Impact of Raw Material Quality in Coke & Iron Making

India – Mongolia Coal Webinar, 10th Feb'21
Coal Preparation Society of India

Debaprasad Chakraborty
Chief Raw Material Technology Group

Built on **Jamsetji's vision**

To be the **global steel** industry benchmark for
VALUE CREATION and **CORPORATE CITIZENSHIP**.

GLOBAL Presence

Manufacturing operations in **26 countries**

Commercial presence in **50 countries**

A **Fortune 500** Company

A GLOBAL CONGLOMERATE

11th largest steel producer in the world (crude steel capacity)

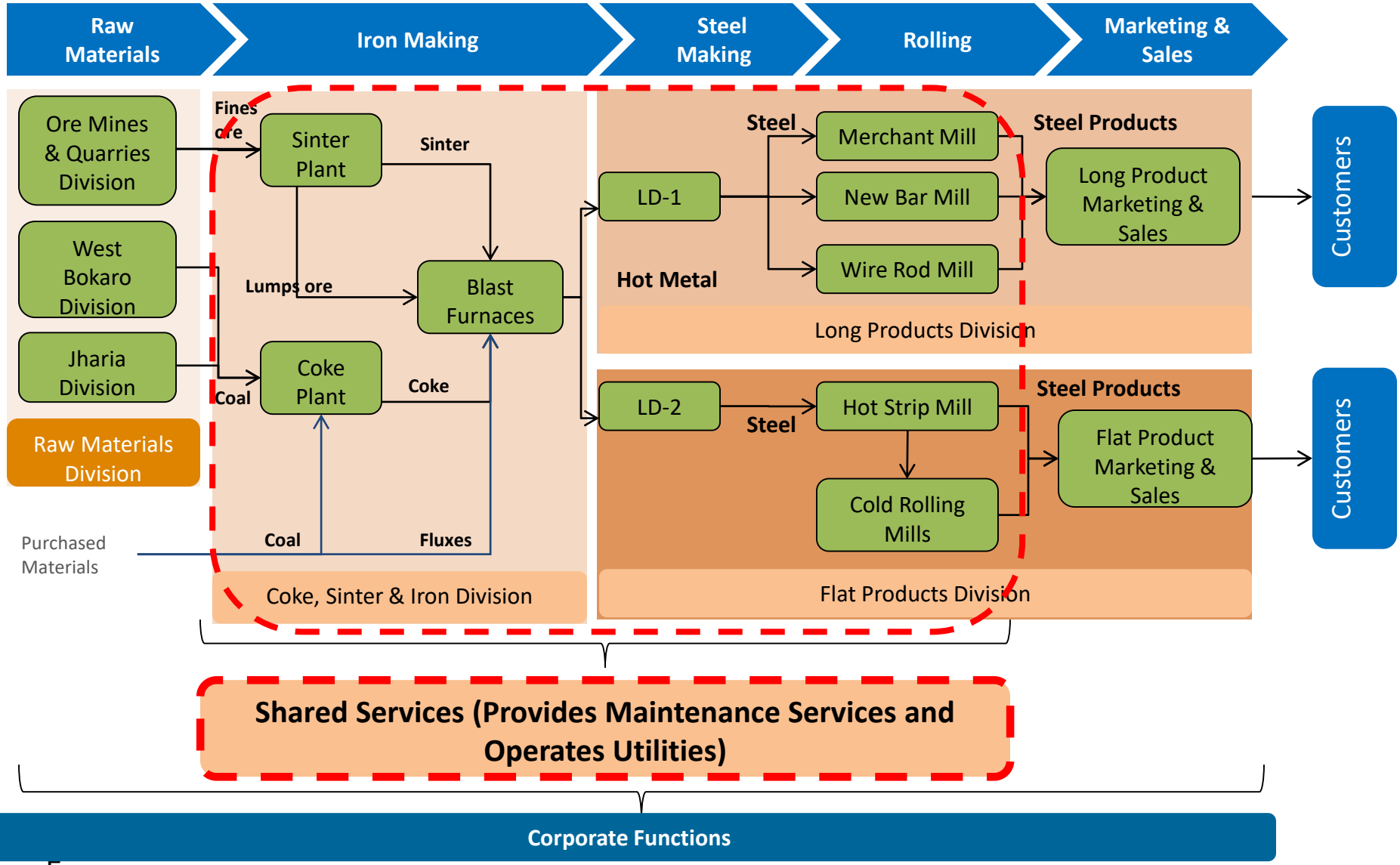
33 MnTPA
annual crude steel capacity

>65,000 employees
spread across 5 continents

₹157,669 cr
consolidated turnover

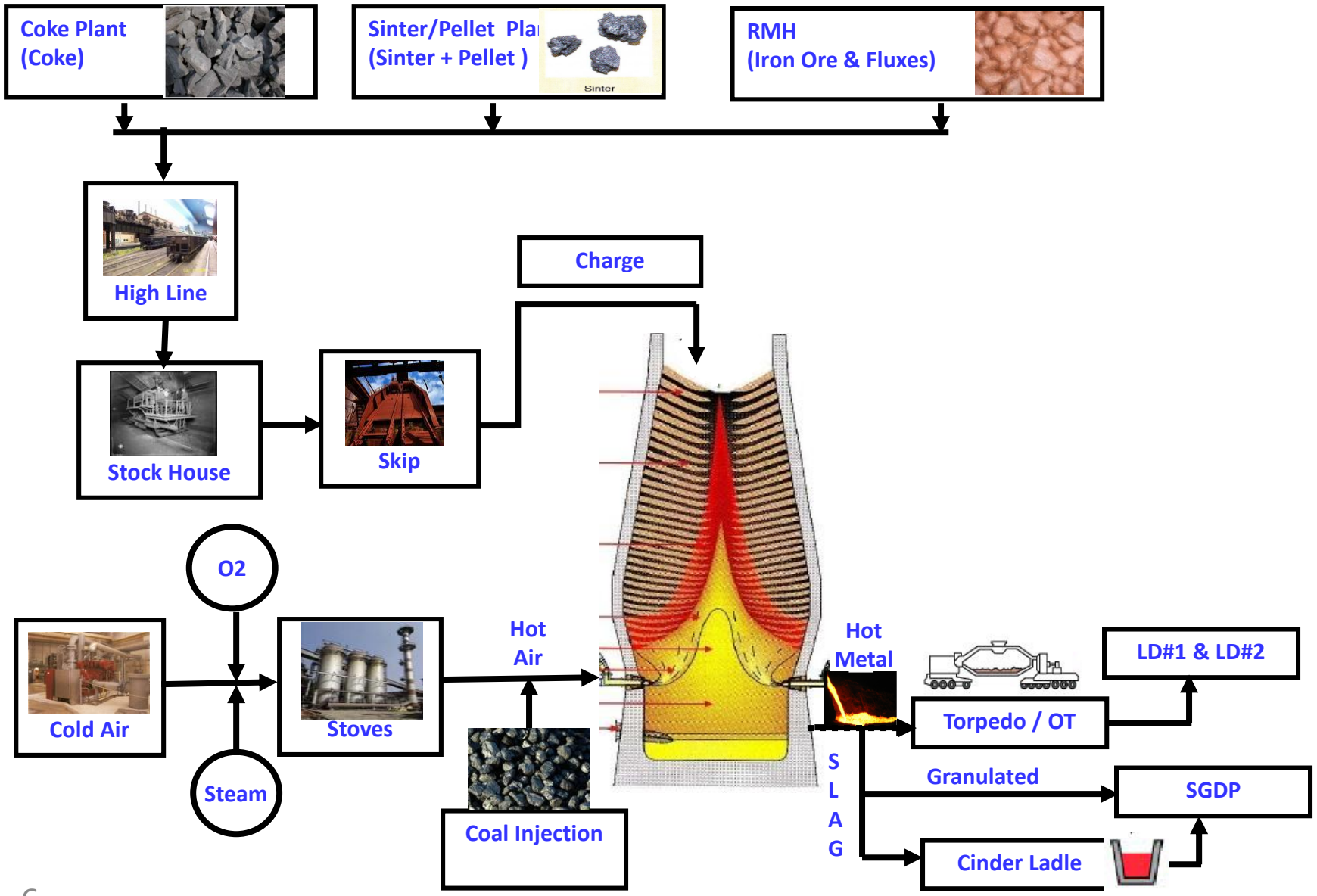
(As of March 31, 2019)

