abstract

Chemistry and inclusion control are two of the main keys to the production of quality steel products. Adjustment of the high level of quality and of steel cleanliness is accomplished during secondary metallurgy and is maintained during continuous casting. Taking metallurgical aspects more and more into account imposes a new approach of interactions between metal, slag, atmosphere and refractory products. In a steel ladle or in a degassing device, many reactions between refractories, steel and slag can contribute to degrading the steel quality by direct dissolution of the refractory with or without precipitation, dissociation, volatilisation, reduction reactions between an oxide and a metallic element, combination of the refractory and a non-dissolved element present in the steel (inclusion). During continuous casting, the attachment of different oxides on the wall of submerged entry nozzle is still a hot topic for metallurgists, since it may cause clogging and influence castability and steel final quality.

Besides, the corrosion of the refractory could also result in the inclusions in steel. It has been confirmed that the MgO inclusions and calcium aluminate inclusions with MgO island(s) in Al-killed steel grades originate from the corrosion of refractory. Furthermore, alloys also contain some inclusions. These exogenous inclusions from refractory and alloys are an important source of non-deformable inclusions in Al / Si-Al/ Si–Mn-killed steel as well. So, the effect of refractory on the evolution mechanism of these exogenous inclusions also requires detailed investigation.

In the present paper, the effect of refractories on the exogenous inclusions in different mode of killed steel was reviewed.

Keyword: Refractory; Exogenous inclusion; Steel Cleanliness; Secondary refining; Continuous casting

How can endoscopic inspection enhance industrial monitoring especially focusing on refractory lining status? Today and tomorrow

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ADI-Industrial Services

Abstract

Endoscopic inspection is nowadays a well-known technology widely used for one single purpose: “live” and accurate assessment FROM INSIDE the reactor, at operating temperature, of the real status of refractory lining which cannot be determine by direct vision, while InfraRed Thermography allows FROM OUTSIDE to map the areas which are with wear or damages suspicions.

Digital cameras capabilities have drastically improved these last years both from size wise and quality. ADI-Industrial Services took advantage of this progress to develop new devices or technology to improve quality of the videos/pictures recorded now in HIGH DEFINITION and improving its productivity on site operating with MULTIVIEW endoscopes (2 or more cameras in the SAME equipment)

Mastering the recording side, the development of dedicated software enables to improve even more, not only pictures quality but also the storage of the pictures in such a way that they can be used as DATA for further DATA analysis a next step use of Artificial Intelligence and Machine Learning, fully in line with Industry 4.0 concept.

High performance alternate quality refractory for hearth of reheating furnace

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Abstract

Merchant mill of Durgapur Steel Plant (DSP) is producing TMT bars. It has one pusher type reheating furnace. For maintaining a steady production in merchant mill, DSP need to have consistence furnace hearth life of about 1 year. So, costly ZCC blocks are used in preheating zone.

Under prevailing operating conditions of RHF of Merchant mill, hearth refractory has to withstand very high abrasion, thermal shock and vibration during operation. The hearth refractory also should have high volume stability and high strength.

With this background, improved quality High Alumina brick has been developed jointly with SRU, IFICO and RDCIS to conduct trials in DSP. Trial bricks have been manufactured in SRU, IFICO and supplied to DSP after evaluation of its properties.

Developed brick was lined in preheating zone of reheating furnace of Merchant mill. These developed bricks give satisfactory result. As the bricks are manufactured in SRU, IFICO, also an in-house source for low cost hearth brick is now available with us.

Keywords: Reheating Furnace hearth, High abrasion resistance brick

Total Refractory Management in Re-heating Furnace in Bokaro Steel- A new experiment and new experience.

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SKG Refractories Ltd

Abstract

SKG Refractories Ltd was engaged in doing the TRM (Total Refractory Management) in Reheating furnace in Bokaro Steel Ltd. This was an experiment of first of its kind done in any of the Indian steel plant and BSL is pioneer in this. The result obtained was very satisfactory. It saves cost and increases productivity of the Reheating furnace in BSL and as a result the contract of 3 more furnaces was awarded to SKG. This paper discussed the kind of improvement happened after the furnace was given for TRM. SKG Refractories has already indicated that that ample scope is there for further reduction in cost and furnace downtime with the use of prefab refractory cover on skid pipes. It also will bring down the carbon di oxide emission due to less consumption of fuel. The product has already been developed and actual field trial was made in Bokaro steel RH furnace No 3. Which was very encouraging. But further study is needed to generate the data to establish the improvement in energy saving, manpower saving and availability of the furnace.

Development of a New Refractory Repair Technology in Roof Area of Reheating Furnaces in hot condition at SAIL-Bokaro Steel Plant

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Abstract

Reheating Furnaces of HSM are major consumer of Refractories material. Different types of refractory bricks, ceramic modules, castables etc are used in different areas of RHF as per drawing. As per original drawing and conception, 128 ceramic burners of PCPF make of different diameters are installed in the roof of Reheating Furnaces.

Due to thermal stress and shock, sometimes during operation whole or partial part of ceramic burners falls off leading to holes in the affected area. This leads to heat loss as well as increase in downtime of furnace leading to overall production loss.

A new repair method has been developed for repair of the affected area during hot running condition using tools and tackles that are easily available. Prefabricated Y shaped Anchors of length 500 mm consisting of a T joint are wrapped with Ceramic Fibre with the T portion protruding out. Lancing pipes/rods are cut as per requirement which are used as supports. Number of anchor requirement depends on the actual diameter of the fallen burner. The prefabricated anchors are arranged in a circular structure around the periphery of the fallen burner with the T portion resting on top of Rods/Channels for support. Then a layer of slurry of dense castable is poured for initial base making. Next layer and layer of dense castable are poured till the whole area is sealed. Finally slurry of insulyte powder is deposited on top of the castable layer to seal the whole structure and prevent any heat loss. The whole process takes about 1.5 hours for one burner and can be easily undertaken during short downs like roll change in mills.

This type of innovative repair has helped to cope with surprise roof/burner failures in between campaigns of furnace and lessened furnace down time thus improving overall productivity.

Key Words: Reheating Furnace, Ceramic Burners, Y shape, T shape

Development of a New Refractory Repair Technology in Ceramic Module Area of Reheating Furnaces in hot condition at SAIL-Bokaro Steel Plant

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Refractory Engineering Department, SAIL-Bokaro Steel Plant, Bokaro – 827001, Jharkhand

Abstract

Reheating Furnaces of HSM are major consumer of Refractories material. Different types of refractory bricks, ceramic modules, castables etc are used in different areas of RHF as per drawing. As per original drawing and conception, ceramic modules of size 300X300X300 mm are installed in the recuperative zones having length is 13250mm. In this area the operating temperature range varies from 800 to 1150 Deg C.

In the recuperative zones, ceramic fibre based modules are fixed on MS plates through welded clits/anchors.

Due to thermal stress and shock, sometimes during operation modules fall off leading to holes in the affected area. This leads to heat loss as well as increase in downtime of furnace leading to overall production loss.

A new repair method has been developed for repair of the affected area during hot running condition using tools and tackles that are easily available. Clits/Anchors are first welded to welding rods and then installed in individual modules. Lancing pipes/rods are cut as per requirement which are used as supports. The total module structure including the attached clit and welding rod are hung in the hole through supported lancing pipe/ rods. Small fibre pieces are also poked around the hung module area for further sealing. Finally slurry of Insulyte powder is spread on top of the module structure to seal the whole structure and prevent any heat loss. The whole process takes about 30 minutes for one module and can be easily undertaken during short downs like roll change in mills.

This type of innovative repair has helped to cope with surprise module failures in between campaigns of furnace and lessened furnace down time thus improving overall productivity.

Key Words: Reheating Furnace, Ceramic Module, Clits

Replacement of Module Area with High Alumina Refractory Bricks in Recuperative Zones of Reheating Furnace#2,4.

S C Mohapatra, A K Rajak, Sabir Ali

SAIL-Bokaro Steel Plant, Bokaro – 827001, Jharkhand

Reheating Furnaces of HSM are major consumer of Refractories material. Different types of refractory bricks, ceramic modules, castable etc. are used in different areas of RHF as per drawing. As per original drawing and conception, ceramic modules of size 300X300 mm are installed in the recuperative zones having length is 13250mm. In this area the operating temperature range varies from 800 to 1150 Deg C.

In the recuperative zones, it is seen that there is frequent failure of roof in the module area mainly due to thermal stress and shock. In the year 2016, RHF#2 module area 1.5 rows were replaced with high alumina bricks (62% alumina) on trial basis after a lot of discussion and deliberation. The results have been very positive and there have been no failure in that replaced are since 2016. In April 2022 RHF#4, 2 rows have been replaced with high alumina bricks. The Expected life of installed bricks has been envisaged to be around 10 years.

If we go through the cost analysis, total Cost of Module set for 2 years life is approx. Rs 23 lacs including application cost i.e. cost per year comes to Rs 11.5 lacs.

Bricks installed in recuperative zones having types WBA and WBC. In view of the cost benefit analysis and overall performance, it has been decided to replace 2 rows of RHF#3 from module to high alumina bricks.

