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

PRESENT AFFILIATION	**RND MANAGER AT DALMIA BHARAT REFRACTORIES LIMITED**
AREAS OF INTEREST	
Education	**B.Sc Chem (Hons)** **B Tech (Ceramics)**
Experience	**• 10 years**
Projects:	
Publication/ Patent	1.New generation Burnt Alumina-magnesia Spinel brick for Ladle Metal Zone - Avishek Mitra, K.B.Panda, Birendra Prasad, S.K.Hazra,Ingo Gruber in ICRJ 2019, Jamsedpur, India 2. Development of Burnt Alumina-magnesia-Spinel brick for Steel Ladle Lining - Avishek Mitra, S.K.Hazra, Birendra Prasad, Ingo Gruber, Shankha Chatterjee in UNITCER 2019, Yokohama, Japan 3. Effect of different additives on the grain growth of Magnesia Spinel brick - Avishek Mitra, Dr. PR Rauta, S.K.Hazra, Birendra Prasad in InTeC 2019, Thiruvananthapuram, India 4. Improvement of properties and performance of Rebonded Magnesia Chrome Bricks for RH Snorkel - Avishek Mitra, S.K.Hazra in UNITCER 2022, Chicago, USA 5. Variation of elastic properties of Magnesia Spinel bricks with varying percentage of spinel for Cement Rotary kiln - Avishek Mitra, PR Routa, S.K.Hazra in ICR 2022, Aachen, Germany 6. Development of creep resistant Magnesite checker brick for glass tank furnace regenerator - Avishek Mitra, SK Hazra, Glass International 2021 7. A Case Study - Life Enhancement of RH Snorkel through improved quality of Rebonded Magnesia Chrome Bricks - Avishek Mitra, K.B.Panda, Birendra Prasad, S.K.Hazra,Ingo Gruber in ICRJ 2022, Jamsedpur, India

A CASE STUDY - USE OF RECYCLED MATERIAL IN RH DEGASSER LOWER VESSEL MAGNESIA CHROME BRICK

Avishek Mitra, Sanat Hazra

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- Introduction
- Recyclate Material Analysis
- Trials
- Field trial
- Conclusion

INTRODUCTION

RH degasser is one of the best among various secondary refining process due to its high refining efficiency and productivity.

The refractory lining in the RH vessel and snorkels are subjected to severe operating conditions due to

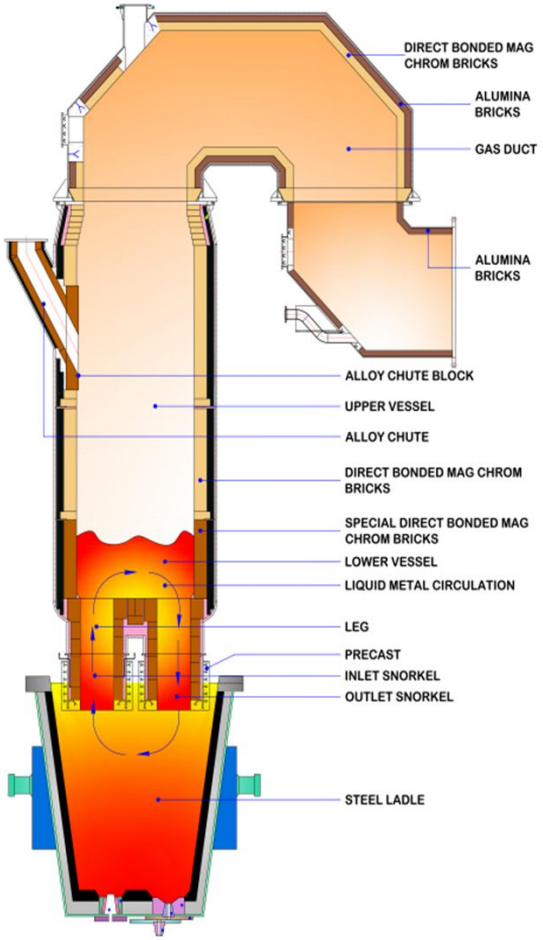
i.high speed liquid steel circulation between the RH vessel and ladle,
ii.chemical reaction in the RH vessel,
iii.temperature fluctuation,
iv.oxygen blowing and vacuum conditions inside.