Tata Steel India – Operations

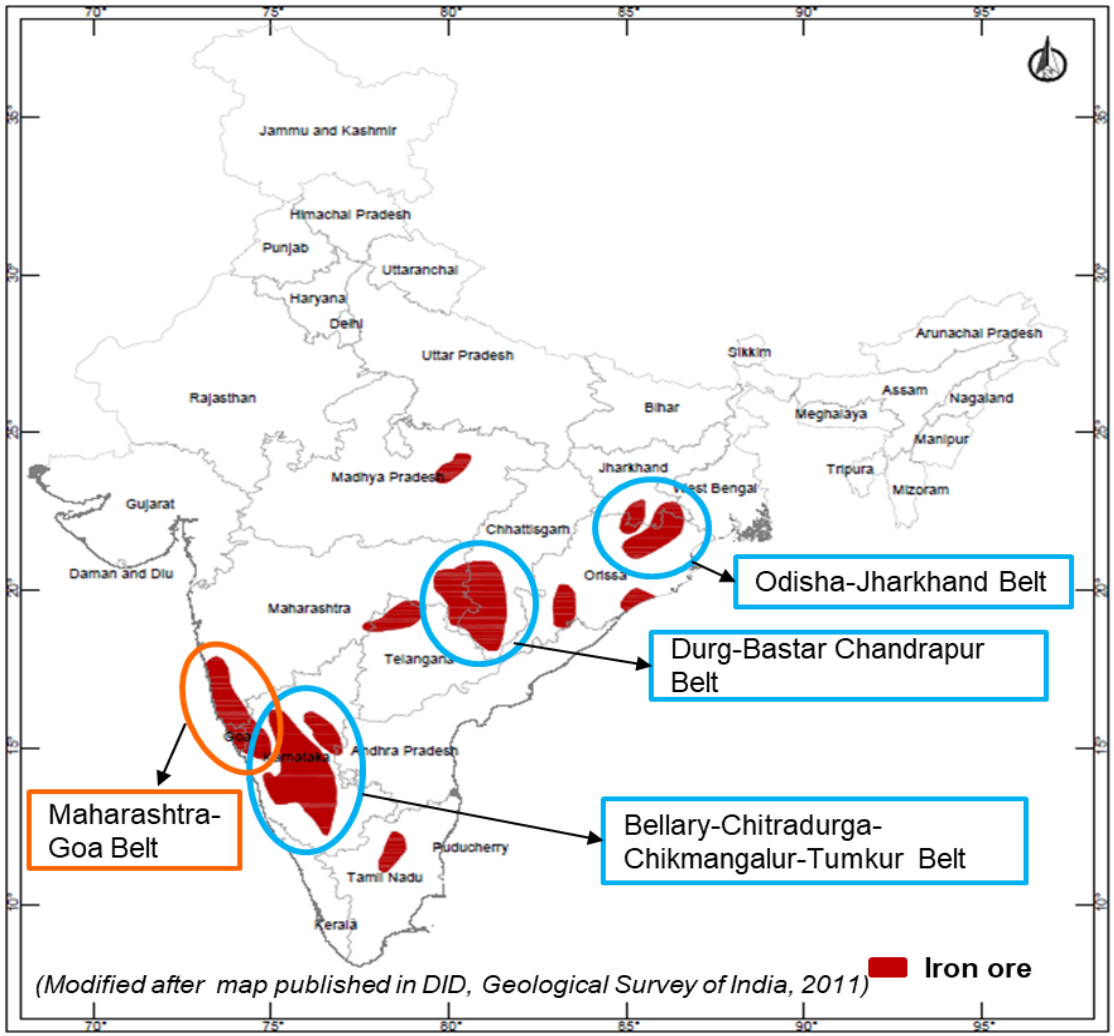


TATA STEEL
#WeAlsoMakeTomorrow

Iron Making



Indian Iron Ore Occurrence : Geological Distribution



Occurrence of Hematitic Ore- Statewise		
State	**Reserve (MT)**	**Wt%**
Odisha	3313	**41**
Jharkhand	2304	**29**
Chhattisgarh	900	11
Karnataka	877	11
Andhra Pradesh	152	2
Goa	470	6
Total	8016	100

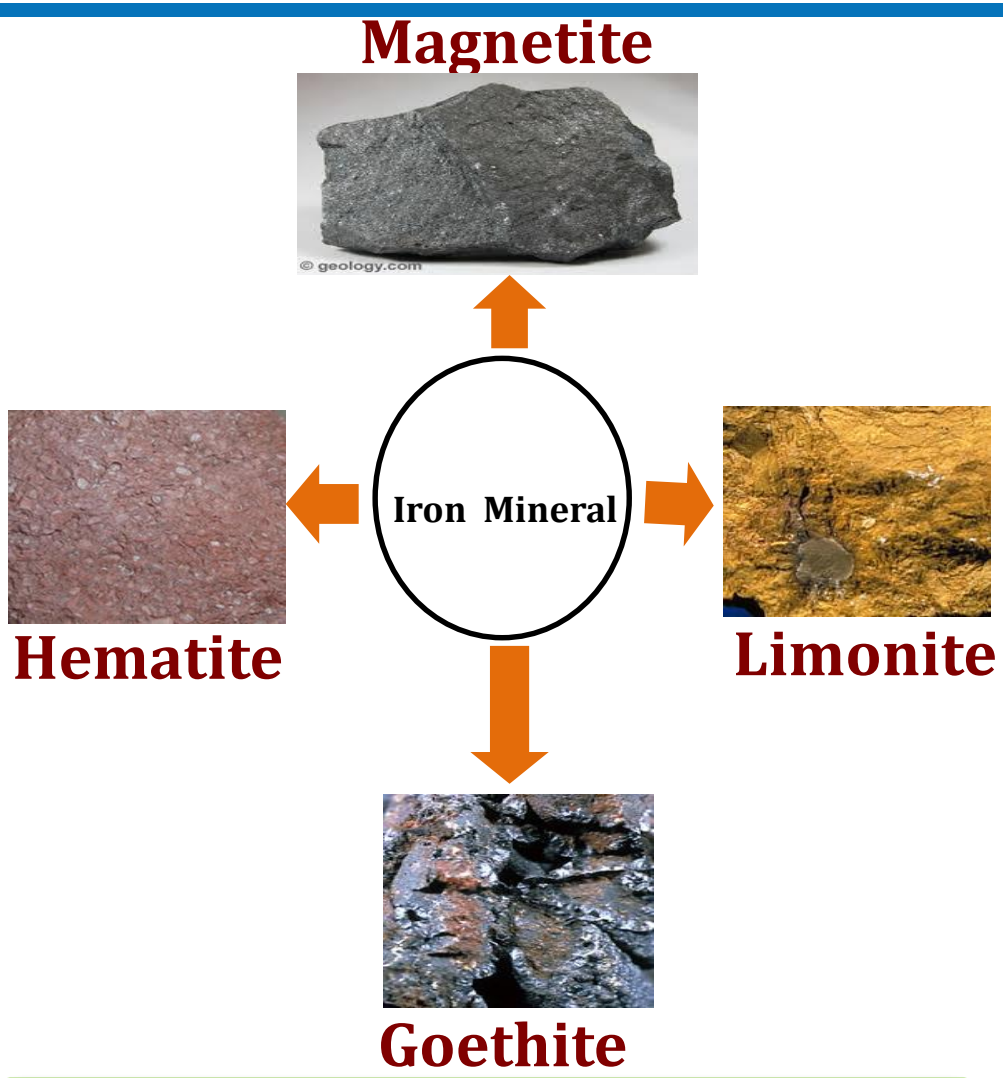
(Source: National Mineral Inventory as on 1.04.2010 presented in IBM Mineral Year Book, 2014)

