UTILISATION OF LOW GRADE IRON ORE IN STEEL MAKING WITH STATE OFART BENEFICIATION & TRANSPORT, -A CASE STUDY FOR MEETING CHALLENGES IN ORISSA STATE

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The abundant resources in Orissa state

- **The abundant resources of Iron ore, Manganese ore, Bauxite, Limestone, Dolomite, Chromites, Coal, Gemstones and Decorative Stones (Granites).**
- **Due to boom in metal industries/Steel, this has prompted planning of development of large scale mining and establishment of mineral based industries in the State.**
- **Base on the large resources of Metallurgical grade Iron ore and bauxite, it has been planned to set up a number of iron and steel plants, aluminum complexes, Power plants etc.**

Steel grade & other mineral resources in Orissa state

- With >5000 MT of iron ore reserves, with a host of accompanying advantages
- Orissa has substantial reserves of other minerals, which go into steel making, like coal – 61,999 MT (24.37 per cent of the national deposit), dolomite – 1734 MT, limestone – 1737 MT & Mn-152 MT.
- Other mineral deposits are:

  Chromites----209 MT

  Bauxites---1808 MT

  We shall cover on low grade IRON ORE for Steel Industries

- **The resources of coal have also invited many industrial houses to set up Thermal Power Projects to cater to the need of electricity for industrial projects/Steel industries.**
  - **-The lucrative occurrences of Diamond have created global eagerness to participate in scientific exploration and exploitation of this valuable mineral and to encourage the investors of International repute**

National Steel Policy

- We can not think of Iron ore without touching Steel
- STEEL is universal intermediate in building up materials base of economy, especially for industrialization & construction of physical infrastructure
- Need to boost per capita steel consumption in rural areas to improve quality of life
  - Target 110 MT annual steel consumption by 2020 AD & 70 MT BY 2012 AD, corrected now to 150 MT principally through domestic steel production
  - Appropriate steps must be taken to ensure adequate & timely supply of basic raw materials & processed inputs from domestic & oversee sources

National Steel Policy

- **Global Steel Scenario**
- **In 2007 the World Crude Steel output reached 1343.5 million metric tons and showed a growth of 7.5% over the previous year. It is the fifth consecutive year that world crude steel production grew by more than 7%. (Source: IISI)**
- **China remained the world's largest Crude Steel producer in 2007 also (489.00 million metric tons) followed by Japan (112.47 million metric tons) and USA (97.20 million metric tons). India occupied the 5 th position (53.10 million metric tons) for the second consecutive year. (Source: IISI)**

Current Steel Scenario *

- **The International Iron & Steel Institute (IISI) in its forecast for 2008 has predicted that 2008 will be another strong year for the steel industry with apparent steel use rising from 1,202 million metric tonnes in 2007 to 1,282 million metric tonnes in 2008 i.e. by 6.7%. Further, the BRIC (Brazil, Russia, India and China) countries will continue to lead the growth with an expected increase in production by over 11% compared to 2007**
- **Domestic Scenario**
- **The Indian steel industry have entered into a new development stage from 2005-06, riding high on the resurgent economy and rising demand for steel. Rapid rise in production has resulted in India becoming the 5 th largest producer of steel.**
- **It has been estimated by certain major investment houses, such as Credit Suisse that, India's steel consumption will continue to grow at nearly 16% rate annually, till 2012, fuelled by demand for construction projects worth US$ 1 trillion. The scope for raising the total consumption of steel is huge, given that per capita steel consumption is only 40 kg – compared to 150 kg across the world and 250 kg in China.**

Steel Production & Consumption

- ***Ministry of Steel has projected that the steel capacity in the county is likely to be 124.06 million tonnes by 2011-12. Further, based on the status of MOUs signed by the private producers with the various State Governments, it is expected that India's steel capacity would be nearly 293 million tonne by 2020.***
- ***Production***
- ***Steel industry was delicensed and decontrolled in 1991 & 1992 respectively. Today, India is the 5th largest crude steel producer of steel in the world. The share of Main Producers (i.e. SAIL, RINL and TSL) and secondary producers in the total production of Finished (Carbon) steel was 33% and 67% respectively during the period 2007-08***

