Presenter Name: SANDIPAN SEN

Paper name: AN OVERVIEW OF STEEL LADLE AT DURGAPUR STEEL PLANT

PRESENT AFFILIATION	**Senior Manager, Refractory Department, SAIL – DSP**
AREAS OF INTEREST	**Refractory characterisation**
Education	**B. Tech. in Ceramic Technology from Government College of Engineering and Ceramic Technology, Kolkata**

Experience	• **ESSAR Steel Limited (June'2008 – August'2010)**
	  • Experience in 150 Ton DC EAF, Steel Ladle, Tundish, RH Degasser at SMS- 1.
	• **Central Glass & Ceramic Research Institute (March'2011 – March'2012)**
	  • Experience in development and characterization of high density, high strength, corrosion registrant Al2O3-Cr2O3 refractory, effect of TiO2
	• **Steel Authority of India Limited – DSP (April'2012 – till date)**
	  • Experience in HM Mixer, 130 Ton Converter, Steel ladle, Tundish, VAD unit, Annular Shaft Kiln (NLCP), Dual Shaft Kiln (NDK) Refractory Procurement, Inspection, Job contract, Audit, MIS

Projects:	• **Full relining of NLCP Kilns in DSP** • **Introduction of Dolomite Refractory in DSP**
Publication/ Patent	• **Densification behaviour and properties of alumina–chrome ceramics: Effect of TiO2** (Ceramic International, V-39, I-1, 2013; ISSN: 0272-8842) • **Introduction of Dolomite Refractory in Steel Ladle Lining** (Strides – DSP, V-5, April'20)