INTRODUCTION

Due to operating conditions as stated, highest wear is observed in the area of snorkel and lower vessel.

Usually, various types of MgO-Cr_2O_3 bricks are used in different areas of the vessel because of their

i.excellent resistance to erosion and corrosion,
ii.high temperature stability,
iii.low thermal expansion
iv.high hot strength.



INTRODUCTION

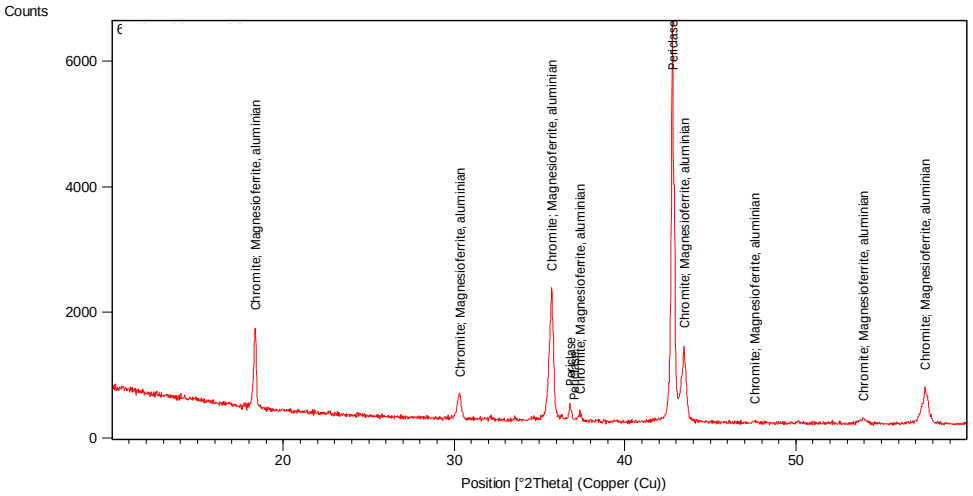
The recycling of the used refractories is currently gaining in importance for both economic and ecological reasons, such as

- Increased prices for raw material,
- Dependence on raw material supplies
- Need to reduce CO_2 emissions and energy consumption.

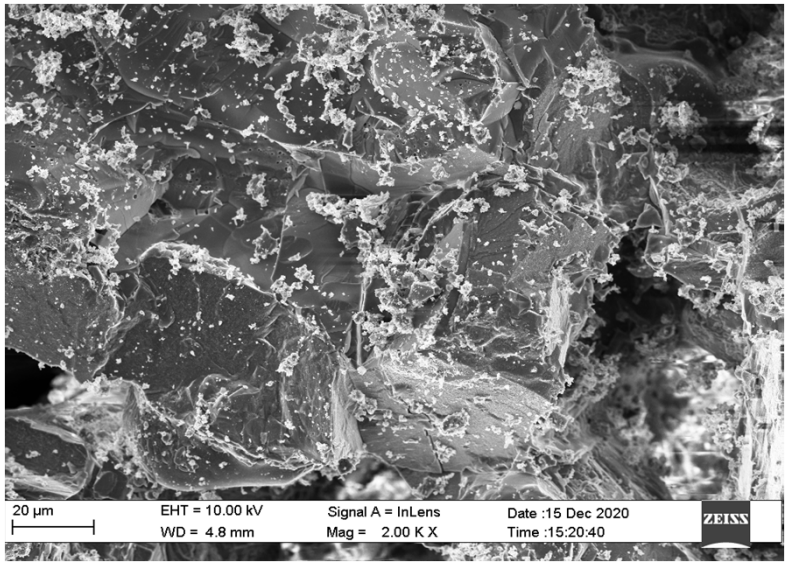
Recycled Magnesia Chrome refractories are used in land-filling at various sites. However, the highest benefit can be achieved when they are used as secondary raw materials for the production of refractories.