Bottom Purging Improvement of Steel Ladle at LD#3 (TSL JSR)

Amit Banerjee, Monoj Halder, Prasanta Panigrahi, Navneet Sinha, Brijender Singh
Tata Steel

Abstract

This paper describes the journey for improvement of porous plug performance at LD#3 TSCR. The main goal of Porous Plug is to create bubbles to float out all type of inclusion present in liquid steel as well as temperature & composition homogenization in secondary metallurgy .The cleanliness of steel is always a big issue in secondary refining & hence Porous plug plays the most important role there. Different type of Porous plug is available in the market like Random, Slot, Segment, Hybrid etc. Porous plug has been selected for any steel industry depending upon the application, chemistry of steel, ladle size & configuration etc. Reduction in bottom purging efficiency results in use of top lance purging, which ultimately results in improper homogenization of temperature and chemistry which causes downgrading of steel quality.

Present Bottom purging system was introduced in TSL JSR LD#3 from 2016 & there has been continuous study, analysis & different measures taken to improve the purging performance.

Porous Plug material characterization ,postmortem analysis, Trial of new design porous plug, Improvement in physical observation of purging through camera, improvement in safety Pad Inspection, Improvement in argon gas line connectivity, Auto coupler & mechanical leakages, Purging Plug maintenance improvement (Usage of PFD), Purging Programmer improvement, HMI control & display improvement, Ladle Logistic Improvement, all these various studies & initiatives were taken to improve purging performance at LD#3. Currently the full bottom purging efficiency at LD#3 is 97%, further work is ongoing to achieve 99% full bottom purging efficiency.

Modern Techniques In Improving Steel Quality In Tundish

Ashish Gadre

Allied Metallurgical Products Pvt Ltd , Bangalore

Abstract

In high productive steel making shop, the challenge has been to maintain or even enhance the steel quality without compromising on the steel plant productivity. The challenge has been to maintain or improve the steel quality in the tundish during the casting without affecting the overall productivity.

This directs the whole focus in having the perfect blanket of the active flux / synthetic slag in the tundish which remain in fluid form even after the changes in composition and temperature during course of casting. Also to offer good effect on improving the steel quality the active flux need to have high potential to catch and importantly retain the detrimental inclusions like Al2O3.

Allied Metallurgical Products Pvt Ltd, Bangalore has come up with excellent solution with the low alumina , carbon free active tundish flux – **Insulex Basi 1.**

The product is easy to use and supplied in fine granular form. The product is carbon free low melting active flux which remains in liquid form even after absorbing large quantity of floating inclusions including Al2O3. The surface tensions of the product during casting is such that the floated inclusions are held tight and not allowing it to flow towards the SEN. The product is very effective in all steel grades specially Al killed low and ultra low carbon steel through slab and CSP casting.

The industrial use of product by steel majors have reported absorption of alumina to tune of 25 - 30 %, reduction in start up failure & rejections and control on slivers. Its also been reported to have uniform stopper position due to less deposits in nozzle.

Refractory Design Modification by Application of Monolithic Refractory Material and Improvement of Steel Ladle life in SMS-III BSP, SAIL

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Abstract

In Bhilai Steel Plant (BSP), SAIL, SMS-III Steel Ladle Refractory Relining pattern was designed by the technology provider Primetals Technologies Limited (erstwhile Siemens VAI) along with RHI Magnesita (erstwhile RHI Refractories). After project stage the design was modified with monolithic refractories in back up lining along with change in lining pattern of working lining. The average steel ladle life of SMS-III increased with the modified design from 19.38 heats in FY 2018-19 to 38.78 heats in FY 2021-22. Along with increase of shop production the ladle life increased gradually, however, the in-house modified design has not only increased the ladle life, but also reduced the ladle side wall refractory failure. This paper is about the refractory design change by application of monolithic refractory material and improvement of BSP, SMS-III steel ladle refractory life through modification of refractory relining pattern.

Keywords – Steel Ladle; Refractory Design Modification; SMS-III; BSP-SAIL

Design of the State-of-Art Technology of RH Snorkel and itsPerformance

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TRL Krosaki Refractories Limited, Belpahar – 768 218, Odisha (INDIA)

Abstract:

Selection of Refractories for RH degasser particularly for snorkel is very critical and important as this equipment is used in severe operating conditions. The overall performance of RH degasser depends basically on three parameters. One is the direct bonded magnesia chrome (DBMC) brick quality, second is the design of Al2O3-MgAl2O4 spinel castable and third is its metallic shell and anchor design. At the same time the quality of repairing material particularly gunning mass is equally important to enhance the snorkel life. TRL Krosaki has done a lot of work in all the above areas and is capable to select or design the best quality refractories to get satisfactory performance based on operational parameters and grade of steel. Some of the plant produce more electric grade steel which is very corrosive to DBMC bricks. But the development of one special quality DBMC brick can withstand such severe operational parameters. Requirement of castable is also studied in detail and accordingly suitable castable is designed having excellent thermo- mechanical properties along with very good spalling and slag corrosion resistance. To improve the performance further it is suggested to reinforce the castable with the introduction of steel fiber. Cooling of metallic shell is also mandatory to prevent the stability of the whole structure. One special kind of shell design along with cooling effect help to enhance the performance. While assembly of the bricks it is essential to make it with zero gaps in between to prevent the slag/metal penetration. A high precision equipment is used for grinding the surface of the bricks, in order to ensure assembly of the bricks with zero gaps and no mortar.

In this paper, the details properties of DBMC bricks and Al_2O_3-$MgAl_2O_4$ castable are discussed. The assembling technique is also discussed while providing some pre-assembled snorkel with proper installation. Finally, the performance of snorkel is discussed at different plants having different operational parameters.

Keywords: Artificial Intelligence, Machine Learning, Big Data, Digital Twins, Prescriptive maintenance, Refractory technology

Stabilization of RH degasser in SMS-III, Bhilai Steel Plant, SAIL

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Abstract

In Bhilai Steel Plant, SAIL, SMS-III shop comprises of one RH degasser unit for production of ultra-low Carbon, low Hydrogen steel with average heat size 165 Ton. The principal function of RH degasser unit is removal of gases like H2, N2, O2 etc., natural decarburization, forced carburization with top oxygen blowing lance, liquid steel composition adjustment by addition of alloys, temperature adjustment and making clean steel as per customer requirement. The first heat through RH degasser was taken on dated 08.10.2018. From FY 2018-19 to FY 2021-22 the RH degasser unit of BSP SMS-III has gone through average life of 44 heats to 81 heats respectively and in FY 2022-23 cumulative average life is 91 heats upto August 2022. From the initial starting phase to current status RH degasser unit has been stabilized along with the shop. This paper is about the stabilization of RH degasser in SMS-III, Bhilai Steel Plant (BSP), SAIL.

Keywords – RH Degasser; Stabilization; SMS-III; BSP-SAIL

Automatic Mould Level Control With Eddy Current Sensor, Automatic Surface Inspection System and Wireless Continuous Temperature Measurement System

Arpan Chakraborty and Hannu Suopajärvi

Vesuvius India Limited

Abstract

Vesuvius as a global leader in molten metal flow engineering develops innovative and customised solutions, often used in extremely demanding industrial environments, which enable our customers to improve their manufacturing processes.

One of such solution is measuring tundish steel temperature continuously throughout the sequence even measuring temperature during preheat as well. The basic advantages of continuous tundish temperature measurement are:

- Preheat temperature control to avoid refractory erosion & optimum gas consumption
- Reduction of breakout risk due to high temperature.
- Reduction of freeze out risks by ladle change anticipation
- Productivity/ quality increase by casting speed adjustment as per steel temperature.
- Better control and monitoring superheat temperature thus in turn saving energy.
- Recording data throughout to investigate any event later.

With the joining of SERT Metal to Vesuvius Group, the strengths and expertise of both companies were merged into a global Automatic Mould Level Control (AMLC) Solution, based on several tens of years with several hundreds of casting strands equipped with Vesuvius systems throughout the world.

Reveal CAST is a fully automated surface inspection system to ensure the best quality of the produced semi products such as cast/scarfed/ground slabs, blooms, and billets. Based on the novel laser illumination and imaging techniques, the system produces extremely high-quality images from hot glowing surfaces, which are analyzed with state-of-the art Deep Learning algorithms.

Technologies for preventive maintenance for the extension of the lifetime of coke ovens and hot blast stoves

Matthieu LEHEUT
FIB-Services International S.A. Luxembourg

Abstract

FIBS is a company active in the development of technologies for the preventive maintenance of refractory linings of industrial furnaces. Since 1987, FIBS has developed high expertise and technologies are now daily applied in many factories around the world.

Since 2019, FIBS has decided to develop its activities in India through a partnership with the company BFSC Bokaro. BFSC Bokaro has a team of specialized technicians who have been trained by FIBS in order to apply FIBS technologies in the best conditions.

The technologies currently offered in India are mainly intended for Coke Ovens and Hot Blast Stoves.

Coke Ovens

Since 1992, FIBS has developed a complete line of products and equipment for the repair and treatment of coke ovens including ceramic welding, glass coating, S-Bricks, endoscopy, and liquid dusting (FIBS is the pioneer of liquid dusting).