AN OVERVIEW OF STEEL LADLE AT DURGAPUR STEEL PLANT

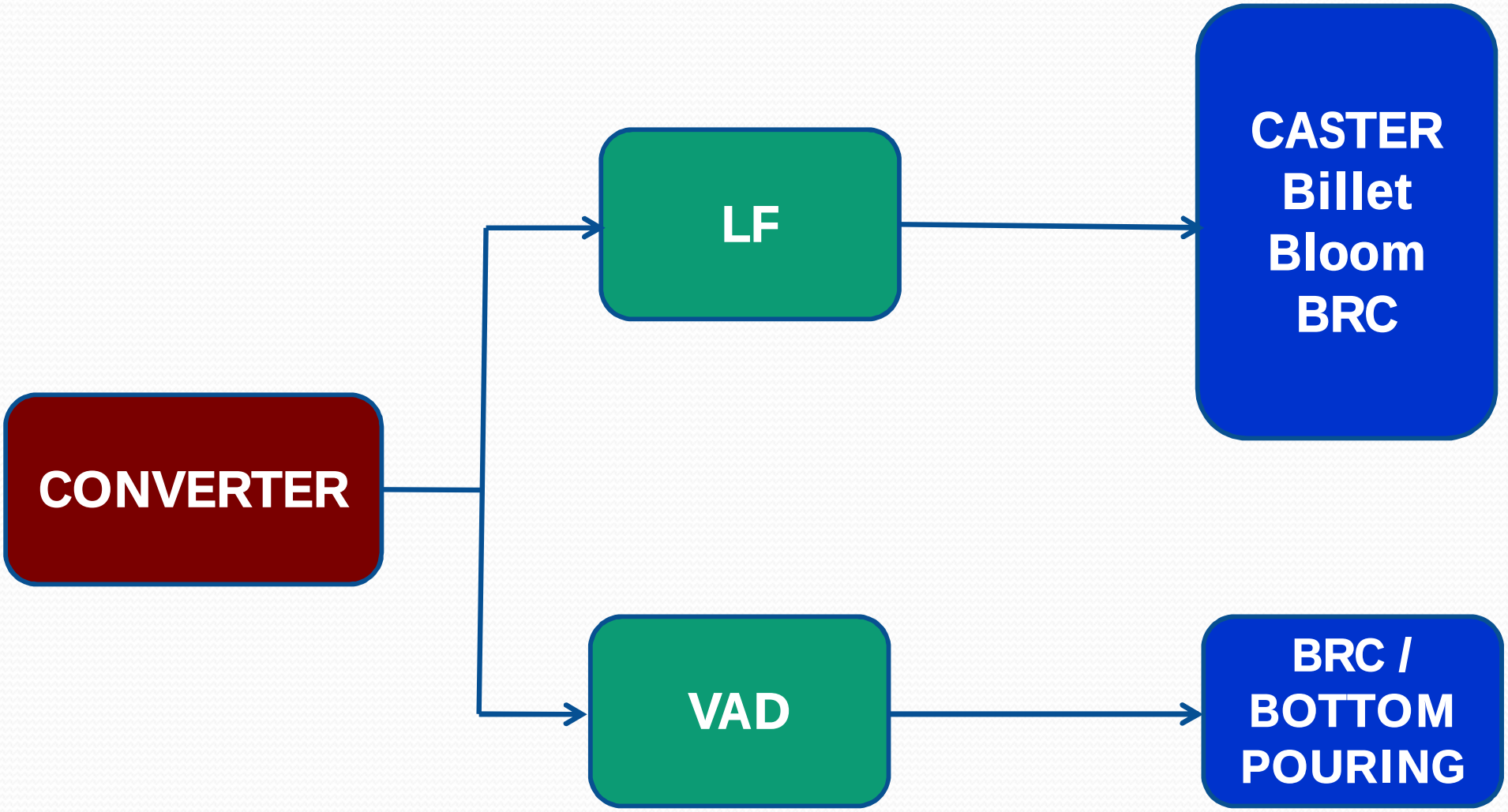
Presented by

Niral Topno (SMS**)**
Sandipan Sen (Refractory**)**

Facilities available in BOF shop

- **Mixer : 2 no. of 1300 T**
- **Converter : 3 no. of 110/130 T with Bottom purging**
- **Ladle : 36 in steel/VAD route**
- **LF : 3 no. of 130 T**
- **VAD : 1 no. of 130 T**
- **Caster : 2 no. of Billet caster**
  1 no. of Bloom Caster
  1 no. of Bloom cum Round Caster
- **Annular Shaft Kiln: 3 nos. for Lime calcination (300 TPD)**
- **Dual Shaft Kiln : 1 no. for Dolomite calcination (300 TPD)**

Process Flow Diagram



Steel Ladle lining practice

PARAMETERS	AREA					
	WALL				BOTTOM	
	METAL ZONE		SLAG ZONE			
	SAFETY	WORKING	SAFETY	WORKING	SAFETY	WORKING
QUALITIES	70%LMC & 39%Al2O3 bricks & MCH	Mag Carbon	70%LMC & 39%Al2O3 bricks & MCH	Mag Carbon	70% LMC & MCH	MagCarbon with AMC in impact pad
THICKNESS(mm)	65 & 50	178	65 & 50	178	100 & 65	250
APPROX. WEIGHT(Ton)	10	14	6	6	4	3
Approx. AVG.LIFE(HEAT)	LMC: 3 campaigns Rest renewable	70-73	LMC: 3 campaigns Rest renewable	42-44	LMC: 3 campaigns Rest renewable	42-44

Functional Refractories

- Slide gate system : FLOCON 6300 Series – II
  Bore Dia. 50mm
- Teeming block : 2 pcs. of 90% Al_2O_3 ULCC PCPF quality
  Height of Teeming Block: 425 mm
- Inner Nozzle : 90% Al_2O_3 ULCC PCPF quality / MgO-C quality
  Length of I/N: 278 mm
- Outer nozzle : 90% Al_2O_3 ULCC PCPF quality
- Purging system : IPV
- Seating block : Single / 2pcs. of 90% Al_2O_3 ULCC PCPF quality
  Height of Seating Block: 450 mm
- Type of Porous Plug : Directional Plug
- Porous plug length : 360 mm