RECYCLATE ANALYSIS REPORT

MgO (%)	SiO_2 (%)	CaO (%)	Al_2O_3 (%)	Fe_2O_3 (%)	Cr_2O_3 (%)
65.80	1.20	1.15	6.20	7.00	18.10



XRD of Recyclate MCR65
Phases found - Periclase, Chromite, Magnesio-ferrite



FESEM micrograph of Recyclate MCR65

TRIAL BATCHES

Raw Materials	RS	T-1	T-2	T-3	T-4	T-5
FMCR	85	75	65	55	45	35
Chromite	15	15	15	15	15	15
MCR65		10	20	30	40	50

The set of trial samples were

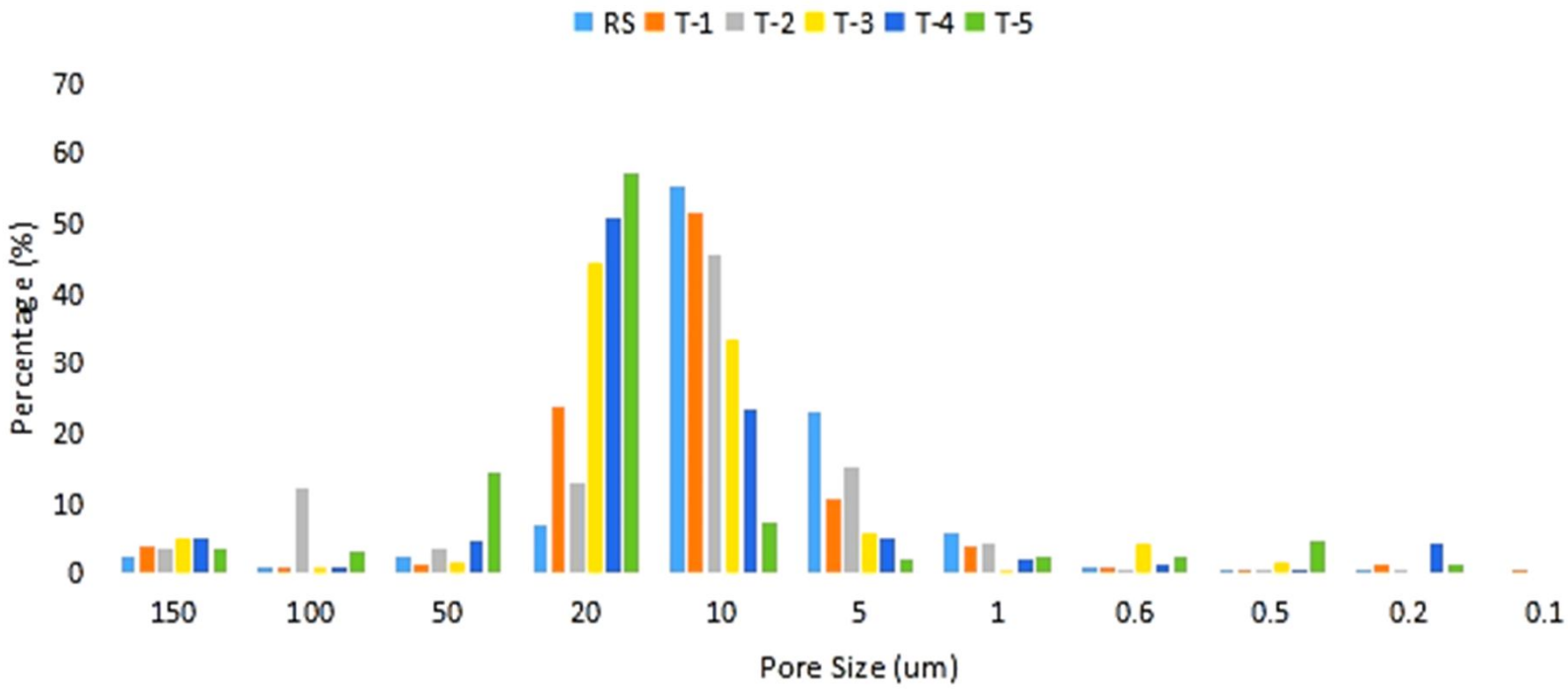
- shaped into bricks by using industrial hydraulic press with a specific pressure of 1.8 Ton/cm^2
- The samples were dried at 110 ° C for 24 hrs and then at 160 ° C for another 24 hrs.
- The samples were fired at 1800 ° C with predetermined heating schedule and soaking time in high temperature tunnel kiln.

