Need for Innovations and R&D in Indian Iron & Steel Sector

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Outline of Presentation

- Imperatives for the Steel Industry
- Drivers for Innovation – Sustainability and Competitiveness
- Some glimpses of R&D Initiatives at SAIL, RDCIS

Imperatives for the steel industry

- **Environmental concerns**
  - Reduction in Greenhouse Gas Emissions
  - Recycling of Wastes

- **Resource Concerns**
  - Energy intensive operations
  - Dependence on non-renewable sources (fossil fuels)
  - Scarce allied resources (including land and water)

- **Manpower Concerns**
  - Employee safety and health
  - Need for automated handling of hazardous operations
  - Skills and training needs

Imperatives for the steel industry

- **Challenges from alternative materials**
  - **Need for innovative steel products and applications**

- **Weight reduction in applications**
  - **Use of high strength steel products with attendant environmental benefits**

- **Need for greater use of IT and automation in the industry**
  - **Deploying data analytics for solutions**
  - **Using e-commerce platform for transactions**

The Indian context

- India was the second largest steel producer in 2018
  - 101.287 MT finished steel in 2018-19
- India was the largest producer of sponge iron in 2018
  - 46.56 MT in 2018-19
- National Steel Policy 2017 envisages
  - 300 MT of steel by 2030-31
  - 160 kg per capita steel consumption (74.1 kg in 2018)
- Import component of finished steel
  - 7.83 MT in 2018-19

Perspectives on Sustainability

- Consumption in developing economies will continue to grow
- Some key sustainability indicators, like the following, therefore assume importance
  - Greenhouse gas emissions (1800-2000 kg CO_2/TCS)
  - Energy intensity (~5.5 Gcal/TCS)
  - Material efficiency (~ 95-96%)
  - Environmental Management Systems (Water Consumption ~2.2m^3/TCS)
- Data on sustainability indicators do not indicate a dramatic shift for the better
  - Innovative solutions are needed for change
- Further, the Indian industry needs to close in on gaps with respect to the sustainability indicators

➡ *Need for innovation becomes all the more pressing !*

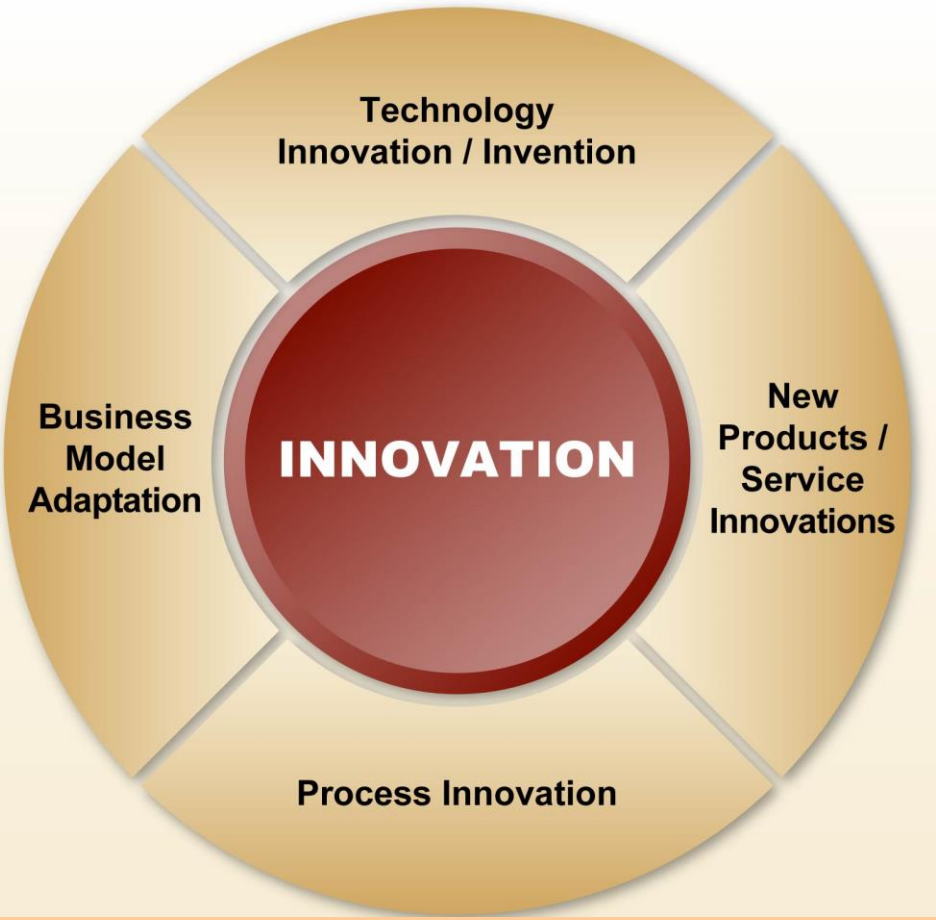
Innovation

- Innovation is adapting to new realities and are modern time necessities to survive, grow and sustain leadership edge