70% of hematitic iron ore reserve is from Odisha-Jharkhand

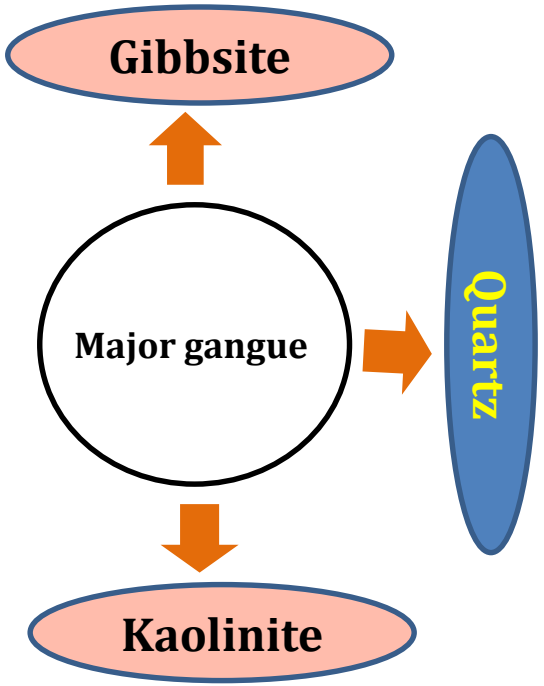
Iron ore Deposits- Ferruginous nature

Iron ore Deposits- Siliceous nature

Type of Iron Ore Deposits



Minerals	Composition	Fe %
Magnetite	Fe_3O_4	63% - 71%
Hematite	Fe_2O_3	58% - 69%
Limonite	$FeO(OH).nH_2O$	40% - 58%
Goethite	FeO(OH)	50% - 62%



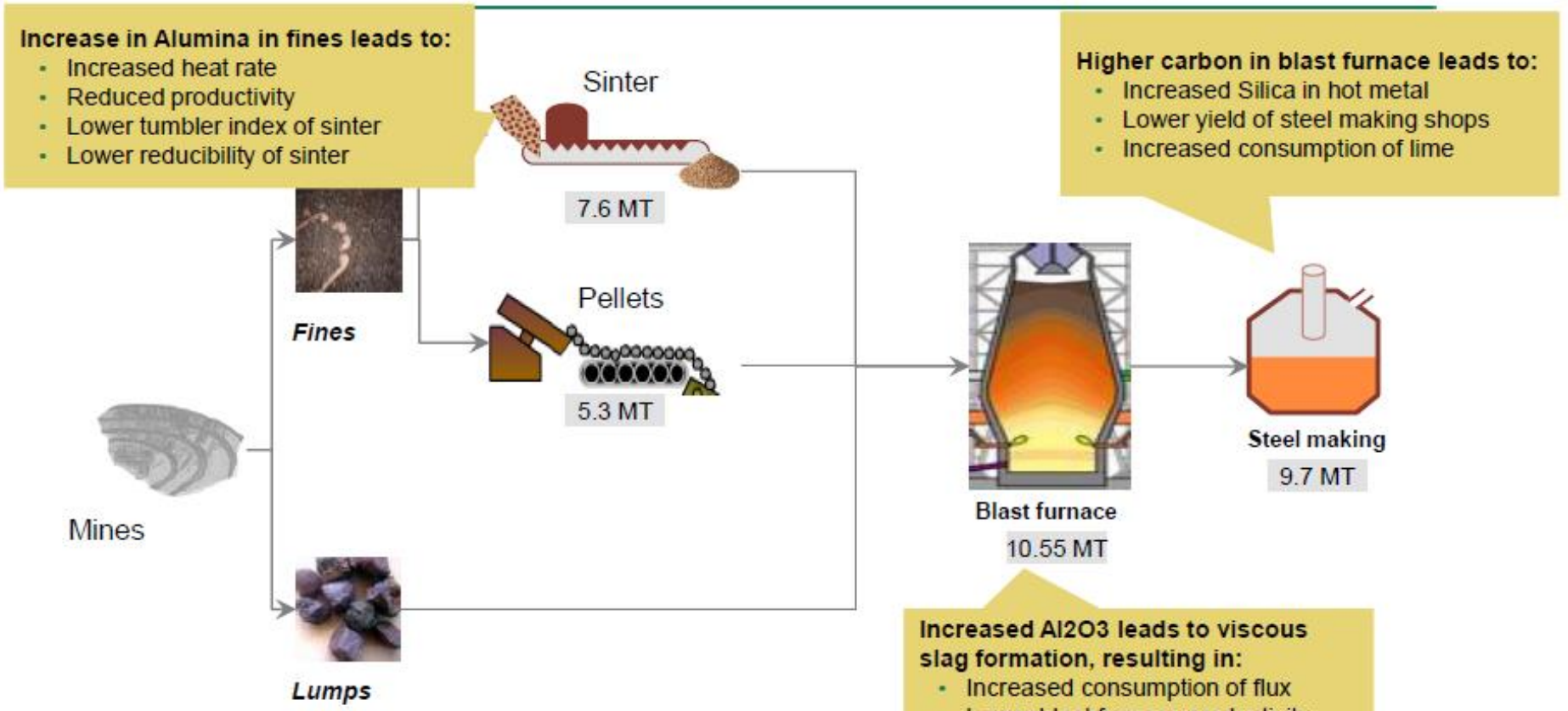
Softness increases with higher goethite

Responsible for high alumina product

Why gangue needs to be removed..???

Increasing alumina levels impacts agglomeration, blast furnace as well as steel making process

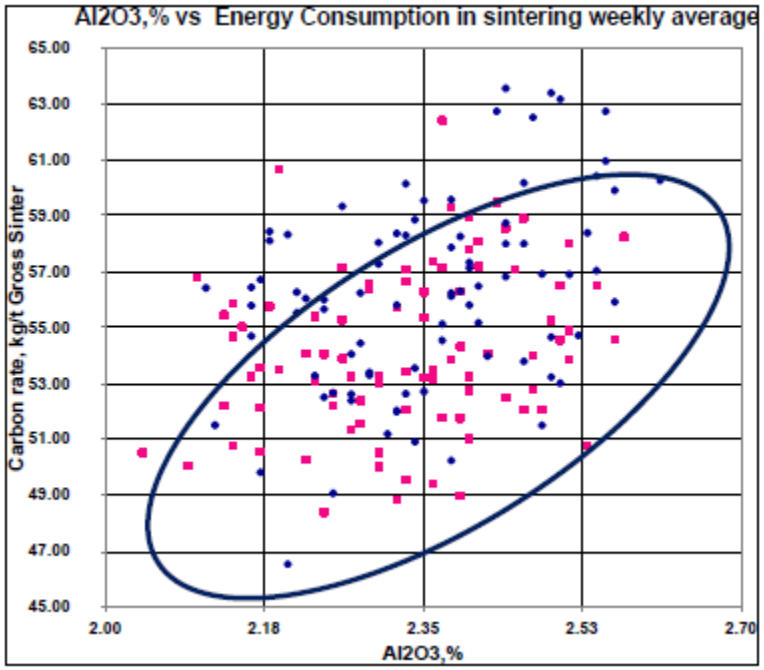
Iron Ore to Liquid Steel Flow – Jamshedpur Works