Hot Blast stoves

FIBS was the first company in the world to offer endoscopic-assisted ceramic weld repair in hot blast stoves. FIBS technologies applied to hot blast furnaces and coke ovens have already extended the life of many furnaces worldwide. The presentation will give a complete overview of the technologies and the application proposed by BFSC Bokaro and FIBS in India.

Laser Contouring System – Scanner (Refractory Thickness Measurement)

Xavier Rabec, Ramalakshmanan & Ravishankar Kundu
Vesuvius India Limited

Abstract

Steel plants and other metal producing facilities are large and capital-intense companies competing in worldwide market. This highly competitive environment demands seamless operations and full control over processes. Vesuvius Digital Services provide the tools which allow engineers and operating personnel to make decisions based on quantitative data, where previously, experience and naked eye measurements were the only options.

Vesuvius Digital Services products provide remaining refractory thickness in metallurgical vessel with highest accuracy.

ANTERIS laser scanner product line provides unique features and exceptional integration in our customer's facilities.

ANTERIS is paired with our own State-of the- Art HYPERION software suite, offering best performance in business and unparalleled integration possibilities.

Laser contouring systems are devices designed to measure remaining thickness of refractory left in lining of a metallurgical vessel. This technology and systems are developed and Owned by Process Metrix which is a unit of Vesuvius.

Advanced Tundish Outlet Modifier

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Vesuvius India Limited

Abstract

Advanced Tundish Outlet modifier is a refractory product surrounded the outlet of tundish and Submerged entry nozzle. During steady state steel casting a boundary layer is formed along the floor of the tundish.

Air ingress is happened through the permeable tundish lining creates reoxidation within the boundary layer leading to generating of undesirable non-metallic inclusions. During ladle change or draining the boundary layer and reoxidation species are entrained to the tundish outlet resulting in build-up in the flow channel below to mold.

ATOM provides a physical boundary to contain the re-oxidized boundary layer (during unsteady state events such as ladle change or end of sequence drain. It is having internal steps as well as external lip.

Internal steps are to generate turbulence to minimize cold/dead zones around the outlet also turbulence destabilizes vortexing during low level events in the tundish. It helps to maximize surface for collection of nonmetallic inclusions on the ATOM instead of in the flow channel below to mold.

External lip helps to prevents entrainment of the re-oxidized steel layer along the floor into the tundish outlet and allows for reduced height of the device providing for lower drain levels at end of cast and reduced residual tundish skull It ultimately helps to reduce internal defects in final steel products related to steel flow by

- Less mold flow pattern changes related to cold steel influence
- Less mold level variations during first heats (cold steel) due to stopper position fluctuations (viscous effect on regulation)
- Less surface defects related to improved steel flow regulation
- Less stopper flushing related to solid inclusion deposition

Leveraging Digital Technology in Managing Torpedo Ladle Lining

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Bankim Chandra Tripathy, Sujat Ali Khan

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Abstract

Efficient performance of torpedo ladle refractories is key for smooth functioning of steel plants operating at higher productivity levels. Condition of refractory lining of a torpedo is presently monitored periodically by visual inspection of hot face and thermal imaging of steel shell during shutdowns or between heats. Torpedo Hot Spot Detection System (THSDS) is an in-motion system that uses the infrared (IR) technology aided with digital techniques to capture the steel shell temperature and estimate the remnant refractory lining thickness during transport of hot metal from Blast furnaces to Steel making shops. THSDS automatically raises an alarm at the operating desk and triggers SMSs if the predetermined temperature threshold is exceeded. The alerts prevent dangerous and loss-making incidents of loss of containment of liquid iron. THSDS frontend allows the operator to monitor the health of all torpedoes in circulation. The system acts a decision support tool for the operator to stretch torpedo refractory life. Torpedo Hot Spot Detection System (THSDS) was developed by an inhouse team of Tata Steel in 2017 and is successfully implemented at its Jamshedpur and Meramandali plants.

Keywords: Refractory, Thermography, Torpedo ladle, Torpedo Hot Spot Detection System (THSDS), Infrared (IR) Technology, Digital

A comparative investigation of the physio-mechanical characteristics of amorphous and crystalline silica extracted from rice husk ash

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Department of Ceramic Engineering, Indian Institute of Technology (Banaras Hindu University), Varanasi, 221005, India

Abstract

Rice husks, which are considered to be agricultural waste, are often employed as an inexpensive source of SiO2 in the fabrication of composites that are based on silica. Despite the fact that much work has been published on the use of RHA as a source of silica, little precise information on the behavior of RHA collected at various temperatures is known. We provide a thorough investigation of the physical and mechanical behavior of silica made from RHA amorphous and crystalline silica. XRD is used to analyze the phase of RHA treated at different temperatures. Above 400 C and below 800 C, amorphous silica is formed. RHA undergoes a phase change between 800 and 900 °C; then it transforms to the crystalline phase. The cristobalite and tridymite phases dominate crystalline silica. The obtained RHA has particle sizes ranging from 552.2 nm to 1212 nm and surface areas ranging from 0.258 m2 g-1 to 73.97 m2 g-1. The mechanical and physical characteristics of silica compacts made with RHA at various temperatures have been investigated. Because of the smaller size and disordered character of amorphous silica, the green density of silica compacts generated using crystalline silica is higher than that of amorphous SiO_2. Compared to crystalline silica, sintered silica compacts made from amorphous silica have higher relative density and strength. The foregoing occurrence may be linked to amorphous silica's less viscous nature and higher conversion rate to the cristobalite phase. The bulk density and compressive strength of the produced silica compacts are 1.59 g/cm3-1.97 g/cm3 and 20 MPa-52 MPa, respectively. The obtained data were compared to the SEM micrograph.

Effect of thermal treatment on phase and microstructural evolution of magnesium borate ($Mg_2B_2O_5$) nanorod whiskers prepared via hydrothermal cum reaction sintering process

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Department of Ceramic Engineering, Indian Institute of Technology, (Banaras Hindu University), Varanasi, 221005, India

Abstract

A single phase nano-crystalline Magnesium borate ($Mg_2B_2O_5$) whiskers in the form of nanorod has been synthesized using an optimized Mg:B molar ratio by combining hydrothermal and reaction sintering process. Magnesia (MgO) and boric acid (H_3BO_3) have been chosen as precursor materials. Phase and microstructural changes of as synthesized magnesium borate (MB) crystals during the reaction sintering process in between 700°C to 1200°C has been closely examined with the help of various characterization techniques. All these facilities were used to ascertain the synthesis of single crystalline $Mg_2B_2O_5$ nanorods. Phases of magnesium borate starts appearing on thermal treatment above 700°C. Phase transformation of magnesium borate from monoclinic to orthorhombic followed by triclinic was also observed during the thermal treatment. The optimum temperature to obtain pure triclinic $Mg_2B_2O_5$ phase was found to be in between 1100°C-1200°C. However, fragmentation and agglomeration of magnesium borate nanorods ensues at 1200°C. So, all the characterization techniques of nanorod whiskers confirms the sintering temperature of 1100°C as an optimum temperature for the synthesis of nanorod whiskers for the successful application of the whiskers as a reinforcement for composites.

Thermo-Mechanical Modelling and Simulation for effective Refractory Design in Iron & Steel Industries

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Abstract

Paradigm shift towards systematic and high-end technical approach is mandatory for adaptation and ensuring consistent performance. While development and performance analysis are concerned, herein, the main focus is given on the torpedo ladle refractory lining design in Iron making area and throttling impact on slide gate refractories in steel making area.

In the area of torpedo ladle lining, refractory thickness optimization by maintaining shell temperature is always a challenge. Here, a heat transfer-based model using *Simu-therm* & *ANSYS* is considered to optimise refractory lining thickness by maintaining a shell temperature within allowable limit and the effect of using insulation board against steel shell has been evaluated.

In the area of steel making, throttling is considered as the most critical operation to affect refractory life of collector nozzle during steel flow through slide gate refractories. A Computational Fluid Dynamics (*CFD*) based model focusing on comparison of negative pressure, flow pattern and streamline velocity with different opening ratio at the junction of slide gate top and bottom plate has been presented to evaluate the throttling effect on the slide gate refractories.

By adapting such technology-based modelling and simulation, the process ensures adequate safety and performance during operations in Iron and Steel making areas.

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Quality assessment of critical shaped structural refractory blocks using novel NDT technique

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Abstract

In iron and steel industry various critical shaped structural refractory blocks are used mainly in areas like flow control system, vessel sleeves etc. Performance of these blocks are paramount for smooth running of operation with less downtime. Hence evaluating the quality of these blocks before installation in plant is important. Ultrasonic pulse velocity technique can be used for checking the structural integrity and evaluating the physical and mechanical properties of the blocks. UPV method can easily detect any internal flaws/crack/ void present inside the material and gives qualitative idea regarding density and compressive strength of the material. This paper manifests the potential use of UPV technique for quality assessment of well block, vessel mother block and monoblock stopper.

Intelligent technologies for refractory spend management

Debesh halder & Avijit Pandit,
Mjunction services Limited

Abstract

Technology has created a firm footprint in spend management across industries. It has expanded in key horizons of connected process, automation, linking supply chain networks, tractability, Artificial intelligence (AI), data analysis and forecasting. The different levers of technology offers specific features and have unique deliverables and thereby one need be focused on desired outcome and selecting the right technology levers fit to its purpose.