MOU for Steel Production by 2020

- **STATUS OF MOU:**
- **Very strong upturn in consumption**
  - **World crude steel Prod Growth of 7.5 % during 2001-07 from 752/1995 to 1343 MT/2007**
  - **India growth rate is 7.3% during 2001/07 from 27.3/2001 to 53.1/2007**
  - **Medium term projection of 7.3% for next 2-3 years**
  - **China & India to lead consumption centers**
- **India 5th largest Steel producer in the world now at 54 MT/annum**
- **Per capita steel consumton-40 kgs**
- **India largest Sponge Iron producer in World with 15 MT in 2006(25% of world production)**
- **ORISSA STATE: 49 & odd MoU signed (upto 12/2008) by Orissa to establish steel plants in Orissa.**
- **Many more plants in Chatisgarh, Jharkhand & Karnataka being planned**
- **Aggregate Steel capacity > 75 MT (in Orissa)**
- **Total Iron Ore resources in Orissa as per UNFC = About 4760(IBM),Orissa Govt. puts at 5400 MT Approx**

Mega Steel players in Orissa

- Directorate of Geology/Orissa Govt. is working on exact useable Iron ore resources (lean grade being accounted)
- With existing RESERVE of Iron ore adequate for above Steel Plants/Sponge Iron Plants in Orissa (about > 50 years at @ 50 MT steel /year
- In Orissa ,POSCO is planning a 12 MT Plant (in 3 stages) with Rs. 52,000 crores investment in Paradip-Company-Posco India Ltd)
  - Iron ore allocation-600 MT (2-3 mines)
  - 10 years time-Full capacity
  - Expected Royalty to Orissa state>-Rs.500-600/yr,besides Sales tax, Excise tax's etc
- -12 MT Steel capacity by M/s Arcellor Mittal,Essar-6 MT,Tata Steel-6 MT,JINDAL-6 MT & others
- Steel Production & Consumption
- Steel Production: - Apparent steel consumption for each year upto 2011-12 forecasted at 7.3% annual average rate of growth, similar to growth of GDP.
- Finished Steel Production: Consumption (MT)
- 2006-07 50 MT 43.471
- 2007-08 54 MT --

Mega Steel players in Orissa

- **With this, total finished steel- expected to reach (as per NSP-2005)**
  - **54.00 MT by 2007-08**
  - **70.00 MT by 2011-12**
  - **110 MT by 2018-20 (Import-6 MT,Export-26 MT,Consumption—90 MT) being revised to 150 MTPY// Per capita steel consumption in India =40 Kg/head against Singapore = 500-700 Kg.,world average-173 Kgs/head**

New Opportunities in India for Steel

- New Opportunities in India for Steel, Aluminium, Coal
- New Golden age emerged in Orissa besides Jharkhand, Chattisgarh & Karnataka for Steel /Aluminium Industry, Power plants
- This requires optimal utilization of our natural resources in Orissa/Jharkhand/Chatisgarh /Karnataka.
- This also requires fast track clearances of Mining lease /Forestry /EMP/other statutory clearances for quick establishment of Iron ore mines for steel plants ,as it takes >8 years to develop a mechansed mine (mines Constrn,Power lines,Rly siding,Residences,Prodn Stabilsation)-
- help of state/center reqd here for fast clearances without compromising MC Rules-60/MMRD-56/Forest conservation Acts-78
- Aggregate Investment in India in Steel sector for Total MOU(>250 MT) > Rs.500,000 Cr
- Orissa Investment (upto 2008 MOU) > Rs 200,000 Cr (75.0 MT)
- Iron ore prodn/despatch from orissa /Iron ore Reserve-Orissa
- Year Prodn in MT year Production(MT)
- 2003/4 34.89 2007/08 74.50 (22% growth rate)
- 2004/5 46.05
- 2005/6 55.50
- 2006/7 65.00

Orissa Iron ore Resources (1 of 2)

- Iron ore Reserve in Orissa
- District Reserve(MT)
- Keonjhar 3574.00
- Sundergarh 1605.00
- Mayurbhanj 35
- Jaipur-Keonjhar 82
- Jaipur 10
- Total 5306.00
- Source:Director of Geology,Orissa
- Iron ore Reserve in Leaseholds mines & freeholds
- District Reserve Reserve in
- in leasehold(MT) Freehold(MT)
- Keonjhar 2316 1258
- Sundergarh 574 1031
- Mayurbhanj 28 07
- Jajpur-Keonjhar 82 --
- Jajpur -- 10
- Total 3000 2306
- Source:Director of Mines,Orissa

Orissa Iron ore Resources (2 of 2)

