Slurry pipeline: Cost effective solution for steel industry for transportation of iron ore/coal for long distance by K.K.Mehrotra, Former CMD, MECON
Background

• India’s steel production in 2016 : 95.6 Mt

• 3rd largest producer in the world

• Second largest producer of DRI in world in 2016

• National Steel Policy document : 300 Mt/yr steel production by 2030-31

• Key assumption for such growth
Background

• Increase in per capita steel consumption: 63 kg to 130-140 kg
• Factor responsible for raising per capita steel consumption are:
  ► Massive investment in infrastructure
  ► 10% projected growth of manufacturing sector
  ► Development of 100 smart cities
  ► Emergence of rural market
Background

• Crude steel capacity by 2030-31 : 300 Mt

• Each 1 t steel requires 1.6 t prepared ore i.e. 2.0 – 2.1 t ROM

• ROM for domestic steel production incl. DRI by 2031 : 600 Mt

• Considering export of ore only 75 Mt

• Total ROM requirement by 2031 : 675 Mt
Iron ore scenario in India

- Total resources of ore : 28.5 billion t

- Hematite : 17.88 billion t
  - Reserve category : 8.09 billion t
  - Remaining resources : 9.79 billion t

- Magnetite : 10.62 billion t
  - Reserve category : 0.02 billion t
  - Remaining resources : 10.62 billion t
  - Av. Fe content in magnetite : 35-40 %
Iron ore scenario in India

• Magnetite reserves are not being exploited, these are mostly in eco fragile zone of Western Ghats.

• These reserves remain locked for next decade, can be considered for exploitation through sp. mining method to take care of environmental issues.

• Entire present steel production comes from hematite ore. Over 85% hematite ore reserves are medium to high grade (+60%), used directly in BF & DRI plants.
Iron ore scenario in India

• These reserves will last for only 45 years

• IBM has revised the cut off from 55% to 45% Fe for minable reserves.

• Total reserves with cut off of 45% Fe will be much higher than present estimate.

• Over 6 decades mining of +63% Fe ore & washing ore to get favourable alumina silica ratio resulted in piling of over 100 Mt rejected
Iron ore scenario in India

low grade fines & slimes with Fe of 45-55% at various mine heads

• Slimes / lean ore mountains are not only occupying precious land at mines but posing environmental problem

• Economical steel production by metallurgical processes desires ore burden with +62% Fe
Iron ore scenario in India

- For effective utilisation of lean ore & to conserve precious natural resources for sustainable development, beneficiation is must in today’s context.

- Mineralogical characteristic of lean ore revealed removal of undesirable elements by grinding to minus 200 mesh for enriching Fe from 45 to 60%.

- In general beneficiation units are installed at mine site for ease of handling of ROM & concentrate is transported to consuming centres.
Hematite ore reserve

Recoverable Reserves of Hematite (Mt)

- Jharkhand - Odisha Sector, 5617
- Bailadila - Rowghat - Dalli - Rajhara Sector of Chattishgarh and other deposits of Maharashtra, 913
- Bellary - Hospet belt and other deposits of Karnataka, 876
- Goa Region, 469
- Deposits of MP, AP, Rajasthan & UP, 216
- Goa Region, 469
- Jharkhand - Odisha Sector, 5617
## Annual freight by Railways: Major material

<table>
<thead>
<tr>
<th>Year</th>
<th>Total, Mt</th>
<th>Coal , Mt</th>
<th>Ore , Mt</th>
<th>Ore Prod. , Mt</th>
<th>Finished Products, Mt</th>
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<td>970</td>
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<td>493</td>
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<td>2013-14</td>
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<td>1101</td>
<td>551</td>
<td>117</td>
<td>135</td>
<td>44.9</td>
</tr>
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</table>
Need for slurry transportation

• Railways is most preferred mode of transportation for bulk commodities e.g. coal, ore etc.