Being a strategic item for Steel manufacturing & Refractory producers, Chief Procurement Officers (CPOs) have specific challenges in managing spend of Refractory & its raw materials. Cost maintenance, margins, consistency, continuity & traceability to name a few. No specific technology lever can meet these challenges in standalone. On contrary comprehensive digital suits developed for generic organizational requirement may not be the cost effective way either.

Trend analysis of key raw materials like magnesia, Alumina, ocean freight are effective in decision making on the time horizon of sourcing. However those need to be coupled with demand supply scenario in domestic market to discover optimum price. More often than not it's being observed 'apparent view of the market is projecting a reverse scenario of actual sentiment'.

In our recent past we have seen when a perfect competition is created under extreme volatility we could substantially arrest cost. Reverse auction is one of the proven tech-tool which creates perfect competition. But using the same in standalone may not yield same result. Systematic information gathering, assessment of price through cost models, assessing geo-political scenario & market sentiment, all have big role to play in creation of perfect competition. A comprehensive assessment of multidimensional cost influencers' are need of the hour & AI can leverage the same.

Therefore CPOs managing refractory spend are challenged with identifying of existing & emerging tech-tools, assessment of fit to use and cost benefit analysis while adopting digital technologies or tech-based processes. They have to have answers for the following outcome:

a. Is data analysis tool providing trends, insights, forecasting?
b. Is the process is effectively capturing all cost elements?
c. Is the tool capturing data on performance guarantee, Quality and delivery consistency?
d. Is the process is flexible to evolve negotiation strategies with changing scenario?

Challenges in selection of right technology / tech process is high. However it's worth investing time before deploying tech-tools. Because an effective implementation of right technology can create huge difference.

Advancements in Refractory Maintenance practices at RINL-Visakhapatnam Steel Plant

L. Srinivasa Rao, V.Venkateswara Rao, Sandipan Roy, A.Pratik Priyank

RINL-Visakhapatnam Steel Plant

Abstract

Rashtriya Ispat Nigam Limited, the corporate entity of **Visakhapatnam Steel Plant** is a public sector enterprise under the Ministry of Steel, Govt. of India. It is the first shore based Integrated Steel Plant in the country having three Blast Furnaces, six LD Converters and six rolling mills, with a rated capacity of 7.3 MT Hot Metal and 6.8 MT liquid steel.

Refractory Engineering Department (RED) procures the refractories and carries out the application of the same for the core production departments viz. Sinter Plant, Blast Furnace, Steel Melt Shop, Rolling Mills, Calcining Plant, Thermal Power Plant and Foundry for refractory maintenance of furnaces of these shops. Refractory maintenance practices followed in Visakhapatnam Steel Plant are mentioned. Various technological improvemental activities implemented for betterment of refractory maintenance practices in Visakhapatnam Steel Plant and the benefits obtained are brought out. Initiatives in future for improving the refractory lining of various units of Visakhapatnam Steel Plant are discussed.

Introduction of newly designed ladle heating system to reduce the arcing time for improved performance of refractory

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Abstract

In Steel Melting Shop steel is tapped from steelmaking furnace e.g BOF, EAF or EOF. Liquid steel is sent for further refining in a number of alternative processes known as ladle metallurgy. Ladle metallurgy is sometimes also called ladle refining or secondary steelmaking. In Secondary Steel making stringent operating parameters and strict control on chemistry and consistency is involved for production of high grades of steel. In Secondary Steel making homogenization of chemical composition of liquid steel in the ladle, removal of carbon, oxygen, hydrogen and nitrogen, sulfur and undesirable nonmetallic elements is being done. For a certain grade of steel; these activities are governed by maintaining a particular range temperature of liquid steel. For maintaining the temperature range arcing is done. The arcing duration depends on the drop in steel temperature in ladle furnace. When the arcing duration increases due to drop in steel temperature, then it affects the refractory life of the ladle. The arcing duration was high in Steel Melting Shop of Durgapur Steel Plant which had detrimental effect on the performance of ladle refractory lining.

The new ladle heating system was designed and installed for arresting the steel temperature drop in the ladle furnace. A coke oven gas burner was designed, fabricated and installed. It was utilized for on line heating of steel ladles placed over the transfer car waiting for tapping. The introduction of ladle heating system has reduced the temperature drop in steel ladle. It reduced the requirement of arcing duration and directly contributed in the performance of improved ladle refractory.

Keywords: Steel Melting Shop**,** Secondary Steel making, ladle heating system

New Generation Ladle Slide Gates With Enhanced Ergonomics & Safety, and new generation high performance purging plug

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Abstract

LG3X is designed to adjust metal flow form ladle to tundish with highest safety & ergonomics in application of refractory for all variety of ladle sizes.

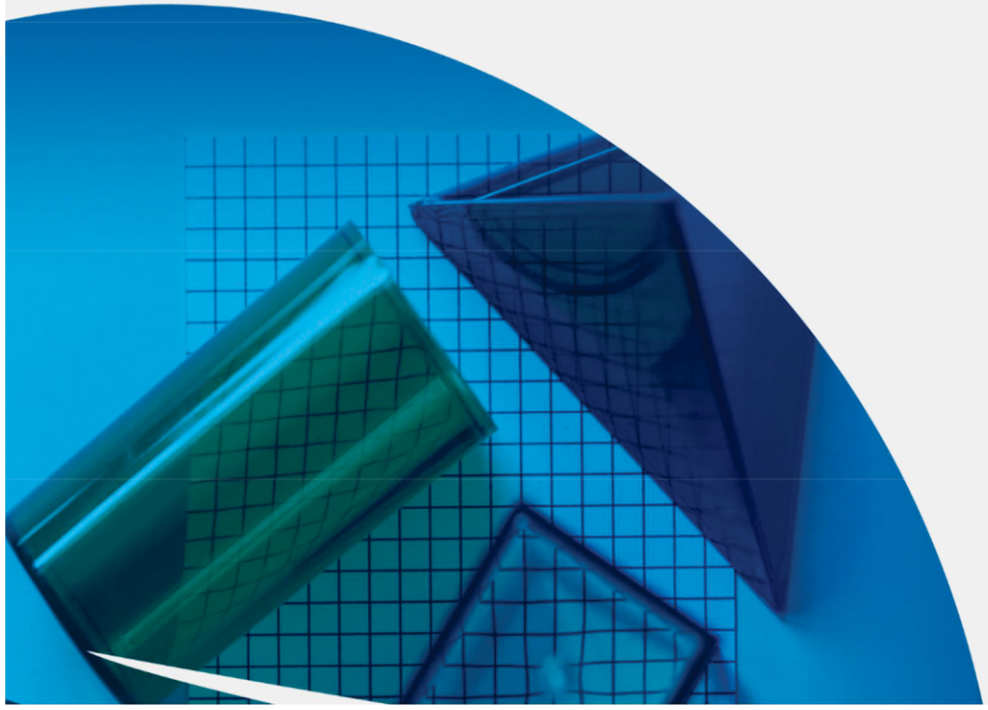
OptiClean™ is the state-of-the-art porous plug, offering enhancements in durability and flow rate customization over the porous competition through:

- High erosion resistance
- Inclusion removal capability
- Better temperature homogenization capability
- Better Opening efficiency (~ 100%)
- Reliable Wear Indicator
- Resistance to Steel penetration during Lancing
- Multi directional flow through smaller bubbles
- Requires less Oxygen lancing
- Engineered argon bubble size for clean steel making
- Combination of porous and Slotted
- Options to have “Lead Catcher” in the purge plug - minimal spare consumption for the IPV Mechanism

REFIS 4.0

Organizer Profile

Souvenir



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23-24 September

Bokaro Steel City
Jharkhand
India

2022

Bokaro Steel Plant

Bokaro Steel Plant - the fourth integrated plant in the Public Sector - started taking shape in 1965 in collaboration with the Soviet Union. It was originally incorporated as a limited company on 29th January 1964, and was later merged with SAIL, first as a subsidiary and then as a unit, through the Public Sector Iron & Steel Companies (Restructuring & Miscellaneous Provisions) Act 1978. The construction work started on 6th April 1968.

The Plant is hailed as the country's first Swadeshi Steel Plant, built with maximum indigenous content in terms of equipment, material and know-how. Its first Blast Furnace started on 2nd October 1972 and the first phase of 1.7 MT Ingot steel was completed on 26th February 1978 with the commissioning of the third Blast Furnace. All units of 4 MT stage have already been commissioned and the modernisation taken subsequently has further upgraded this to 4.65 MT of liquid steel.

Bokaro is designed to produce flat products like Hot Rolled Coils, Hot Rolled Plates, Hot Rolled Sheets, Cold Rolled Coils, Cold Rolled Sheets, Tin Mill Black Plates (TMBP) and Galvanised Plain and Corrugated (GP/GC) Sheets. Bokaro Steel has provided a strong raw material base for a variety of modern engineering industries including automobile, pipe and tube, LPG cylinder, barrel and drum producing industries.