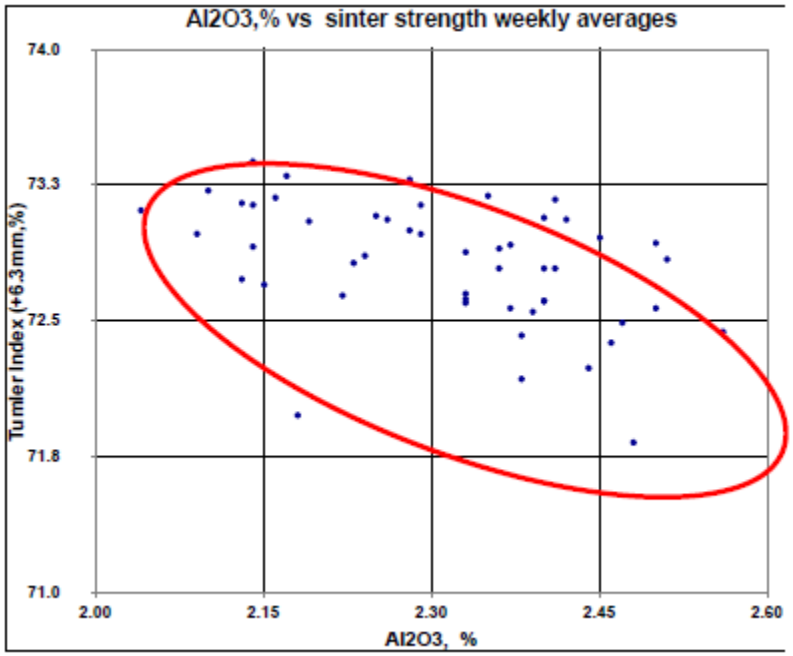
0.1 % Increase in Alumina leads to ~ Rs 277 Crore @ 9.7 mtpa steel

Impact of alumina on Sinter making

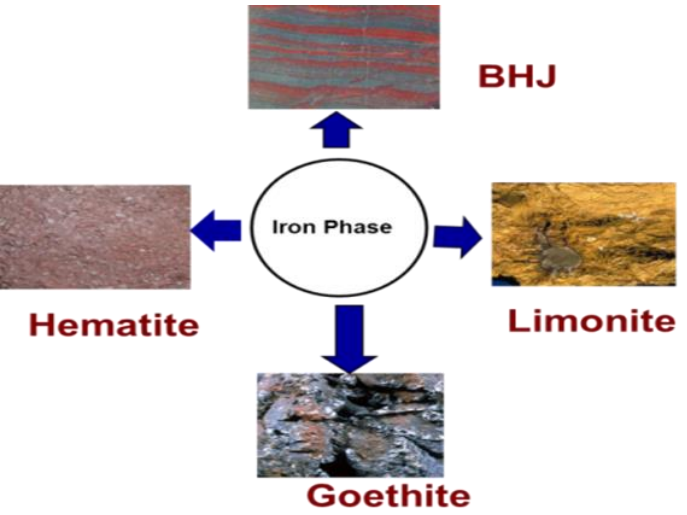
Energy consumption ↑

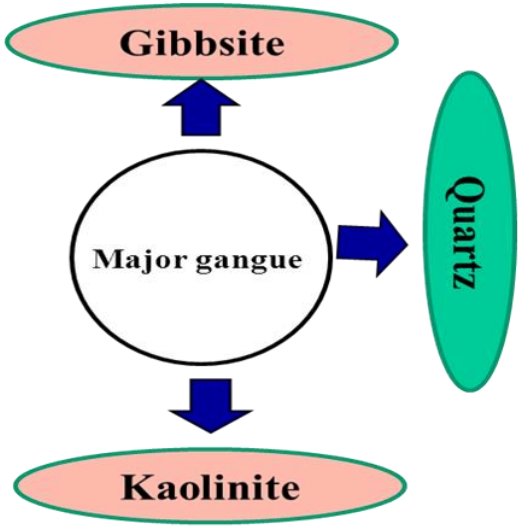


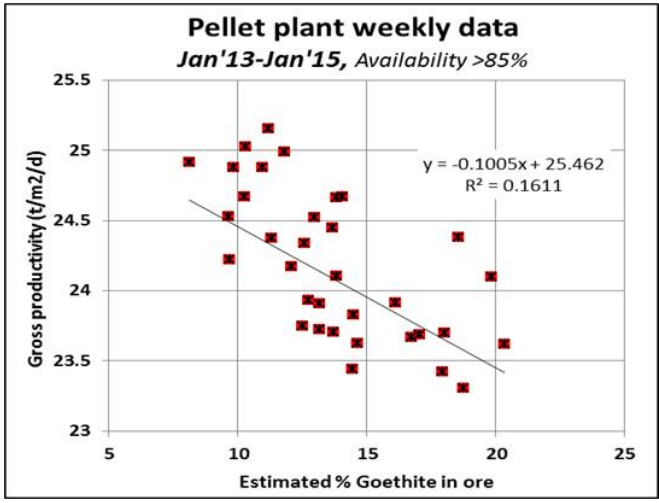
Sinter strength ↓

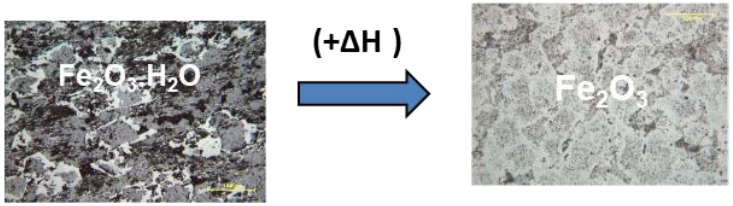


Impact on palletization!