PROPERTIES

Properties	RS	T-1	T-2	T-3	T-4	T-5
AP (%)	16.5	16.8	16.9	17.1	18.8	20.4
BD (gm/cc)	3.26	3.25	3.25	3.24	3.21	3.18
CCS (kg/cm^2)	649	668	579	592	523	501
HMOR (kg/cm^2)	87	85	82	81	72	56

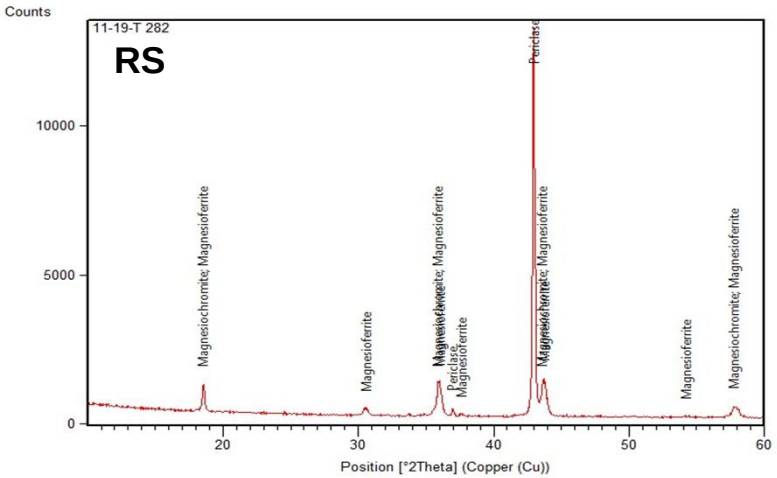
- With 30% usage of recyclate material, T-3 shows properties closer to RS.
- The physical as well as hot properties starts to detoriate in T-4 and T5.
- With 50% recyclate material addition, the HMOR value is almost 35% lesser than that of RS