Bokaro Steel values its people as the fulcrum of all organisational activities. The saga of Bokaro Steel is the story of Bokaroans erecting a gigantic plant in the wilderness of Chotanagpur, reaching milestones one after another, staving off stiff challenges in the liberalised era, modernising its facilities and innovating their way to the top of the heap.

Bokaro Steel is working towards becoming a one-stop-shop for world-class flat steel in India. The modernisation plans are aimed at increasing the liquid steel production capacity, coupled with fresh rolling and coating facilities. The new facilities will be capable of producing the most premium grades required by the most discerning customer segments.

Brand Bokaro will signify assured quality and delivery, offering value for money to the customers.

The Indian Institute of Metals Bokaro Chapter

The Indian Institute of Metals has played a significant role in its 75 years of journey since 1947 in establishing a bond among the metallurgical industry in the country, academics and researchers in the country. The professional course offered and conducted by the Institute is nationally recognized since long, and there are numerous examples of professional success of the candidates. The Institute has established strong interaction with some of the leading professional bodies pertaining to metallurgy and materials, and its arena of activities is ever expanding.

The scope of the Institute activities includes mineral beneficiation, extraction, fabrication, heat treatment, finishing as well as practical and theoretical aspects of metallurgy of all ferrous and non-ferrous metals and alloys. Ceramics and other disciplines and technologies allied to metallurgical problems also come under the scope of the Institute.

The activities of the Institute include organizing national and international technical conferences and programmes, research activities, publications, conducting qualifying examinations etc. Although there is a small permanent staff of the Institute, almost all the activities are carried out through the Honorary services of the Office-bearers, Council Members, Chapter Chairmen, Secretaries and Treasurers as well as a large number of Institute members.

Bokaro Chapter of The Indian Institute of Metals is one of the leading and active chapters having membership strength of around 100. Bokaro Chapter has been formed in the Year 1978. The chapter was established through the support and patronage of SAIL Bokaro Steel Plant. The activities of the chapter include Organizing Technical talks by invited Speakers, organizing National/International Seminars/Conferences, NMD Group awards to executives and non-executives & Shop Performance Awards to different shops at BSL for their outstanding contributions in the field of Metallurgical Engineering.

Bokaro Chapter has hosted the the 16h NMD and 32nd ATM in 1978 and co-hosted the 50th NMD and 66th ATM at Jamshedpur during November 16-19, 2012 along with Jamshedpur, Ranchi and Ghatsila Chapters and TATA Steel. In 2015, IIM Bokaro Chapter organized an International Conference on "Automotive Steel - Outlook &Perspective". Now, Bokaro Steel Plant in association with IIM Bokaro chapter, is organizing “International conference on Refractories in iron and steel industries” on 23rd -24th Sep 2022.

Indian Ceramic Society

Indian Ceramic Society (InCerS), a non-profit organization, was established in 1928 with the blessings and active support of Mahamana Pandit Madan Mohan MalaviyaJi, the main architect for establishing the Banaras Hindu University (BHU), Varanasi, and with the ardent efforts of a few dedicated leaders, namely, Sardar Krishen Singh (Inaugural Chairman), Mr T. W. Talwalkar (Inaugural Secretary), Mr Satyasundar Deb (First President), Dr N. N. Godbole (the then Pro-Vice-Chancellor of Banaras Hindu University), in the fields of ceramic industry and education. During the last seventy-seven years of its existence, the InCerS has grown from strength to strength under the guidance, patronage and leadership of several leading educationists, scientists, technologists and industrialists of the country who served the Society in different capacities. Presently, InCerS has more than 3000 members including foreign members, comprise a wide variety of individuals and interest groups that include scientists, engineers, researchers, manufacturers, plant personnel, educators, students, marketing and sales professionals, and others in related materials disciplines. The InCerS provides members and subscribers with access to periodicals and books, meetings and expositions, and technical information.

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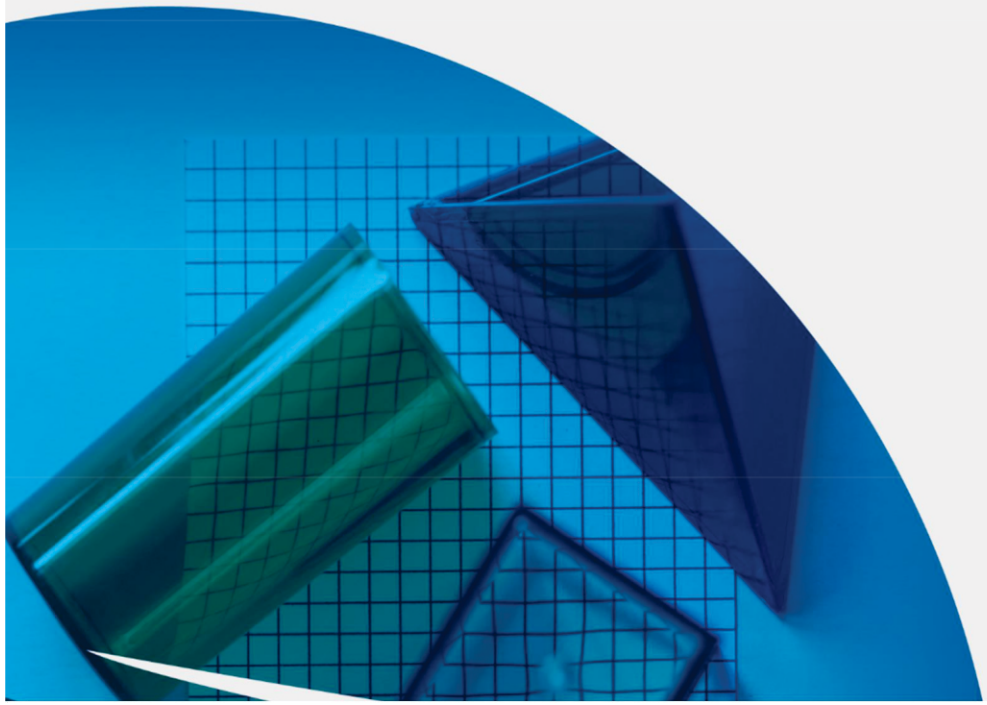

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23-24 September

Bokaro Steel City Jharkhand India

2022

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Dalmia OCL

Gunning hard to realise its dream of being a $1 billion business by 2030, Dalmia-OCL is enjoying the chase, emerging as India's fastest-growing refractory business two years in a row.

Dalmia-OCL is a part of the $1.7 billion Dalmia Bharat Group. Founded in 1939, as one of India's oldest and most respected businesses, the Dalmia Bharat Group today operates in four segments: Cement, Sugar, Power and Refractories.

The group's refractory business, under the banner of Dalmia-OCL, is a leading supplier of a wide range of high-performance refractories to almost all Iron & Steel and Cement plants in India. In fact, nearly a third of the requirement of ladle refractories from India's largest producer of steel is fulfilled by Dalmia-OCL. Long recognised as a leader in Silica and High Alumina refractories, Dalmia-OCL is today servicing customers in over 40 countries across capabilities such as refractory design, manufacturing, application and management.

After acquiring Germany's GSB Group in 2019, Dalmia-OCL now has manufacturing facilities and R&D centres in 7 locations spread across India, Germany and China totalling a production capacity of 350,000 tonnes. As part of its JV with Seven Refractories, it has commissioned a state-of-the-art production line in India to manufacture advanced monolithics that until now had to be imported by customers.

Apart from Iron & Steel and Cement manufacturing, Dalmia-OCL also manufactures refractories consumed in production of Glass, Petrochemicals and non-ferrous metals such as Copper, Nickel, Aluminium etc.

Having made, and continuing to make, a variety of investments in areas such as M&A, enhancement of production capacities and capabilities, R&D and talent acquisition and development, Dalmia-OCL is uniquely poised to profit from Indian Refractory's big leap: overall refractory demand is estimated to grow by a factor of 3x, as Indian steel makers are targeting to grow from 100 MT to 300 MT in the current decade.

Learn more at www.DalmiaOCL.com.

TRL Krosaki Refractories Limited

TRL Krosaki Refractories Limited has pioneered refractories production in India. This Integrated Management Systems (IMS) certified company is one of the premiere refractories company in India with a turnover of Rs. 1924 Crores in 2021-22. The company offers a wide range of products like Basic, Dolomite, High Alumina, Monolithics, Silica, Flow Control Products, Taphole Clay, RH Snorkel and Alumina Graphite Refractories and Refractories Engineering and Technical Support Services.

Having a consolidated installed capacity of more than 3,60,000 MTPA, it caters the refractories products and services requirements of Steel, Cement, Glass, Nonferrous Industries like Copper and Aluminium industries etc. The company has five manufacturing facilities in India and one in China with the main works located in Belpahar, Jharsuguda, Odisha.

Besides having one of the most well-equipped plants, TRL Krosaki Refractories Limited boasts of a world standard R&D facilities. The laboratory of Technology Centre of TRL Krosaki has received the prestigious NABL Certificate of accreditation in accordance with the standard ISO/lEC 17025: 2005. TRL Krosaki has an extensive Sales and Services network across the length and breadth of the country.