- Generating an idea is a beginning; implementing those in practice is a bigger challenge, but the only way out for sustainability

- A firm that does not innovate dies in the long term

Innovation in industrial context



Innovation is about novelty, about doing something qualitatively new or different

Drivers for Innovation: Environment Concerns

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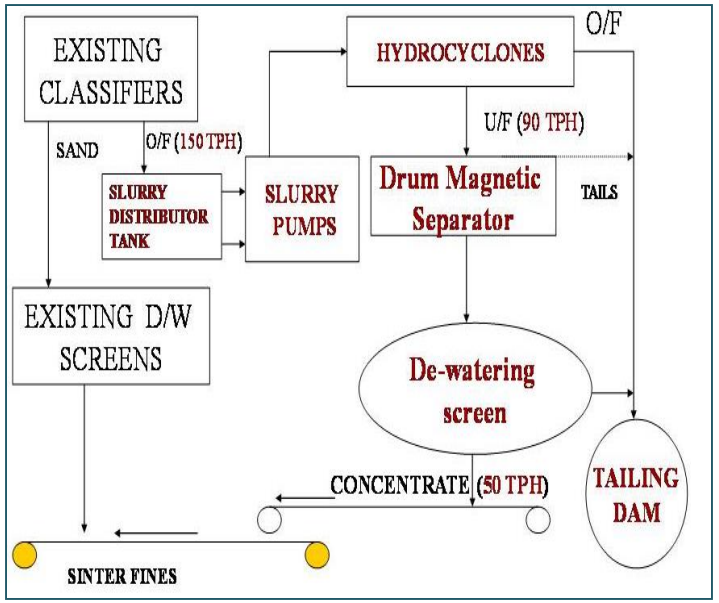
- **Reduced Carbon dioxide emission**
  - Steel industry accounts for 7-9 % of global CO_2 emissions
  - Technologies for Carbon Capture & Storage (CCS) for sequestering Carbon to, say geological formations, and thereby preventing release to atmosphere
  - Innovative use of byproducts in other industries (like BF slag in cement industry) for resource substitution
  - Use of circular carbon : biomass from agriculture, forestry to replace conventional Carbon sources; use of waste gases (like BF gas) as fuel
  - Use of clean sources of energy
    - For example, hydrogen gas, instead of coke
      results in green steel (water vapour instead of CO_2)

Drivers for Innovation: Resource Concerns

- **Technologies for beneficiation of Iron ore**
  - **Would help cost-effectiveness and waste reduction**
  - **Use of dry beneficiation will greatly minimize water consumption**



Deficiency of domestic coking coal

- Technologies that circumvent coke making
- Technologies that allow the use of inferior coking coal

Drivers for Innovation: IT & Automation

- **Pressing Data Analytics to service**
  - Video data of steel plant operations can be uploaded to the cloud for breakdown analysis
  - Customization of equipment maintenance
  - Data analytics for tracing back a product defect to the processing step, alerts on process deviations, analysis of safety related incidents, product planning and pricing

- **IT enabled services and e-commerce solutions**

- **Automation in risk prone areas**
  - Employee health and safety

Drivers for Innovation: Market Trends

- **Quality and cost competitiveness of products**
  - Availability of alternatives, both domestic and imported, that are high on quality but low on cost

- **Techno-economics of production**
  - There are practical limits to lowering costs

- **Innovation in products and processes are therefore needed**
  - To ensure a niche product portfolio
  - For overall commercial sustainability

Requirements for Innovation: Manpower

- **Interaction between industry and academia**
  - **Insights into tailoring curricula for future industry needs**
  - **Collaborative research**

- **Skill development and training needs in industry**
  - **Need to keep abreast with contemporary technology**
  - **Knowledge enhancement initiatives**
  - **Training of workforce on current and future technology**