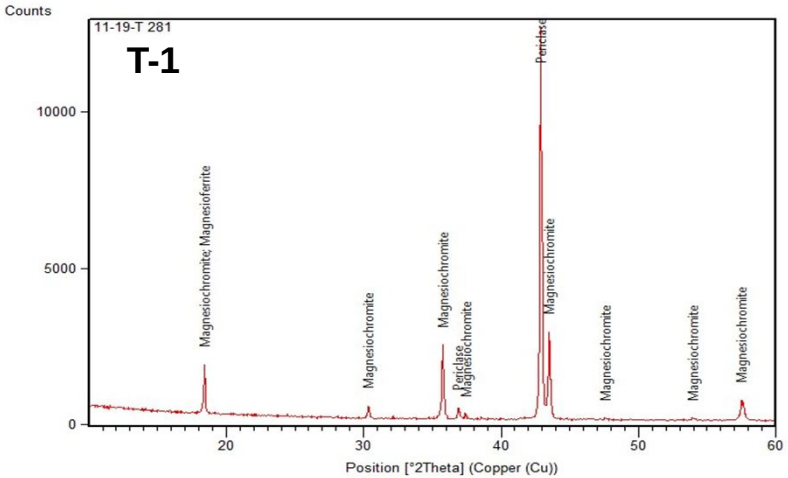
PROPERTIES - PSD

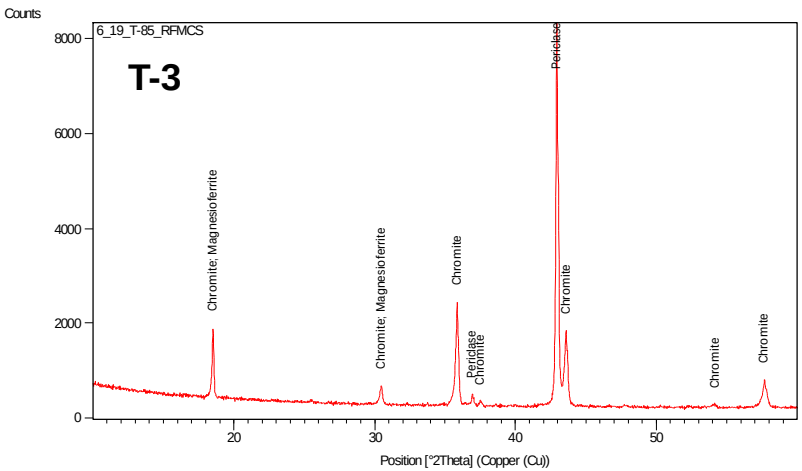


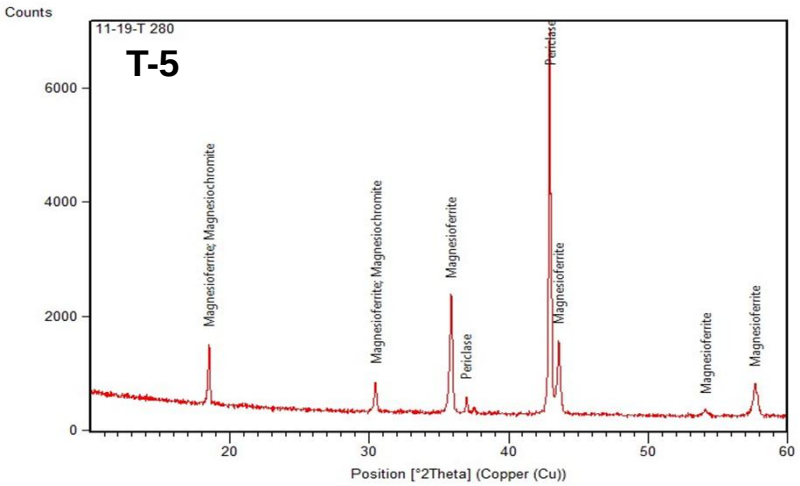
Trail No	Median pore diameter (µm)
RS	1.62
T-1	1.64
T-2	1.67
T-3	1.69
T-4	1.88
T-5	1.94