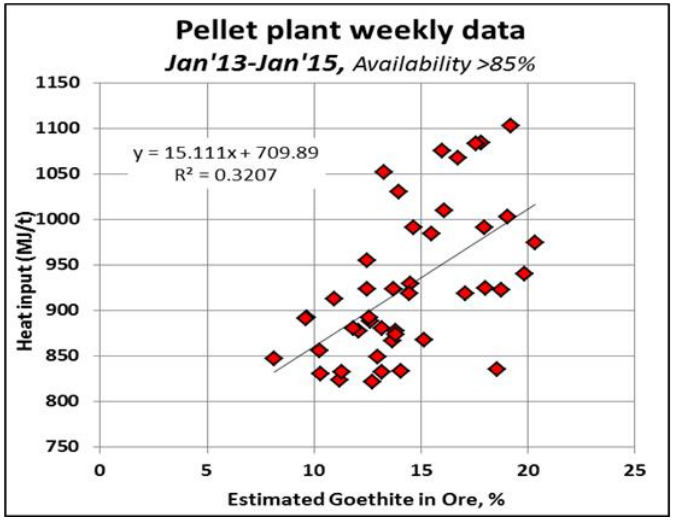




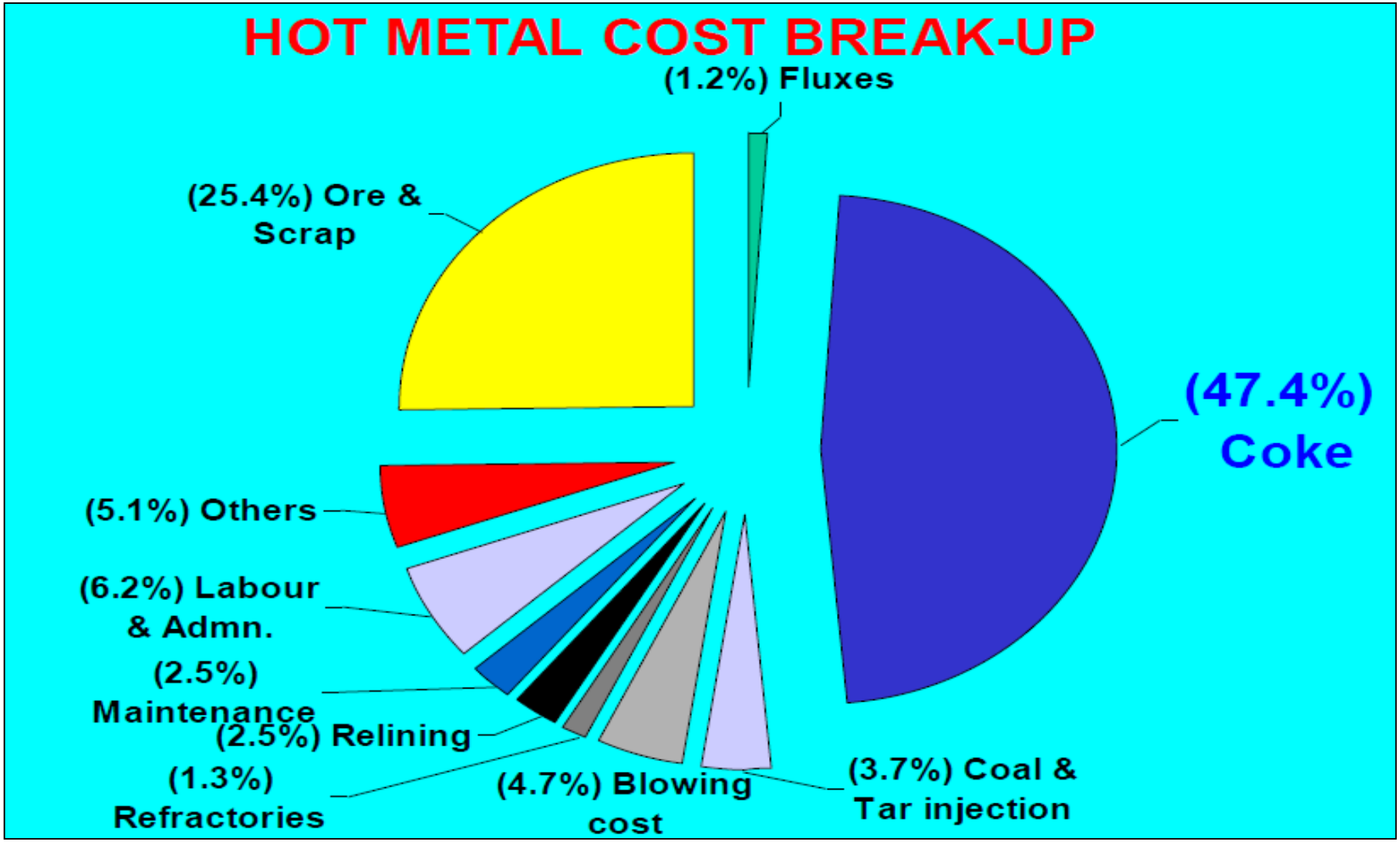




1. Productivity ↓
2. Heat Input ↑



Coke contributes 50% cost to Hot Metal

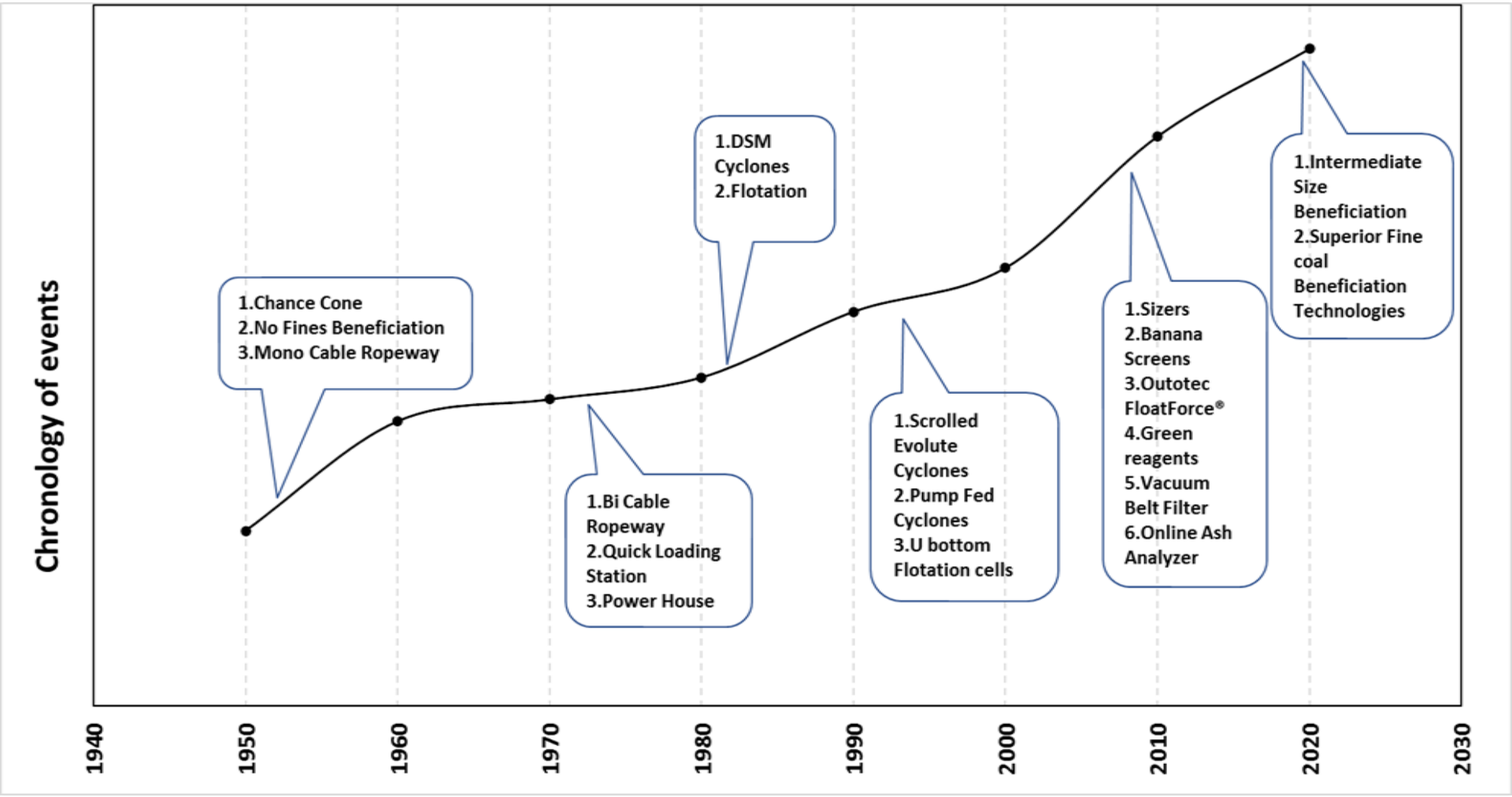


Metallurgical coals- optimization !