- Summary of Iron ore Availability in Orissa
- Resources Reserve(MT)
- Total Resources 5306
- Resources in leaseholds 3000
- Resources granted,
- But not executed 428
- Resources Reserved
- (For SAIL+OMC) 517
- Resources allotted 3945
- Balance Available 1361
- Source:Director of Mines,Orissa
- Strategy for Iron ore to meet Steel demand in orissa
- 1. Iron ore in many areas are not fully explored. Detailed exploration by geological mapping, close spaced drilling & sampling may augment extra IRON ORE RESOURCES
- 2.Directorate of Geology in last 2 years had identified 8 blocks in Keonjhar & 3 blocks in sundergarh
- 3.Small/scattered deposits must be assessed

Strategy for Iron ore to meet Steel demand in orissa -contd

- 4.Gap area between ML areas should be explored
- 5.Systematicexploration be done in all working mines/ML Holders with close drilling say 50x50 m drilling & RESOURCES calculated at 45% Fe cut off, most of Mines have adopted 56% Fe cut offs/Private mines with no BENEFICIATION PLANTS have cut offs at say 60-62% Fe
- 6.Entire ML area be explored with 50x50m close drilling with 45% Fe cut offs
- 7 Every mine be asked to drill at least 25 m/MT Iron ore Reserve in next 2years time(Private mines) to assess RESERVE
- (particularly private mines)
- 8.Subgrade dumps /Iron ore fines dumps be beneficiated by HIGH TECH BENEFICITION RECHNIQUES(cyclone/grinding/HGMS/WHIMS) for upgrading to 65% Fe from 45/50% Fe
- 9 Exploration within BHJ & BHQ bands be done, known to contain Iron ore. Also formation below BHJ/BHQ be examined for IRON ORE Availability by DRILLING
- Iron ore requirement in Orissa state-MOUs
- Formation below BHJ/BHQ to be drilled to ascertain Iron ore
- Total Mou-49 Nos, Aggregate tonnage of STEEL—75 MT
- Iron ore reqd/Tonne of Steel—1600 kgs processed ore or 1840 kgs of raw ore
- 75Mt steel needs—138 MT ore/year
- With present Reserve—will suffice for 40 years for 75 MTsteel prodn/year
- With 45% Fe as cut off (present cut off in Mining-56% Fe),life will increase at least 25%,ie Reserve will increase by 25%

Iron ore requirement in Orissa state-MOUs -contd

- Low grade ore i.e. +45% Fe will be beneficiated by cyclone/HGMS /WHIMS to produce 'CONCENTRATE of +65% Fe with +70% recovery
- Irone ore Slime/processing waste with 40% Fe shall be filtered, so that 30% slime shall yield additional 15% by Volume of extra IRON ORE CONCENTRATE of 65% Fe i.e. RECOVERY shall be about 85%
- Present scenario of Iron ore mining in India
  (Iron ore production in India)
- -Essar Steel Orissa Ltd is planning to beneficiate 11 MT Iron ore fines of 58-59% Fe ,use grinding cyclones /HGMS/Filtration route, upgrade to 64-65% Fe ,recover 75% ,also recover Fe values from SLIMES by Filtration (nearly 50%) i.e. ultimately 85%recovery .Concentrate(iron ore fines of +65% Fe shall be transported by Pipe lines of 260 kms by NH side at 20% of Railways cost
- -By using low grade fines (58% Fe average i.e. from 56% to 60% Fe),Essar plans to produce steel by TECHNOLOGY ROUTE both in beneficiation /transportation /Pelletisation.This will improve 'RESERVE OF IRON ORE IN ORISSA,as low grade ore is not accounted in State Reserve
- -SAIL mines/Tatas/OMC have planned their Mnes operation with Cut off at 56% Fe,A committee covering Rep of Directorate of Geology/Mines /GSI/RRL /Industries Experts from SAIL/Tatas/OMC/Other big operators mines in Orissa,can update Reserve immediately within 6-12months

What Orissa state should do now for updating present Iron ore Reserve in Orissa (Iron ore production in Orissa /India?)