The company is divided into six Sales and Services zones viz. North (Delhi), South (Bengaluru), East (Kolkata) East (Jamshedpur), West (Mumbai) and Central (Belpahar) for providing doorstep service to the customers. Its International Business division is located in Kolkata and has representative offices in UAE and UK (Scunthorpe).

At present, 77.46% shares of the Company are held by Krosaki Harima Corporation (KHC), Japan and SAIL holds 10% shares. Krosaki Harima Corporation is the 4th Largest Refractories Producer in the World. The company has received several accolades for its performance in Quality, Safety, Environment and CSR.

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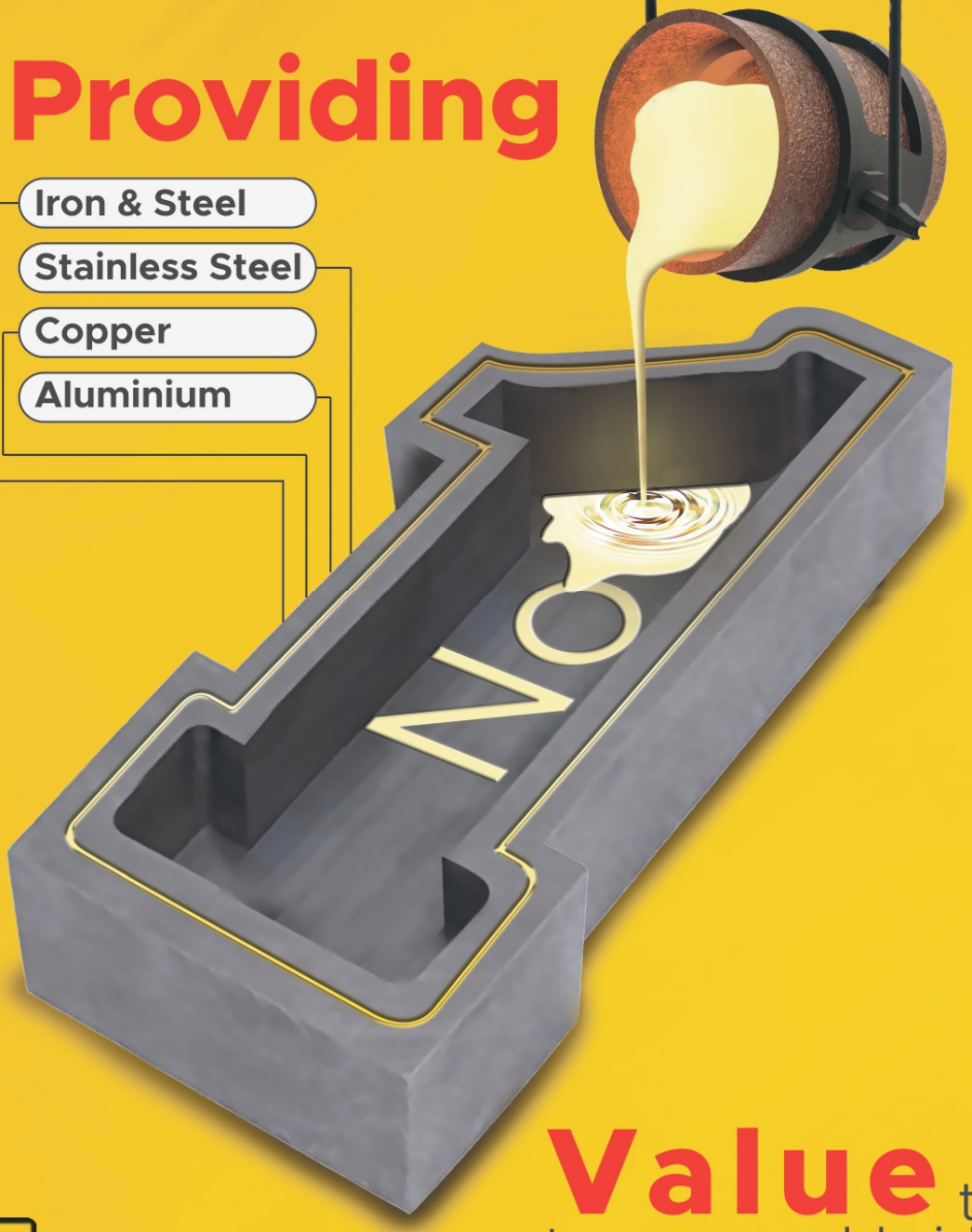
TRL KROSAKI

Providing

- Iron & Steel
- Stainless Steel
- Copper
- Aluminium



Value to customers worldwide

SCAN ME

TRL KROSAKI REFRACTORIES LIMITED

www.trlkrosaki.com

REFRATECHNIK

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QUEENSLAND MAGNESIA

QMAG is part of the global Refratechnik Group and has a strong reputation, established over three decades, for the highest quality magnesia products.

Established in 1991, the QMAG brand is well recognised for its consistency of quality. QMAG is one of the world's largest producers of high grade Calcined (CCM), Deadburned (DBM) and Electrofused (EFM) magnesia. We supply hydrometallurgical, agricultural, refractory and industrial & chemical markets on a global basis. Our QMAG Extra is recognised as a market leading product for refractory applications.

QMAG Extra is produced using QMAG's specially designed vertical shaft kilns, which are an important part of our production process that leads to high quality products. Our kilns are used to convert reactive calcined magnesia to a significantly less reactive form of magnesia – deadburned magnesia (DBM). This process involves heating briquettes made from high grade caustic calcined magnesia (CCM) to temperatures in excess of 2000˚C. The result is a non-reactive, hard, dense and stable material.

QMAG's DBM products are recognised worldwide for the highest levels of quality and consistency. Our vertical shaft kilns are lined with multiple layers of different refractory materials to provide production consistency, long service life and energy efficiency and allows us to operate our kilns 24/7.

QMAG
QUEENSLAND MAGNESIA

WE CREATE SOLUTIONS TO MAKE A SUSTAINABLE DIFFERENCE

REFRATECHNIK

QMAG
QUEENSLAND MAGNESIA

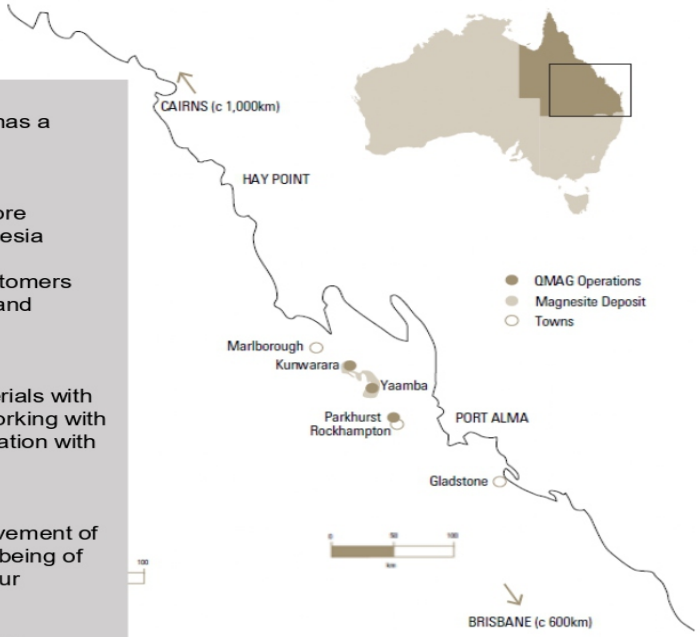
QMAG's operations are in Central Queensland. Its major magnesite deposit has a resource life of over 100 years.
The integrated operation consists of:

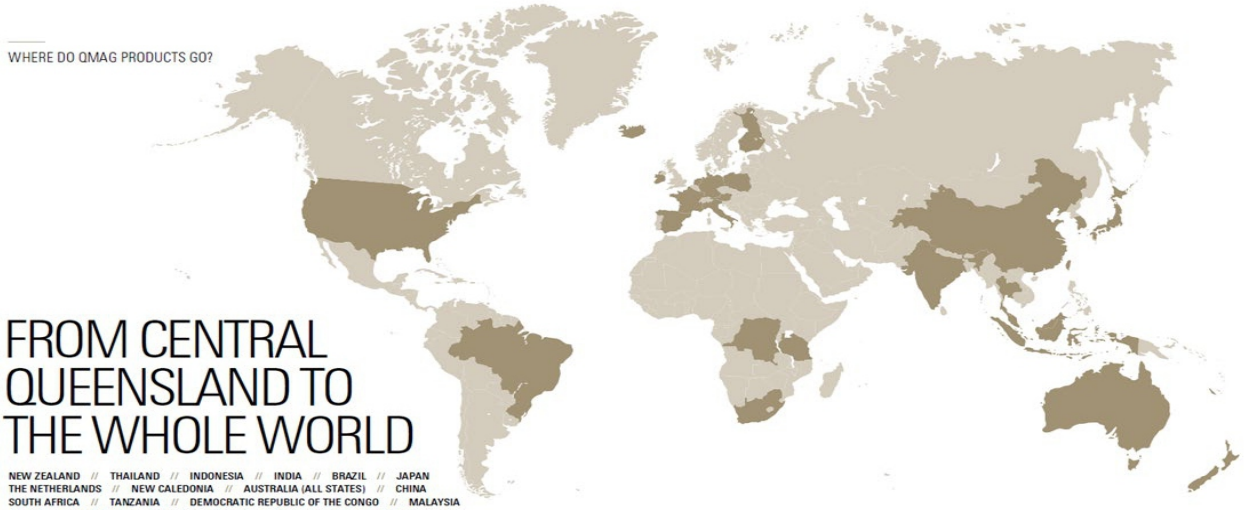
- Mining and beneficiation of magnesite ore
- Processing and production of the magnesia products
- Marketing and distribution to global customers utilising a range of packaging, storage and transport solutions

Our Commitment
To safely produce the highest quality materials with a solution based and sustainable focus, working with respect for the environment and in consultation with local communities.