Levers

- **Blend design to absorb NCC**
- **Usage of PCI at BF**
- **Syn. gas from Coal**
- **Enhance beneficiation Efficiency**
- **Cokemaking Technology**

Technological Journey of Tata Steel – to get higher yields at the same ash



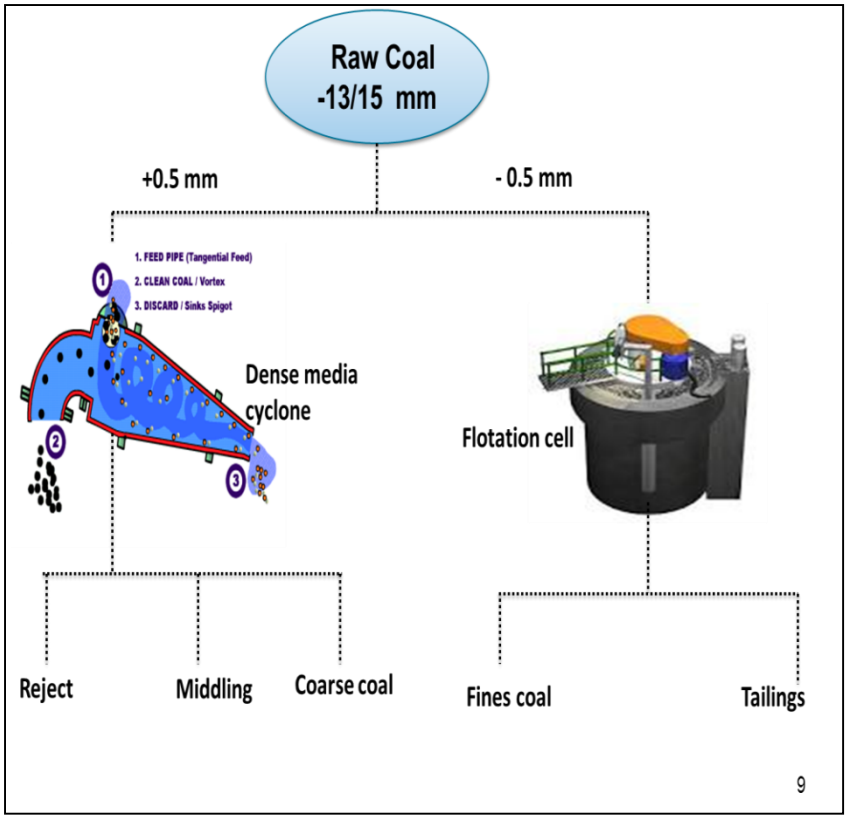
Beyond 2020 - Futuristic Technologies @ TSL

	TSL Coal Washeries *	RoW	Benefits
Coarse Coal Beneficiation *(+0.5mm)*	 Dense Media Cyclone (Medium dia.)	 Dense Media Cyclone (Large dia.)  3-product Dense Media Cyclone	Less no. of parallel modules/stages minimizing bias
Intermediate size Coal Beneficiation *(0.5mm-0.25/0.15mm)*	 Mechanical Flotation	 Reflux Classifier  Spirals  Dense Media Cyclone (Small dia.)	Improved recovery compared to flotation
Fine Coal Beneficiation *(-0.25/0.15mm)*	 Mechanical Flotation	 Jameson cell  Column cell  Jet cell	Improved kinetics & selectivity ,lower operating & maintenance cost

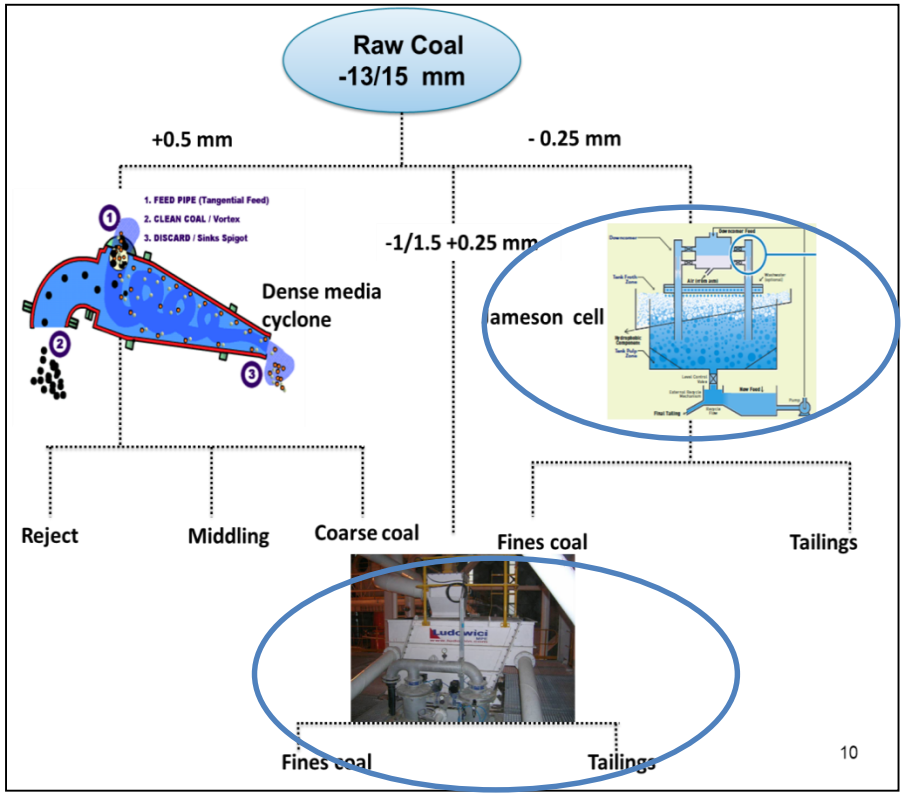
**New Jamadoba washery has : Reflux Classifier for 0.5mm-0.25mm and Mechanical Flotation for -0.25mm*

Concept of Intermediate size beneficiation (Upcoming washeries)