- **Investment in R&D**

SAIL, R & D Initiatives

RDCIS Initiatives: the road ahead

- New pilot coke oven for optimizing coal blend and heating schedule

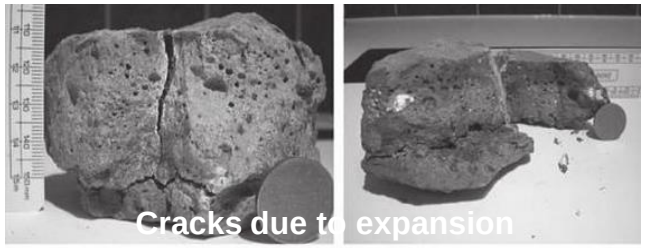
- Pilot scale pelletizing and pellet heat hardening system

- Beneficiation of iron ore fines and slimes

RDCIS Initiatives: the road ahead

- Application of new techniques to improve the quality of sinter
- Augmenting iron making laboratory facilities including softening and melting apparatus
- Use of basic oxygen furnace slag for road making and as ballast material


Pilot Pot Sintering Unit


Cracks due to expansion

RDCIS Initiatives: the road ahead

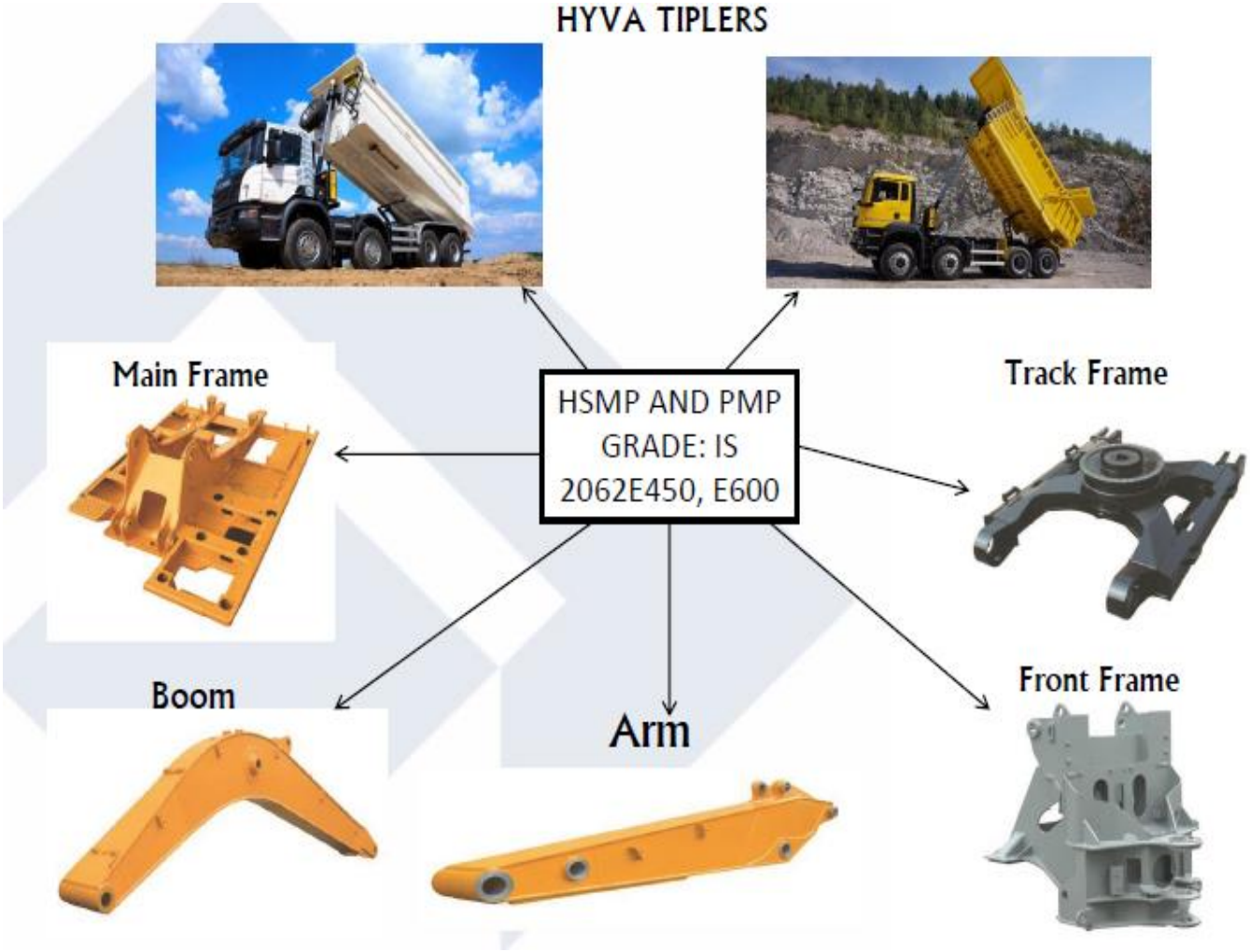
- New products like Nano steel, low density steel, steel for strategic applications, including defence and nuclear energy
- Development of rail head hardening simulator
- Development of robotics laboratory
- Exploring prospects of using Nano coolant, which involves adding nanoparticles (< 50 microns) of metals or metal oxides to water, for enhanced cooling applications