Continuous Improvement
We are dedicated to the continuous improvement of every process in the company for the well being of our employees and to meet the needs of our customers.

Community, Environment, Health & Safety
We understand and respect our responsibility to the people and places in which we operate. We develop our operations and activities in harmony with the environment and in compliance with applicable environmental laws and regulations. We are committed to the health and safety of all our employees, contractors and visitors.





QMAG Pty Limited
246 Boundary Road Parkhurst
Postal address: PO Box 5798 Red Hill, Rockhampton QLD 4701
Phone: +61 7 4920 0200
Email: info@qmag.com.au

Maithan Ceramic Limited

Maithan Ceramic Limited (MCL) is one of the leading refractory manufacturers of India, having a journey of more than 60 years. MCL is a one stop shop for multiple sectors requiring solutions for demanding applications, offering entire product spectrum from shaped to unshaped in Alumina, Basic and Special qualities.

Global leaders in Steel, Glass and Non-Ferrous Metals are our valued Customers. The manufacturing facility in India has a rated capacity of 120,000 MT per annum and has been completely modernized as recently as 2018.

PRODUCT SPECTRUM:

Alumina Bricks
- High Super Duty
- Sillimanite Andalusite
- Mullite
- Corrundum
- Bauxite
- Alumina Magnesia Spinel

Basic Bricks
- Magnesia
- Magnesia Chrome
- Spinel

Carbon Bricks
- Magnesia Carbon
- Alumina Carbon
- Alumina Magnesia Carbon
- Alumina Silicon Carbide Carbon

Alumina Monolithics
- Conventional Castables
- Low Cement Castables
- Ultra Low Cement Castables
- No Cement Castables
- Other Monolithics

Basic Monolithics
- Ramming Mass
- Gunning Mass
- Other Monolithics

Special Refractories
- Silicon Carbide
- Zircon Silicate
- Zircon Mullite
- Magnesia Zirconia
- Alumina Chrome

AREA OF EXPERTISE:
- Steel Teeming Ladle
- Torpedo Ladle Car
- Electric Arc Furnace
- Convertor
- Glass
- Lime Kiln
- Coke Oven
- Blast Furnace Stove
- Blast Furnace
- Pellet Plant

MCL always take a challenge to establish themselves as a credible channel partner to their customers ensuring best quality materials & services. MCL believe in establishing a long term partnership and endeavoring to become self-reliant (Aatma Nirbhar) through Make in India to accomplish the dream of our Prime Minister, Shri Narendra Modi.

MCL combine product customization and application knowhow to deliver a high degree of customer satisfaction.

Sarvesh Refractory Private Limited

SARVESH-Company Profile

SARVESH Refractories Pvt. Ltd. ,established in the year of 1993, located at Rourkela ,Odisha is one of the top refractory manufacturers in the country providing total refractory solutions for Steel, Cement & Mineral Processing Industries equipped with latest production facilities.

Production Facilities

- 75 TPD Rotary Kiln up to range of 1850 deg.C
- High-capacity Impact Mills and Ball mill for grinding
- PLC based Auto-batching system for more accurate recipe management
- 1.5T per batch Eirich Mixers
- 2000T SACMI Hydraulic Presses
- 60 Mtrs. long Tunnel kiln and 50 Mtrs. Long Tempering Kiln with latest temperature control equipment
- Fully automatic Shrink-packaging system
- FIFO System complied finished goods storage facility

Product Range

- Mag-C & AMC Bricks
- Basic Burnt Bricks
- ASC Bricks
- Dolomite Refractories
- Slide Gate & Purging Refractories
- Precast & Pre-fired shapes
- Tundish Spray Mass & DVM
- Basic Gunning & Ramming Mass
- Conv. & Low Cement Castable

Total Refractory Management

- Total Ladle Management
- BOF & EAF Management
- Total Tundish Management
- Functional Refractory Management
- Lime Kiln Management
- Torpedo Ladle Management

SARVESH Refractories Private Limited

SARVESH

RELINE & RELAX

SARVESH REFRACTORIES PVT. LTD

Total Refractory Solution

- Steel Ladle
- Hot Metal Ladle
- Rotary Kiln
- Torpedo Ladle

Refractory Management

- BOF & EAF
- Tundish
- Slide Gate
- Purging

Proudly serving
Iron & Steel Industries
since 1993

www.sarvesh.com

Write us at : **marketing@sarvesh.com**

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SKG Refractories Limited

SKG Refractories Limited is one of the leading manufacturing Company of quality Refractories with a capacity of **45000** TPA based in the central part of India at **Nagpur(M.S.)** as well as at **Raipur (C.G.) We are an ISO 9001-2015 certified company and it is our privilege to mention that we are the first Refractory Company in India to have ISO certification for entire range of Refractory as well as designing & refractory installation.**

We would like to emphasize that we at SKG are a team of young professionals with a progressive outlook. To start with, we set our quality standards really high. High enough for the competition to rise up to our level and sink in their teeth in the competitive standards that had been set by us. We also made it a point to constantly challenge the good and efficient work that was being done by us.

A certain Product integrity is inbuilt into all our systems. Our R&D wing is genetically programmed to think out of the box to deliver customized solutions. We take our customer's feedback to heart.

we have built up an undoubtedly long list of prestigious clientele from **Steel, Cement, Copper, Aluminium, Zinc and Glass industries that includes all major business houses domestically, neighboring countries as well as from Middle East and Africa amongst overseas.**

We have the entire range of products for the Ferrous & non-Ferrous Sectors ranging from **Resin bonded, Dense Basic and High Purity Alumina Refractories**, along with all types of Monolithics.

We are specialized in Turn-Key solutions for Lime Kiln and our vast range of customers are CIMPROGETTI, MAERZ, TERRUZZI, MOLLER, SiC etc. and our client list of Lime Kiln speaks about specialized experiences.

SKG has also been a front runner in offering services to its clients which include complete project on designing and engineering. This enables us to offer comprehensive package to our clients which includes refractory engineering, refractory supplies along with outsourced accessories like Ceramic Fibre, high temperature insulating materials, SS Anchors etc.

SKG's enviable track record of product, service and prestigious cliental has placed us in the higher echelons of customer satisfaction and we have just the customers to thank.

At SKG, we have a history of serving core industries like Iron & Steel, Cement & Lime, Aluminium, Glass, Ceramics, Power & Energy for over 5 decades as the leading super-market for refractories, castables, insulations and allied products. Our repertoire extends beyond products to include complete knowledge partnerships. Making us trusted partners for total refractory management to India's leading players in the core industry.

For decades, SKG has served as thought leaders and pioneers in refractory technology and services for the core sector. SKG offers an array of specially designed products and services, apart from customized services like design and turnkey solutions. All this - with an eye on assuring total quality, adherence to time schedule and value addition at each step. No wonder, when it comes to putting the heart and soul of their manufacturing plants in capable hands, most of the industry veterans turn to us.

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Minteq at a Glance

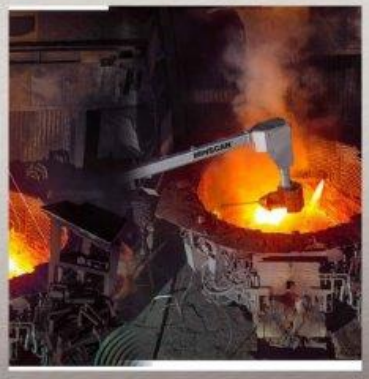
$300M Integrated Solution and Technology Provider

Refractories & Laser Equipment (80%) | **Wire (20%)**

Product	Monolithic Refractories	Lasers & Probes	Calcium & Alloy Wire
# of Production Plant Sites	13	1	2
Key Differentiators	• Most Durable monolithic refractory products • On-site Steel Mill Service • Full service maintenance • Total Costs of Ownership	• World leader in Fastest & most accurate laser solutions • Engineering solutions • Local service • Unique torpedo and Explorer scanner	• Solid core calcium • Treatment solutions • Injection systems – CLU™ • Consistency of recovery

REFRACTORY

MEASUREMENT & APPLICATION SYSTEMS



MEASURE, REPAIR, MAINTAIN

MINERALS TECHNOLOGIES

MINTEQ

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Zircar Refractories Limited

Zircar Refractories Limited (Zircar), an ISO 9001: 2015 certified company, is founded in 1996 has been started producing Silicon Carbide Crucibles in the beginning for non ferrous foundry industries. Soon Clay -Graphite Refractory Components like stopper head for ferrous foundries and Stopper and Ingate sleeve for Rail wheel Factory are being produced and supplying. It enjoys a broader customer base in the ferrous and nonferrous industries and has a wide and well established distributor/dealer's network across the globe. Company has started manufacturing Isostatic press Crucibles in 2017 and also started producing Isostatic Continuous Casting Refractories (CCR) for steel plants. Slide gate refractories (SGR) production line was also started in 2019.