Current flow sheet



Modern concept of Beneficiation



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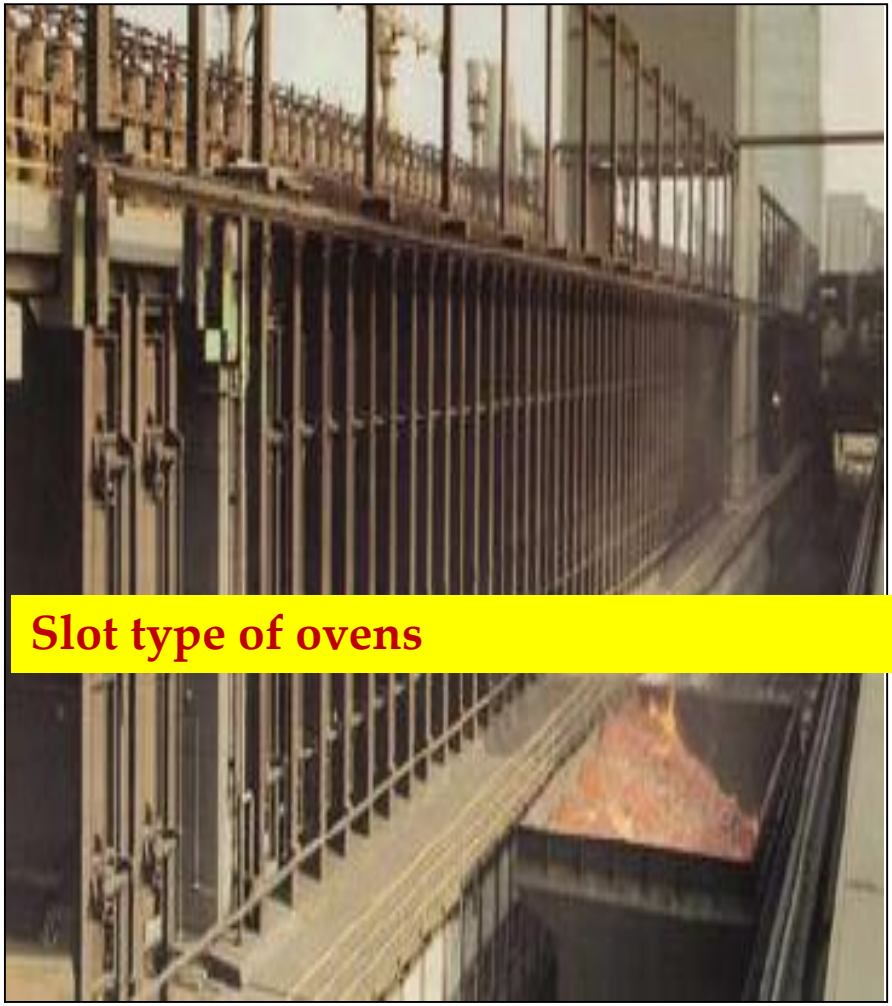
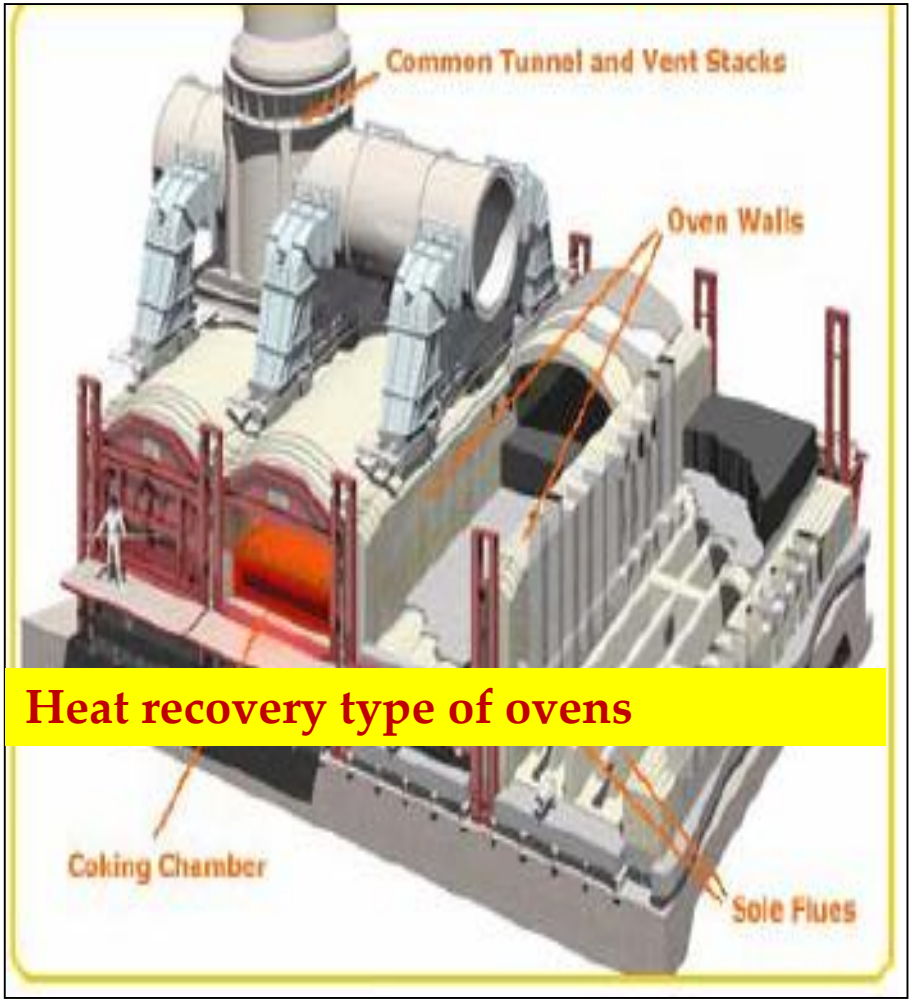
Stamp Charging & Heat recovery ovens



Slot type of ovens



Heat recovery type of ovens

Stamp Charging coke making Technology

- ✓ This technology can accommodate inferior coal in blend by increasing coal cake bulk density through stamping the coal cake before charging. Bulk density of the coal cake goes up to 1150 kg/m^3.
- ✓ A prerequisite is to crush coal finer to achieve the right grain size distribution which is ideally maintained at <3.15mm (fraction) – 87-90%, 0.5mm (fraction) – 47-49%
- ✓ Fine crushing and stamping help the coking coal particles to go very close to each other *(inter granular distance is minimized)* and bind them strongly during coke making which helps making strong coke.
- ✓ In this process, coal cake is made outside in stamping Charging & pushing(SCP) machine by stamping and pushed into the oven from ram side.
- ✓ Coal is discharged into a stamping box and series of drop hammers compact the coal mass in to a solid cake. This cake is pushed into the oven from ram side door.
- ✓ **Advantage of Stamp charging:**
  - ✓ *Lower cost*
  - ✓ *Better quality*
  - ✓ *Higher yield*