PROPERTIES - XRD

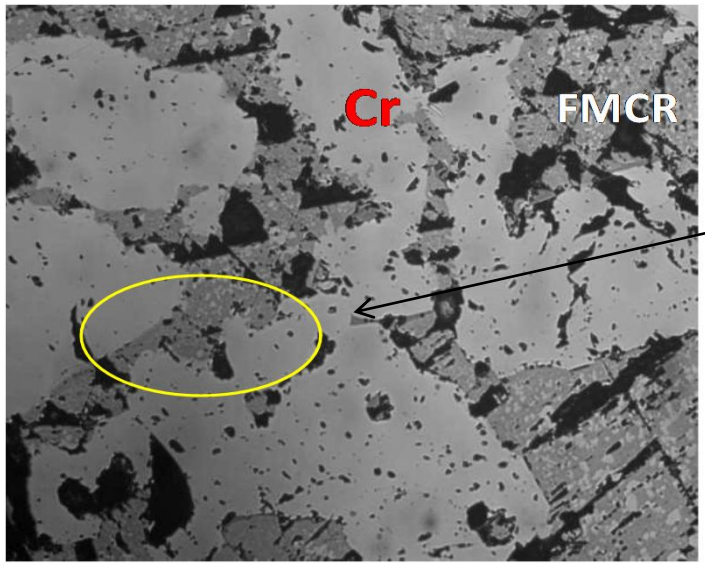






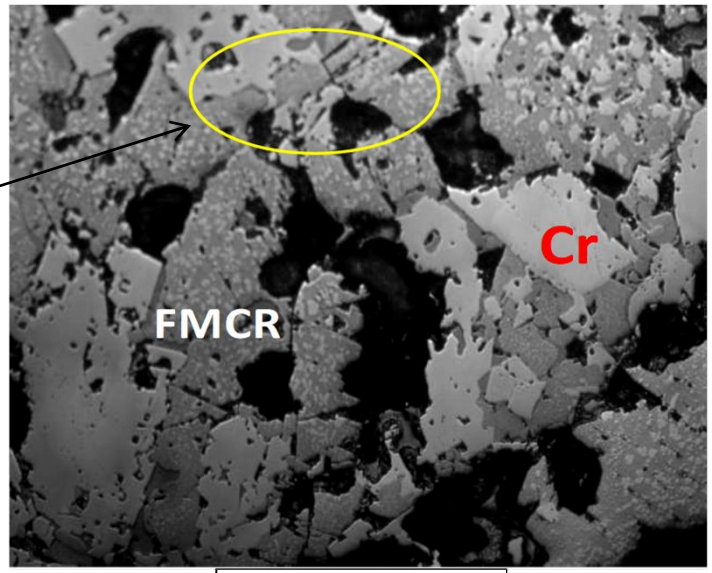


PROPERTIES - XRD

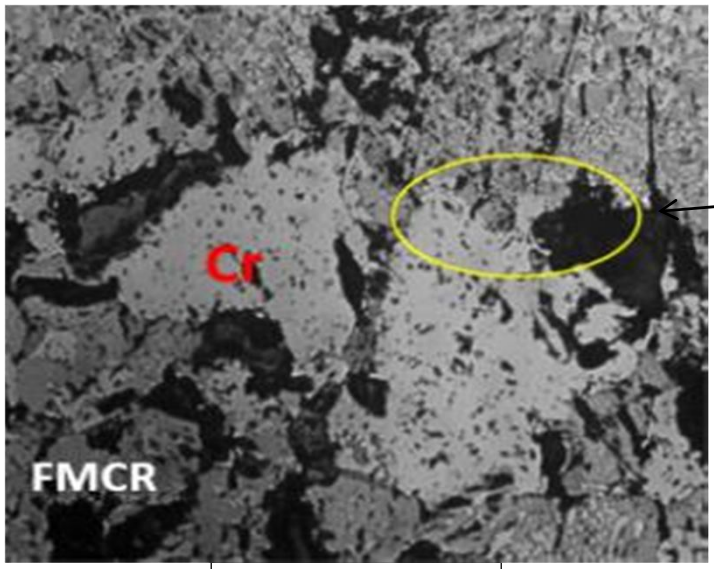


Microscopy of RS

Direct Bonding

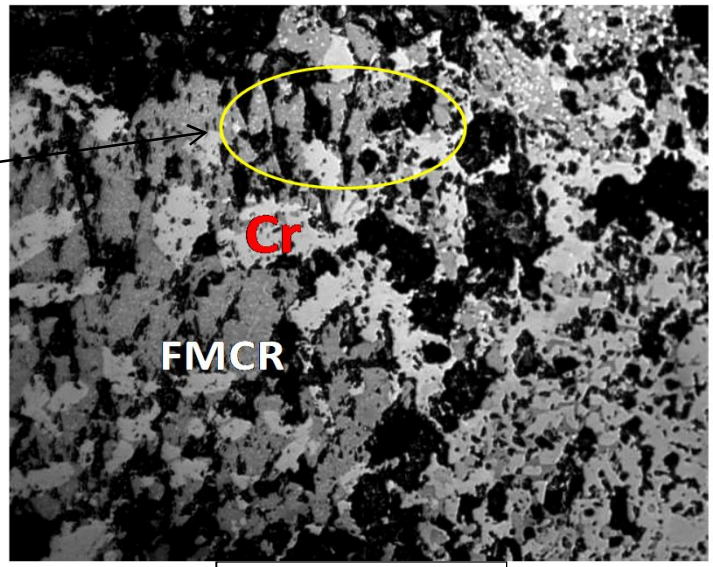


Microscopy of T-1



Microscopy of T-3

Direct Bonding



Microscopy of T-5

PROPERTIES - ROTARY DRUM TEST

➢ Simulative test conducted after lining in rotary drum apparatus and firing with LPG, Oxygen at 1650^{o}C along with Synthetic slag and steel for 6 hrs.