• Steel related traffic is about 27%

• Tremendous pressure on railway transportation system by 2031 due to
  ➤ Increase demand of iron ore, other input materials & dispatch of associated finished products
Need for slurry transportation

► Increase demand of coal both for steel plant & power plants

► Existing railway transportation is not capable of handling fine ore concentrate

► Over saturated route (120% capacity utilisation in some sections)

► Poor last mile connectivity
Need for slurry transportation

► No guaranteed transit time, freight train takes 6 to 8 days for 2000 km journey

► Common track for freight & passenger

► Logistic cost is 13-14% of GDP against 8-10% in developed world

► Pace of infrastructure development is not matching with industry’s requirement
Need for slurry transportation

- No movement of freight train in night in some sensitive areas

- Suffer from lack of adequate haulage capacity & has low heavy haul freight compared to global players 5400 t as compared to China 20,000 t, South Africa 22,000 t & Australia 32000 t

- Freight car turn around time is very low.
Gandhamardhan- Daitari- Maangtoli region in Orissa, Bababudhan of Karnataka, Ongole region of A.P are still not adequately supported by Railway infrastructure
Advantage of slurry transportation

• Bulk transportation of iron ore concentrate in slurry form is environment friendly.

• Eliminate the dependency on the railways and reduce the cost on transportation of ore.

• Insensitive to surface condition such as storm, inclement weather etc.

• 25 Mt/yr of material transportation reduces extra load on railway to the tune of 50 rakes (25 inward & 25 outward) per day.
Advantage of slurry transportation

• Large distance transportation of ultra fine concentrate will require special wagons, which can be avoided by slurry transportation.

• Don’t require return of empties to starting point, ideal for uni-directional traffic

• Up-gradation and utilization of the unused low grade iron ore available at different mine sites across the country will enhance the resource base and support mineral conservation
Advantage of slurry transportation

- Fulfill the statutory requirements of IBM for utililsation of +45% Fe iron ore by way of beneficiation

- Slurry transportation has minimum social impact, shorter route, easier river crossings (without bridging) and minimum en-route losses

- Easier access for construction, operation and maintenance
Global scenario of slurry pipeline – Iron ore

- **Samarco**: from Germano to Point Ubu Pellet Plant in Brazil, 396 km, capacity: 15Mt/yr

- **Da Hong Shan pipeline in China** for Kunming Iron & Steel Corp, 171 km, capacity: 3.5 Mt/yr

- **Anglo Ferrous Minas-Rio in Brazil**, 522 km, capacity: 23 Mt/yr

- **Savage River**, Tasmania, Australia, 85 km
Global scenario of slurry pipeline – Iron ore

- Minas Gerais to Ilheus Port, Brazil, 420 kms, capacity : 25 Mt/yr

- Wellstead to Albany port, Australia, 100 km

- Chongin, North Korea, 98 km, capacity 4.5 Mt/yr

- Zanada Project : Mines to Pointe Noire Port, Cango, 370 kms, capacity 12 Mt/yr (1st phase) under engineering stage
Global scenario of slurry pipeline – Iron ore

- Mount Gibson Ranges to Geraldton, Asia Iron Holding, Australia, 278 km, capacity 10 Mt/yr

- Balla Balla Mines to Port Hedland, Aurox Resources, Australia 110 km, capacity 10 Mt/yr
Slurry pipeline for other mineral

• **Coal**
  Black Mesa, USA : 439 km, Cap : 4.8 Mt/yr
  Belevo-Novosibink, CIS : 256 km, Cap : 3 Mt/yr

• **Copper Concentrate**
  Irian Jaya, Indonesia : 112 km, Cap : 0.3 Mt/yr
  KBI, Turkey : 61 km, Cap : 1 Mt/yr
  Bougen Ville, Papua New Guinea : 27 km, Cap: 1 Mt/yr
• Copper Tailing
  Japan : 64 km, cap : 1.0 Mt/yr
  Ceba, Phillipines: 19 km, cap: 24 Mt/yr