Production facilities at TSI coke making operation

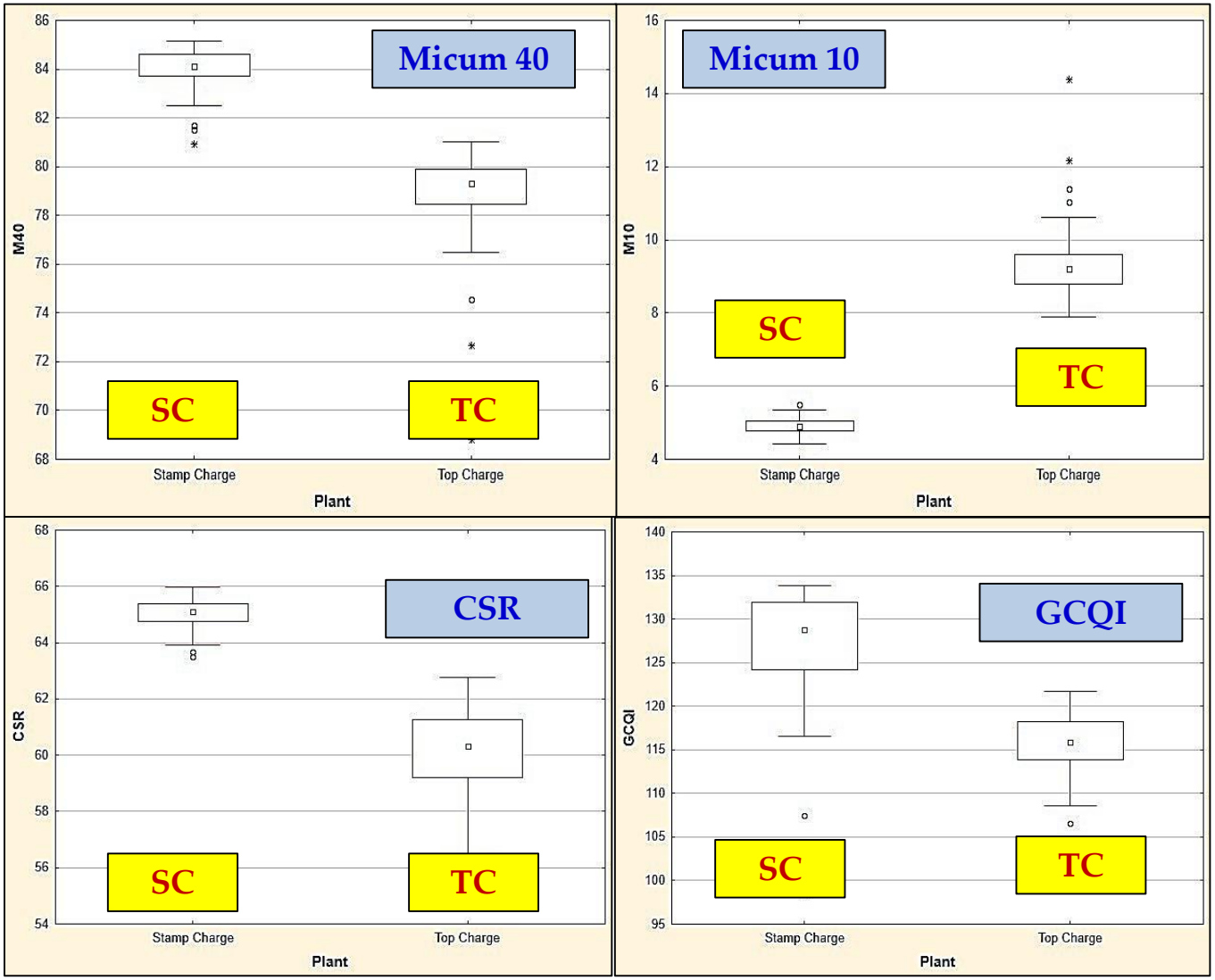
	Jamshedpur Operation	Haldia operation	KPO operation (green field)
Coke making technology	Stamp charging by product recovery	Compaction technology heat recovery	Stamp charging by product recovery
Gross production, Mn Ton, in FY'16	3.5	1.6	✓ 1.5 (during first phase in FY'16) ✓ Additional 1.5 (during 2nd phase)

Blend composition – TC vs SC at JSR operation of Tata Steel

	Jamshedpur Operation	
Coke making technology	Top Charge (*)	Stamp Charge
%Hard coking coals	80 to 85	20 to 30
%Medium coking coals	15 to 20	40 to 50
%Semi soft coking coals	0	25 to 35
Blend richness (1 to 7 scale), lower the no. richer it is;	3.2	4.1

(*) TC operation stopped at Tata Steel JSR plant from Nov'14 onwards

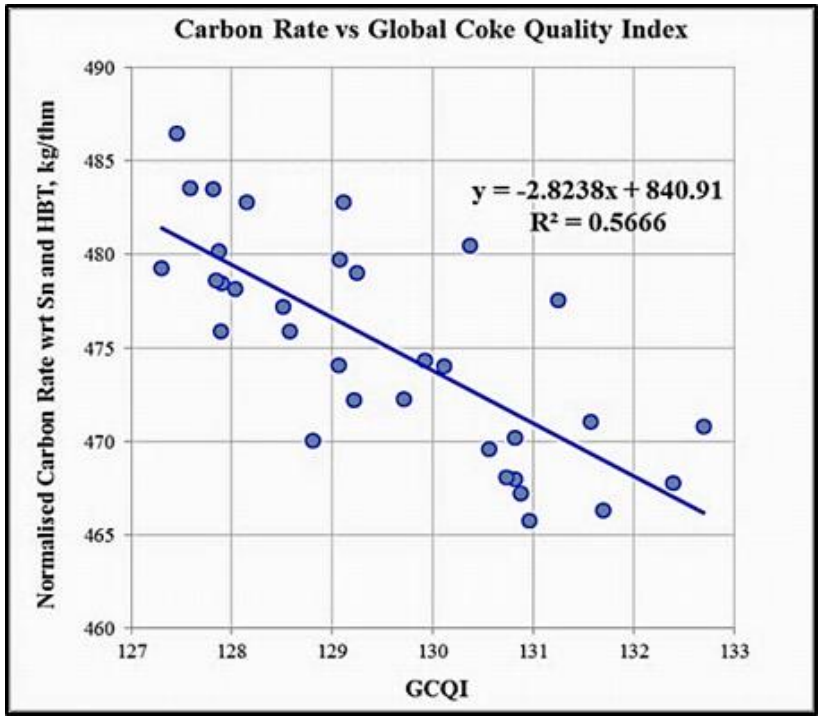
Comparative analysis of coke quality – SC vs TC

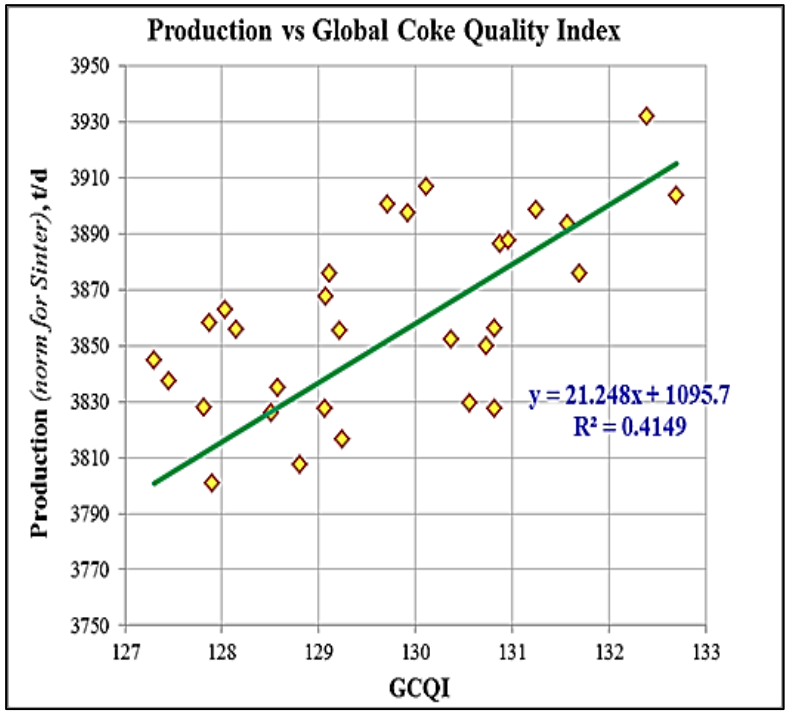


- ✓ Better coke quality achieved for SC coke at lower cost wrt TC coke
  - ✓ Avg. M40 higher by 4 to 6 points
  - ✓ Avg. M10 also lower by 4 to 6 points
  - ✓ Avg. CSR higher by 5 to 6 points
  - ✓ GCQI values are up by 14 to 16 points

GCQI = 0.5*((M40-3.42*M10+100)+(CSR-2.6*CRI+100))

Impact of coke GCQI on Blast Furnace performance





The impact of coke GCQI on Blast Furnace performance is as follows:

- *Carbon rate decreases by 2-3 kg/thm with increase in GCQI by 1 point*
- *Production increases by 0.5-0.75% with increase in GCQI by 1 point*

Acknowledgement

1. **Amrita Roy, Ashutosh Bhushan, Ch. Gopikrishna, Subhadra Sen, Ashok Kumar -** ***"Coking behaviour of Indian medium coking coal at different ash level and its impact on coke quality"***

2. **Bhargav Dhavala, Kunal Mathanker, Dr Suman Krishna Sit-** ***"Evolution of Coal Processing practices at Tata Steel"***


Thank you