Some recently developed products of SAIL

NARRROW PARALLEL FLANGE BEAM 750: USAGE IN CONSTRUCTION INDUSTRY

LINKE HOFMANN BUSCH (LHB) WHEELS: USAGE FOR RAILWAYS

Product Customization for End Users



Product Customization for End Users

Rear Axle Beam developed using HRC SAILFORMING 410 / 450 grades

Live Axle Beam

Dummy Axle Beam

Significant interventions by RDCIS in Product Development (2018-19)

	Product	Remarks
1	2π grade bullet proof (RSP)	Successful ballistic test at ODF Medak, material accepted
2	Non Micro Alloyed IS 2062 E350 BR(RSP)	17000 tons plates produced and dispatched
3	Fire Resistant Steel (DSP)	Developed in two sections
4	Low CE TMT Wire Rod at ISP	Successfully produced meeting all requirements
5	TMT Wire Rod (without micro-alloying) at BSP	Successfully produced meeting all requirements
6	EN 10025-2 S355J2 N grade plates (RSP)	~10000T was exported

Conclusion

- **Innovations in the steel sector are necessitated by**

  - **Environment sustainability**
  - **Business sustainability**

- **There is a great need for a synergistic approach for innovation involving**

  - **Industry and academia**
  - **All stakeholders**

SAIL, through RDCIS, is continually trying to adopt innovation as integral to working

Acknowledgements

Several resources were used in the preparation of the presentation material which are thankfully acknowledged.

HYPERLINK SLIDES

2π grade bullet proof

Designed chemistry and optimized heat treatment parameters for production and supply of armour steel plates of hardness 470 – 510 BHN.

Process Route: ASP-SSP-RSP

Chemistry

C	Mn	Si	Cr	Mo	Ni	B (ppm)	Al	S	H2 (ppm)
0.29	1.27	1.23	0.08	0.22	0.43	18	0.023	0.004	1.8

Mechanical Properties

Plate No.	YS, MPa	UTS, MPa	%EL	CIE (J) at -400C (full size)	Average Hardness (BHN)
5P 181397	1435	1764	7.31	23.7	502.5
5P 181422	1459	1790	8.05	25.58	497.3
5P 181419	1481	1806	8.47	22.62	495.7
5P 181367	1561	1795	7	25.24	495.1

After successful ballistic test at ODF Medak, the material has been accepted

Non Micro Alloyed IS 2062 E350 BR (RSP)

- Nb-V free based steel chemistry and process chart were specially designed
- Processed plates successfully qualified for IS 2062 E350BR without micro-alloying
- All the plates met the specified properties
- 17000 tons plates produced and dispatched

Chemistry (wt%)