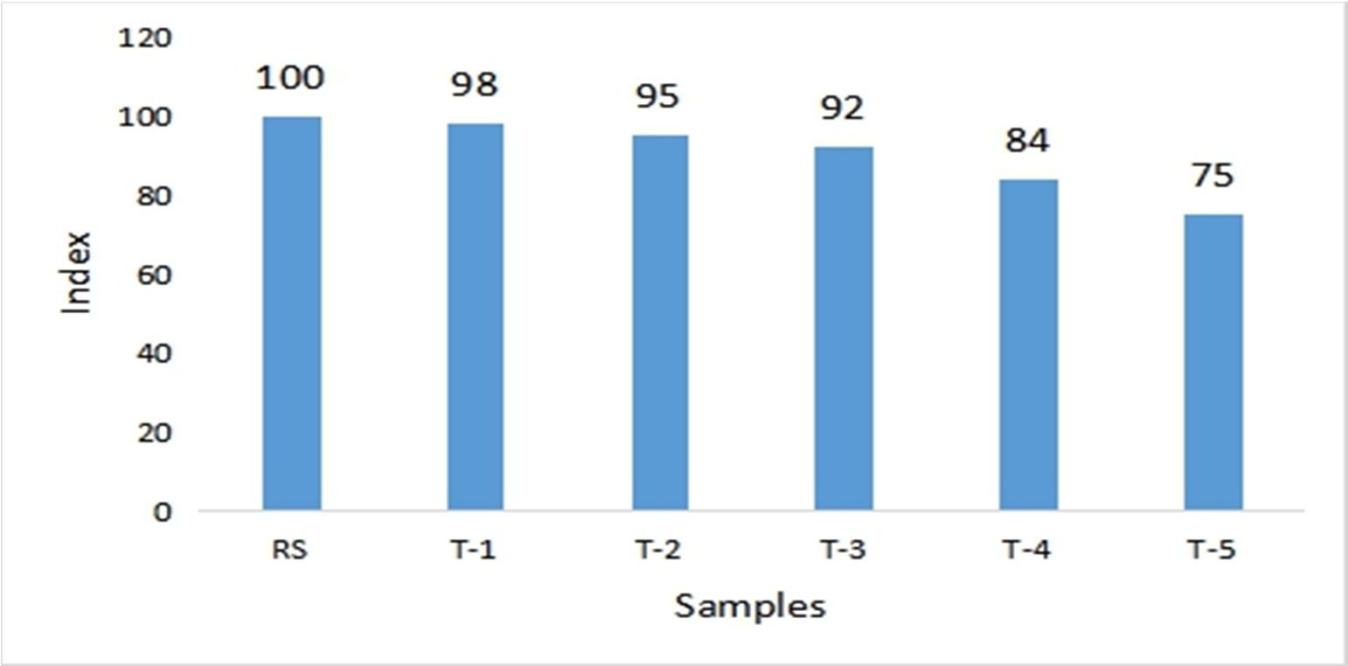
➢ Sample is taken out after cooling and moulded in plaster mould.

Chemistry (Wt%) of Synthetic slag

CaO	Al_2O_3	MgO	Fe_2O_3	SiO_2	MnO
56	29	5	2	6	1.5

Rotary Drum Equipment

PROPERTIES - CORROSION RESISTANCE



T-3 is showing corrosion resistance almost similar to RS

PROPERTIES - CORROSION RESISTANCE

Main passage of slag - Pore, Crack and Grain boundary

$$L = [(r.\sigma.t.\cos\theta) / 2\eta]^{\wedge 0.5}$$

where,
L - penetrating distance of slag
r - average pore radius of refractory
σ - surface tension of slag
t - penetrating time of slag
θ - contact angle between refractory and slag
ŋ - viscosity of slag

So from the above equation, as the pore diameter increases in the trial samples, the corrosion resistance deceases.

- In Plant A where the RS bricks were being used in RH lower vessel was giving life around 80-85 hts and after the total life, the left over thickness (LOT) was around 120-130 mm.
- 5 sets of RH bricks with formulation T-3 was sent to Plant A and average life achieved 83 hts DIDO with a highest life of 87 hts.
- The used bricks were collected and the LOT was found around 100 mm and the penetration was also very less.