Zircar has its plant , situated at Mehsana , in the state of Gujarat (India), 70 km away from Ahmedabad International Air port, having the state-of- the-art facilities to manufacture various types & sizes of Silicon Carbide Crucibles, Clay Graphite Isostatic Crucibles, Continuous Casting Refractories, Slide Gate Refractories and Monolithics which have been well accepted as a reliable product in India and overseas market. The Company plays a dominant role in domestic market to satisfy the demand of its Crucibles and other products. Besides, export of the Company's Refractory products are reaching the customers in more than 40 countries, such as Argentina, Australia, Bangladesh, Brazil, Bulgaria, Canada, China, Chech Republic, Egypt, Eritrea, France, Georgia, Ghana, Greece, Indonesia, Iran, Israel, Italy, Japan, Kenya, Kuwait, Lebanon, Malaysia, Morocco, Nepal, Nigeria, Oman, Peru, Poland, Qatar, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sri Lanka, Singapore, Sudan, Syria, Taiwan, Turkey, U.A.E., Uganda, Ukraine , USA etc.

The Company foresees a continuing and sustainable growth potential of its products in International market in the years to come.

Our Company is committed to provide high quality refractories in a geographical context of proximity for Asian, European , African Customers , the Middle East, US and neighboring countries at the completive cost.

Cored Wire Manufacturing

TUF GROUP

TUFWIRE range include:

• Pure Calcium	Ca	• Sulphur	S
• Ferro Silico Calcium	CaSi	• Ferro Silico Magnesium	FeSiMg
• Calcium Iron	CaFe	• Nitrided Manganese	N-Mn
• Aluminium	Al	• Nitrided Ferro Manganese	N-FeMn
• Ferro Titanium	FeTi	• Carbon	C
• Ferro Vanadium	FeV	• Titanium Sponge	Ti
• Ferro Boron	FeB	• Lead	Pb
• Ferro Niobium	FeNB		

- **Cored Wires available 9mm, 13mm & 16mm dia based on customers demand.**
- **Other grades / specifications can be made available as per requirement.**
- **Horizontal / Vertical packing options**

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Our Global Footprints

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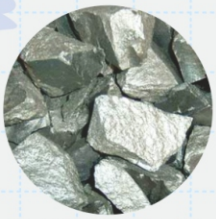

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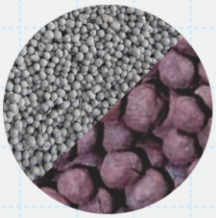
MANGANESE ORE



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TUF Metallurgical Pvt Ltd
JL-21, Village Amria, P.O. Kolorah, P.S. Domjur, Dist. Howrah, West Bengal - 711411, India **Tel.:** +91 11 43051000

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- **Reduce Overall Maintenance Costs**

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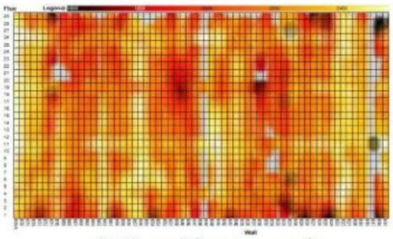
Emission Compliance



Battery Thermograph

Jamshedpur office : ***FOSBEL INDIA PRIVATE LTD.***, A/6, Balsam Lane, Ashiana Gardens, Sonari, Jamshedpur – 831 011. Ph.: + 91 657 2315318 / 2315193

Head Quarters : ***FOSBEL INC.***, 20600, Sheldon Road, Brook Park, OH 44142, USA. Ph.: + 1-216-362-3900 Fax.: + 1-216- 362-3901, Website : www.fosbel.com

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- Basic Oxygen Furnace
- Blast Furnace
- Torpedo Ladle
- Charging Ladle
- Copper Converter
- Cement Rotary Kiln
- Lead Rotary Kiln
- Glass Furnace & So on

PRODUCT RANGE

- Magnesia Carbon Bricks
- Alumina Magnesia Carbon Bricks
- Magnesia Chrome Bricks
- Magnesite Bricks
- Alumina Bricks
- Silica Bricks
- Clay Bricks
- Well Blocks
- Seating Blocks
- Tap Hole Sleeves
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Manufacturing Unit:
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Bokaro Branch Office:
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BOKARO, JHARKHAND, INDIA – 827001

Mobile:
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8102622018

E-Mail:
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MR. ADARSH SINHA (DIRECTOR) #9958988136
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E-MAIL:
brahma_dhn@rediffmail.com
brahmarefractories@gmail.com

ADDRESS:
WORKS: Madhugora, Rajganj Sijua Road, Rajganj-826006, Dist-Dhanbad (Jharkhand)
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Website: www.manishri.com

Esskay Machinery (P) Ltd.,
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Dist: Cuttack-754022
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- Own Technology & Installation Team for TRM.

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- To Establish our own Refractory Manufacturing Unit in Odisha.
- To create Employment Opportunities for 1000+ youth.
- To Make India **Atma Nirbhar** in the Refractory Manufacturing Technology.
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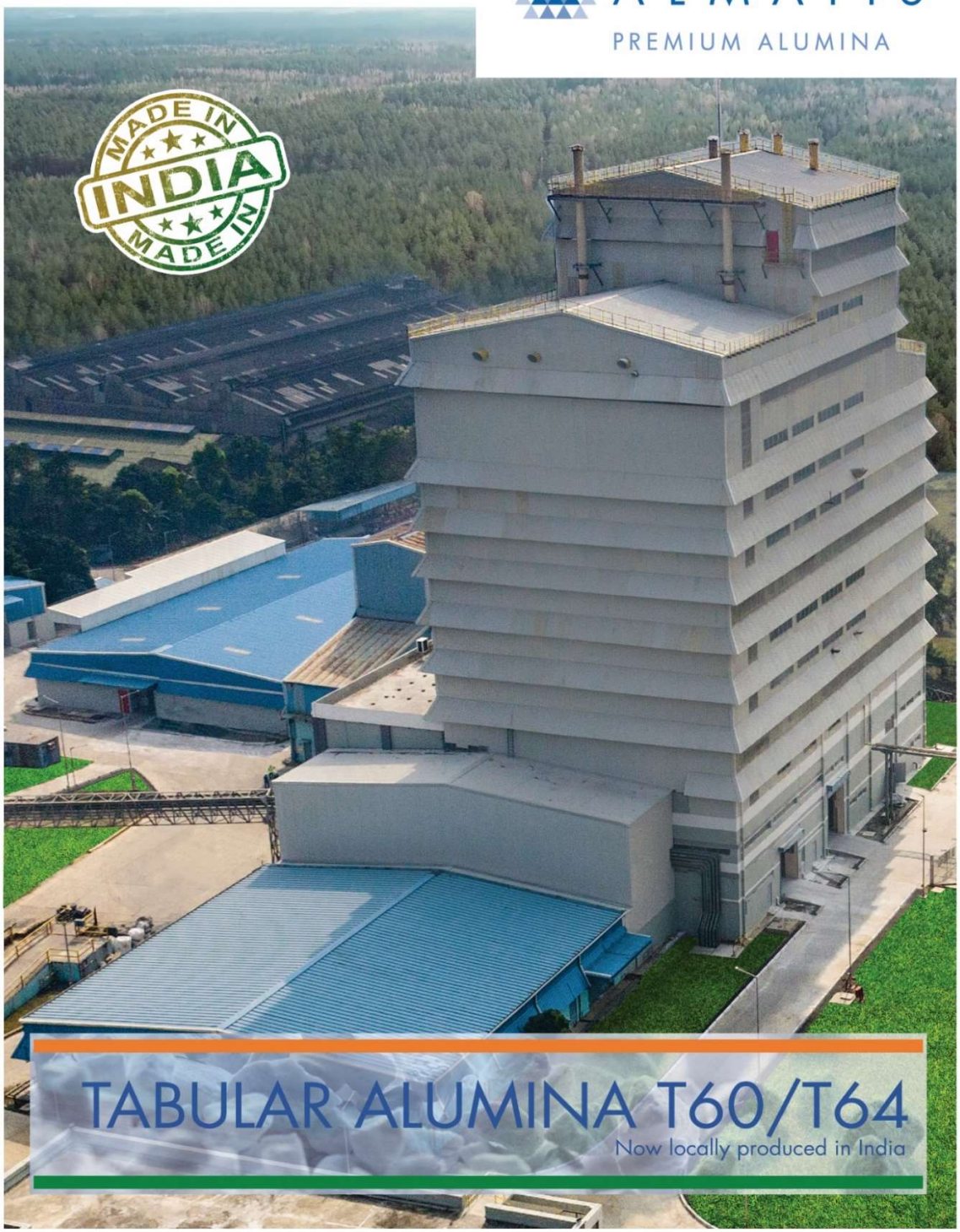

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