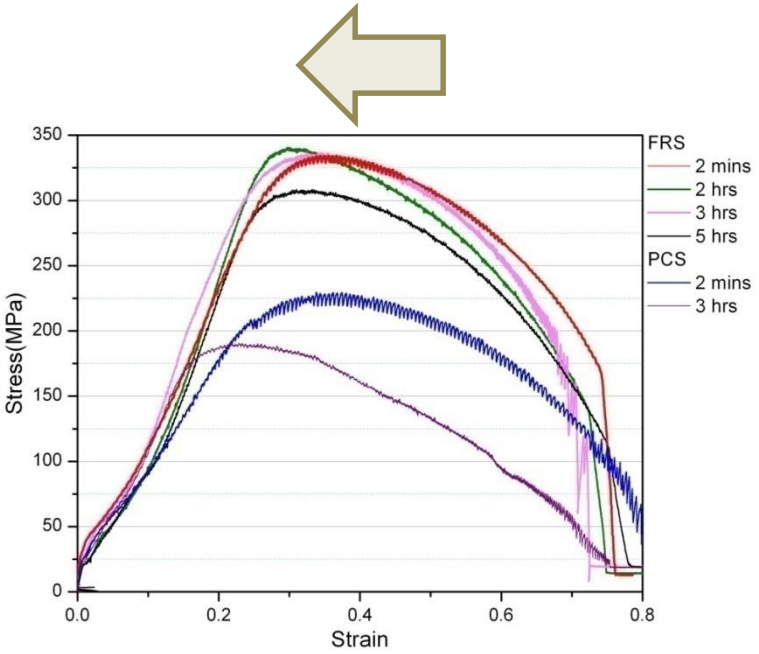
C	Mn	Si	Al	S	P
0.15-0.20	1.0-1.4	0.17-0.298	0.011-0.040	0.008-0.027	0.020-0.030

Mechanical Properties

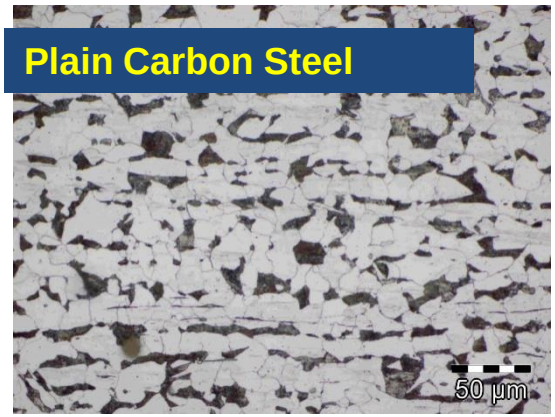
	YS (MPa)	UTS (MPa)	% El	CIE, J at RT
Spec	350 min. (< 20mm)	490 min.	22 min.	27 J min.
	330 min. (20-40mm)	490 min.	22 min.	27 J min.

Fire Resistant Steel at DSP

- Fire resistant steel has huge potential in steel structures where fire may take place,
- As per IS: 15103, yield strength of steel at 600^{o}C should be at least 2/3rd of specified value at room temperature.
- One heat made at DSP and successfully processed into WPB 160/ NPB 250 sections.
- Results of RT tensile test and at 600C met all the requirements as per IS:15103 .
- Performance evaluation under actual fire condition will be carried out at Fire Research Lab of CBRI Roorkee.



Grade	UTS MPa	YS (<12 mm) MPa	Elong., % min.
FR–Fe 410	410	300	21
FR–Fe 490	490	350	18



Low CE TMT Wire Rod at ISP

Steel	C	Mn	Carbon Equivalent
Earlier	0.21-0.25	1.0-1.3	0.40-0.42
Now	0.16-0.20	0.75-0.85	0.30 – 0.34

Benefits

- ✓ RHF soaking temperature reduced by 50°C
- ✓ Reduction in energy consumption
- ✓ Reduction in Mill scale generation
- ✓ Improvement in Yield
- ✓ Improvement in Refractory Life
- ✓ Reduction in number of grades reducing the risk of mix up
- ✓ Higher Mill Speed

Non-microalloyed TMT Wire Rod at BSP

Steel	C	Mn	Nb	V	CE
Earlier	0.21-0.25	1.0-1.20	0.010	0.025	0.42-0.44
Now	0.16-0.20	0.75-0.85	Nil	Nil	0.30 – 0.34

Benefits

- ✓ Established through SMS-I
- ✓ Easier steel making due to lower ferro-alloy additions
- ✓ Lower segregation leading to more uniform chemistry
- ✓ Reduction in number of grades reducing the risk of mix up
- ✓ Highest mill speed leading to high productivity

EN 10025-2 S355J2 N at RSP

- Product was successfully produced by RSP with the help of modified process chart provided by RDCIS

Chemistry (wt%)

C	Mn	Si	Al	S	P
0.15-0.17	1.24-1.3	0.25-0.33	0.016-0.05	0.005-0.009	0.020-0.030

Mechanical properties

	YS (MPa)	UTS (MPa)	% El	CIE, J at RT
Spec	345 min.	470-630.	22 min.	27 J min.
Achieved	377-449	505-592	22-31	36-127 J min.

Export order was serviced