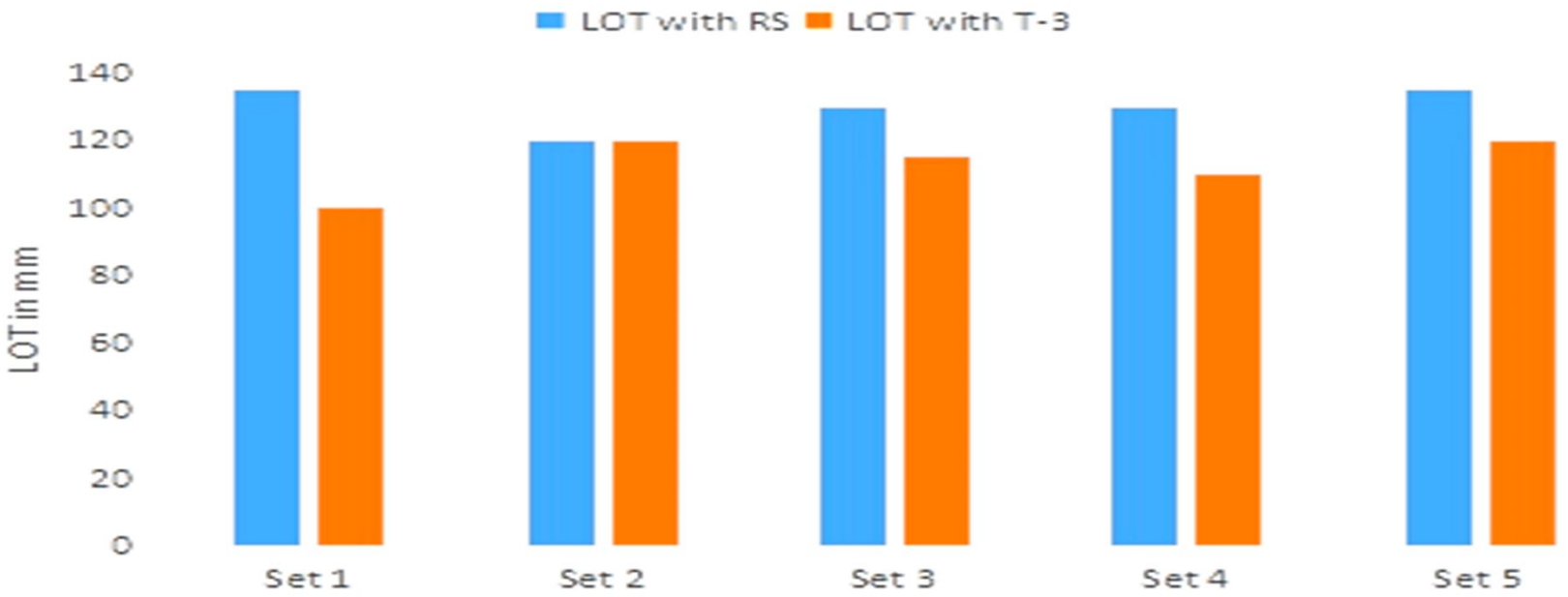
	RS	**T-3**
RH Lower vessel at Plant A	37	5
Average Life (hts)	85	83
Average LOT (in mm)	120	100

FIELD TRIAL

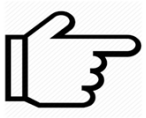
Sl No	RS		T-3	
	LOT (mm)	After hts	LOT (mm)	After hts
1	120	87	102	82
2	127	83	107	87
3	115	85	109	85
4	130	86	107	82
5	118	85	101	81

RS after use

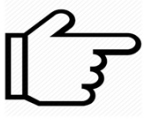
T-3 after use



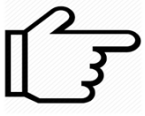
CONCLUSION



We have tried to correlate and compare characteristics and wear mechanisms of magnesia chrome bricks with varying recyclate materail by evaluation of thermo-mechanical properties



Presence of 30% recyclate material showed similar physical and thermo-mechanical propoerties to that of 100% virgin material based bricks.



This trial sample with 30% recyclate material was used in Plant A and the result found was almost similar with that of 100% virgin sample.

REFIS 4.0

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Bokaro Steel City Jharkhand India

2022

THANK YOU

Dalmia OCL