• Limestone
  Kensworth Beds, UK : 92 km, cap: 2.0 Mt/yr
  Calveras, USA : 28 km, cap: 1.5 Mt/yr

• Phosphate Slurry
  Velep, Brazil: 120 km, cap: 2.0 Mt/yr
  Golasfertil, Brazil : 14 km, cap: 1.0 Mt/yr

• Uranium bearing gold slime
  Barldrosco, South Africa : 19 km, cap: 1 Mt/yr
Indian scenario- Existing Iron ore Slurry pipeline

Kudremukh to Mangalore , KIOCL, 68 km, capacity 8.0 Mt/yr

- Kirandul (Baildaila Sector) to Vishakhapatnam Essar Steel, 267 km, capacity 8.0 Mt/yr

- Barbil to Kalinganagar, BRPL ,Orissa, 230 km, capacity 4.0 Mt/yr

- Joda( Dabuna )- Paradip, Orissa, Essar Steel, 253 km, capacity 8 Mt/yr
Indian scenario- Proposed iron ore Slurry pipeline

Kirandul – Bacheli – Nagarnar - Vizag , NMDC
455 km , capacity 10 Mt/yr (Ongoing project )

• Mangalore to Tornagallu: 350 km by JSW (Advance stage of implementation) both for ore/coal , investment Rs 2100 crores

• Barbil to Angul, Orissa, JSPL , capacity 12 Mt/yr (Ongoing project )
Slurry Pipeline Routes

- 300 km Barbil-Angul (JSPL)
- 253 km Dabuna-Paradip (Essar Steel)
- 218 km Barbil-Jajpur (BRPL)
- 455 km Kirandul-Nagarnar-Vizag (NMDC)
- 267 km Kirandul-Vizag (Essar Steel)

Source: Infrastructure Study Report for 300 Mnt Steel by 2025, Ministry of Steel, Govt. of India, SteelMint
Major System of slurry pipeline

- Storage tank & agitator
- Dispatch & Receiving terminals
- Slurry Pipeline
- Pumping stations
- Valves / Choke stations
System design of slurry pipeline

- Pressure monitoring stations
- Scraper Launcher / receiver
- Cathodic protection system
- SCADA System
- Return water pipeline (Optional)
Cost benefit analysis

- **Investment cost**: Rs. 4.50-5.0 / t/ km (for min. distance of 100 km & 10 Mt/yr capacity)

- **Operating cost**: Rs 0.60 / t/ km

- **Railway freight charges for ore**: Rs 1.60 / t/ km

- **Road charges**: Rs 3.50-5.0 / t/ km
For JSPL, Angul Plant

Transporting iron ore from Barbil to Angul by road: Rs 2000/t

Same distance by Train: Rs 820/t

Same by slurry pipeline: Rs 400/t

80% saving compared to road & 50% saving compared to rail
Essar is saving Rs 1200/t from for transporting ore slurry from Barbil, Keonjhar to Paradip Pallet Plant.

Report prepared for slurry pipeline from Mangalore to Vijaynagar for JSW shows only 15% of the cost of transport by slurry pipeline over other means of transport.
Conclusion

- Railway is unable to cope up with ever increasing demand of iron ore & other input materials by steel sector in next one decade

- To enhance ore reserve base, beneficiation of lean ore is must, Railway is not in a position to transport ultra fine ore/concentrate as it needs special wagons.

- Iron ore slurry transportation is well established mode of transportation in world as well as in India.
Conclusion

• Ore transportation by slurry pipeline is cost effective, efficient & environmental friendly

• Common carrier slurry pipeline can be laid to cater to many consumers in a zone / region

• Formation of Slurry Transportation Authority under the Ministry of Steel (MoS) in line with NHAI for laying and operation of slurry pipeline in country.
THANK YOU