Operational Parameters For LF

- LF heat size : 120 T
- Converter Tapping Temp. : 1640° – 1680° C
- Ladle temp. after tapping : 1570° - 1620° C
- Ladle temp. after LF :

  For Billet : 1610° – 1620° C (for 1st heat in VM tundish)
  1585° – 1600° C (for sequence heat)

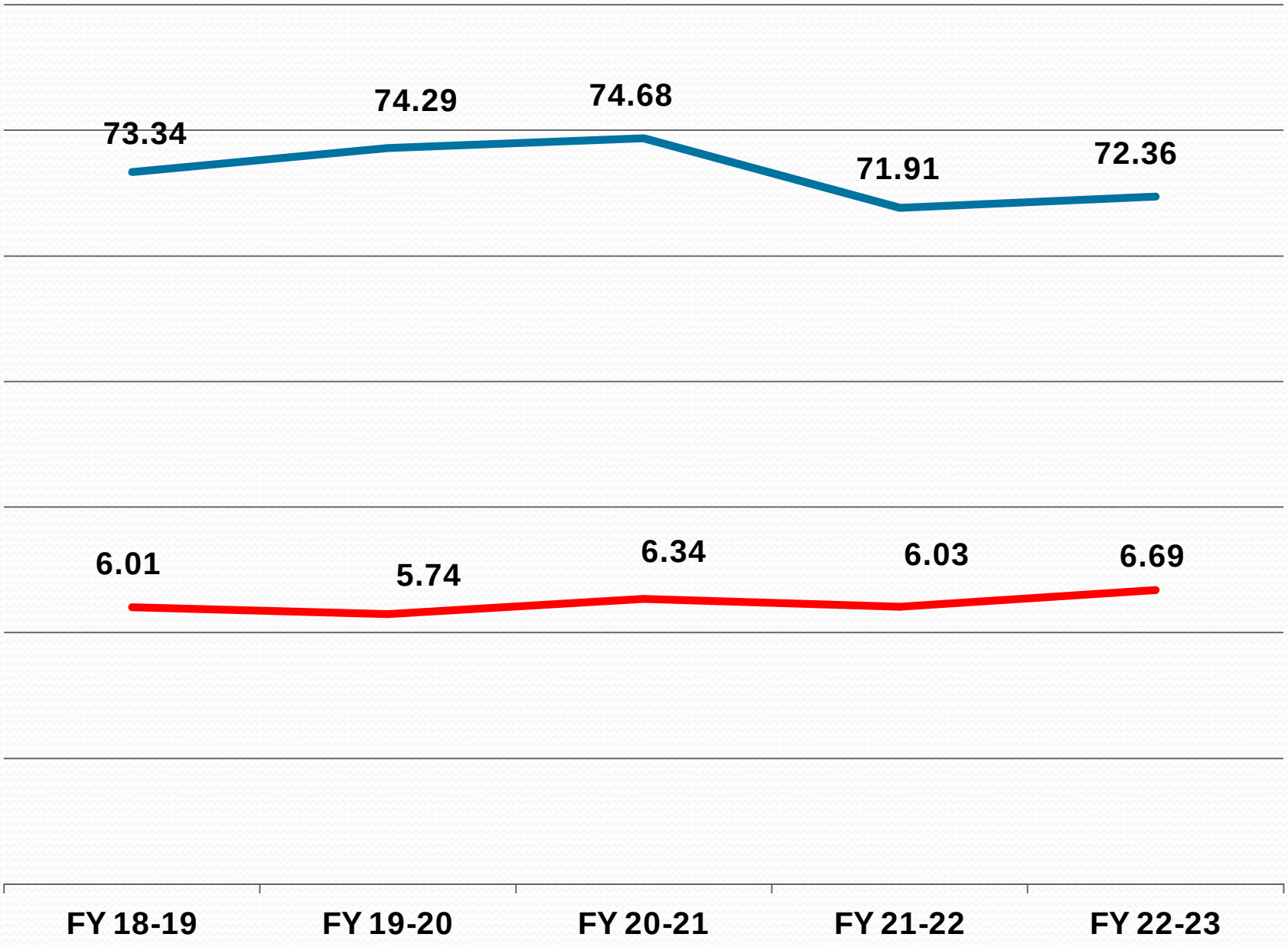
  For Bloom: 1615° – 1620° C (for 1st heat)
  1585° – 1600° C (for sequence heat)

- Avg. treatment time : 40 mints.
- Avg. Arcing time : 20 mints
- Purging : Continuous @ 10 - 12 bars
- Avg. No. of heats/ day through LF : 100% except VAD heat

Operational Parameters For VAD

- VAD heat size : 110T
- Ladle temp. before VAD : 1600 - 1610^0 C
- Treatment time : Avg. 160 mints.
- Arcing time : Avg. 45 mints
- Purging : Continuous @ 10 - 12 bars
- Vacuum during arcing : 550 - 750 mili bar
- Vacuum during deep degassing : <5 mili bar
- No. of heats/ day : 4 heats (Avg.)

Techno-economic parameters for Steel Ladles



Factors affecting the ladle life

- ***THERMO MECHANICAL WEAR AND SPALLING***: Thermo-mechanical wear and spalling is caused by stresses, generated by thermal expansion or mechanical shocks; resulting cracks in the microstructure of bricks.

- ***LADLE TREATMENT***:
  - *Stirring/Purging*: High flow rate of gases through purging plug (sometimes) causes abrasion/erosion of ladle wall.
  - *Arcing & Purging:* Any mismatch in purging rate w.r.t. arcing leads to high erosion in slag belt.
  - *Power input*: Higher arcing period resulting more erosion of bricks.
  - *Slag carry over*: More carry over slag leads to jam formation in top ring.
  - *Slag composition*: Lower Slag basicity (< 1.5) leads to higher erosion of refractories. Low MgO content in slag directly affects MgO – C lining.

Factors affecting the ladle life

- Quality of lime: Poor quality of lime (reactivity < 280) ultimately affecting the ladle life.
- *Process time*: Holding of liquid steel at high temperature under vacuum increases refractory erosion rate.

- ***PREMATURE TOP RING FAILURE***: During cleaning of top skull by anchor hook, brick joints become loose and get dislodged from the top.
- ***OVER HEAT SIZE***: Damages the free board lining and lead to premature failure of ladles.
- ***HANDLING OF BRICKS***: Corner breakage, due to mishandling, leads to joint exposure, through which metal penetration may occur.
- ***PREHEATING AND HANDLING OF GREEN LADLES***: Green ladles must be handled with proper care to avoid any dislodging of bricks with proper preheating.

Slag Analysis at LRF

FY	FeO	CaO	SiO2	Al2O3	MnO	MgO	CaO/SiO2
2018-19	1.95	51.41	26.59	6.11	2.44	8.63	1.93
2019-20	4.65	49.99	27.47	3.95	2.49	8.47	1.82
2020-21	1.99	50.79	28.71	6.70	2.09	6.37	1.77
2021-22	3.45	50.04	26.91	4.38	3.21	9.38	1.86
2022-23 (till Aug'22)	2.51	50.91	26.93	3.97	3.55	9.68	1.89

Developmental Activity

- ✓ Replacement of I/N in hot condition at a life of 20 – 25 heats.
- ✓ Replacement of ladle top shell in periodic manner.
- ✓ Stabilization of double porous plug resulting in uniform purging and less localized erosion in slag zone lining.
- ✓ Use of slag modifier in ladle.
- ✓ Quality modification of free board lining from MCH quality to MCB quality
- ✓ Stabilization of Dolomite ladle sets as alternate material of MgO-C ladle sets.

Future targets

- ✓ To achieve Avg. Steel Ladle life of 80 heats (short term goal), and to increase the same to 100 heats (long term goal)

- ✓ Introduction and stabilization of Steel Ladle Sets on Total Ladle Management (TLM) basis.

Thank you