- What Orissa state should do now for updating present Iron ore Reserve in Orissa (Iron ore production in Orissa /India?)
- All sub grade(54 to 58 or 60% Fe) use-can be blended with rich materials to get 63%average grade
- Geostatical quality control to be adopted in mines>1 Mt/year
- Ore bedding/blending facilities in mines/plant>1 MT/year
- Slime reprocessing by Filtration/HGMS
- Sinter ability studies with 20% of Fines recovered from slime addition (80% Fines+20% recovered fines from Slime) ,15% extra RESERVE
- More emphasis be placed on Mine Lease holders for adopting all above steps-mandatory for RESERVE Conservation
- New Mines in Iron ore required to be added in Orissa (MT) by 2020(12 years from now)
- POSCO = 22
- ESSAR = 12
- LN Mittal = 22
- TATA Steel = 12
- Jindal = 12
- Others = 10
- Total = 90 --New Mines in Iron ore required to be added in Orissa (MT)
- Since 90 MT Iron ore capacity is to be stepped up in Orissa by 2018, we need quick Mining Lease, EMP, EIA, and Forestry Clearance within 2-3 years
- Mines Construction, Prodn stabilization will take 4 yrs+3 years=7 years

Domestic Demand Projections

- Domestic Demand Projections
- For Crude Steel Production of say 110 (MT) as per plan
- -Iron ore requirement---1600kgs/tonne i.e. 1840 kg of raw ore
- 110 MT steel production needs 211 MT of raw ore/year
- With 25,000 MT Iron ore Reserve, it will suffice—25000/211 =211 years
- This presumes NO EXPORT from India (presently 50% of Prodn is exported i.e.>100 MT/year)
- By EXPORT ,India gives opportunities for INVESTMENT in foreign countries
- Of course we need Dollars/Foreign trade, therefore EXPORT is to be controlled /WTO

Minerals Resources development & Regulation-Hoda committee recommendations

- (a) Covering changes in MCR & MMDR Act 1948 for grant of RP, PL & ML etc
- -Regarding sustainable development of land oustees
- -Regarding fast track approval of environment & forest clearance etc
- -Regarding infrastructure development in mining areas
- -Regarding states asking for value addition as pre-condition to grant ML
- -Regarding ban on export of iron ore
- help of state/center reqd here for fast clearances without compromising MC Rules-60/MMRD-56/Forest conservation Acts-78.Amenment in these central Legislation is required immediately in PARLIAMENT(taking into consideration of opinion of Mineral rich states like Orissa /CG /Jharkhand/Bihar/MP/Rajasthan)

UTILISATION OF LOW GRADE IRON ORE IN ORISSA STATE

- Purpose-Area of concern to day is –Best practices in clean & green Mining & Beneficiation Techiniques
- While Essar steel orissa Ltd had signed a MOU with Orissa Govt for putting up a Steel Plant at Para dip of 4 MTPY at an estimated expenditure of Rs.10,000 & odds crores , now planned for 6 MTPY steel plant at about Rs.15,000 crores
- Applied for a no of iron ore Mining leses,particularly for virgin deposits like Mankadnacha,Badamgarh,Balia Parbat,Khandadhar,thakurani,Malangtoli Iron ore deposits & few of ML application has already reached Orissa govt. level for consideration for M L grant
- subject to ESOL spending >25% capital outlay of Project cost ,the state govt may consider the ML application for allocation of 'Iron ore Reserve for 25 years steel production on basis of 1600 kgs of processed Iron ore /tonne of steel making capacity

- However, it takes 8-10 years for any mechanized Iron ore mine (say 5 MTPA) installation, development of mines,crushing,screening,Beneficiation plant, mechanized loading. siding development, Tailing dam installation including detailed exploration of deposit for mine planning purpose, EMP, EIA, forestry clearance prior to Mining lease grant,
- therefore Essar Steel Orissa without waiting for Mine allocation, planned for a beneficiation plant installation/operation by procurement of low grade Iron ore fines of 58 % Fe,Beneficiate the same by a state of art beneficiation using grinding ,cyclones,HGMS route to up grade to +64.5% Fe with about +70% recovery.
- For this 5-6 no of representative Iron ore low grade fines samples (5 tonne each) were collected from a no of iron ore mines of Barbil area, tested in RRL, Bhubaneswar for various beneficiation tests. Different beneficiation process routes combination were considered considering highest recovery & lowest cost of production & final process route is as under
- Rom Quality-60.17% Fe, ROM volume-11 MTPA
- Size--+100 mesh upto 10 MM
- Beneficiation route adopted—Roll crusher-Screw classifier-Hydro cyclone-Rougher spiral-cleaner spiral-Magnetic separation (HGMS)-final products
- -Final product of Iron ore fines---Fe-66.07%
- Recovery—70.16 %
- Tailings analysis- Fe-44.42%, Recovery—29.84%
- Tailings can be filtered further at Tailing dam,& about 50% Fe values can be recovered with +64.5% Fe.thus total recovery becomes about 70+15=85% with products of + 64.5-65% Fe

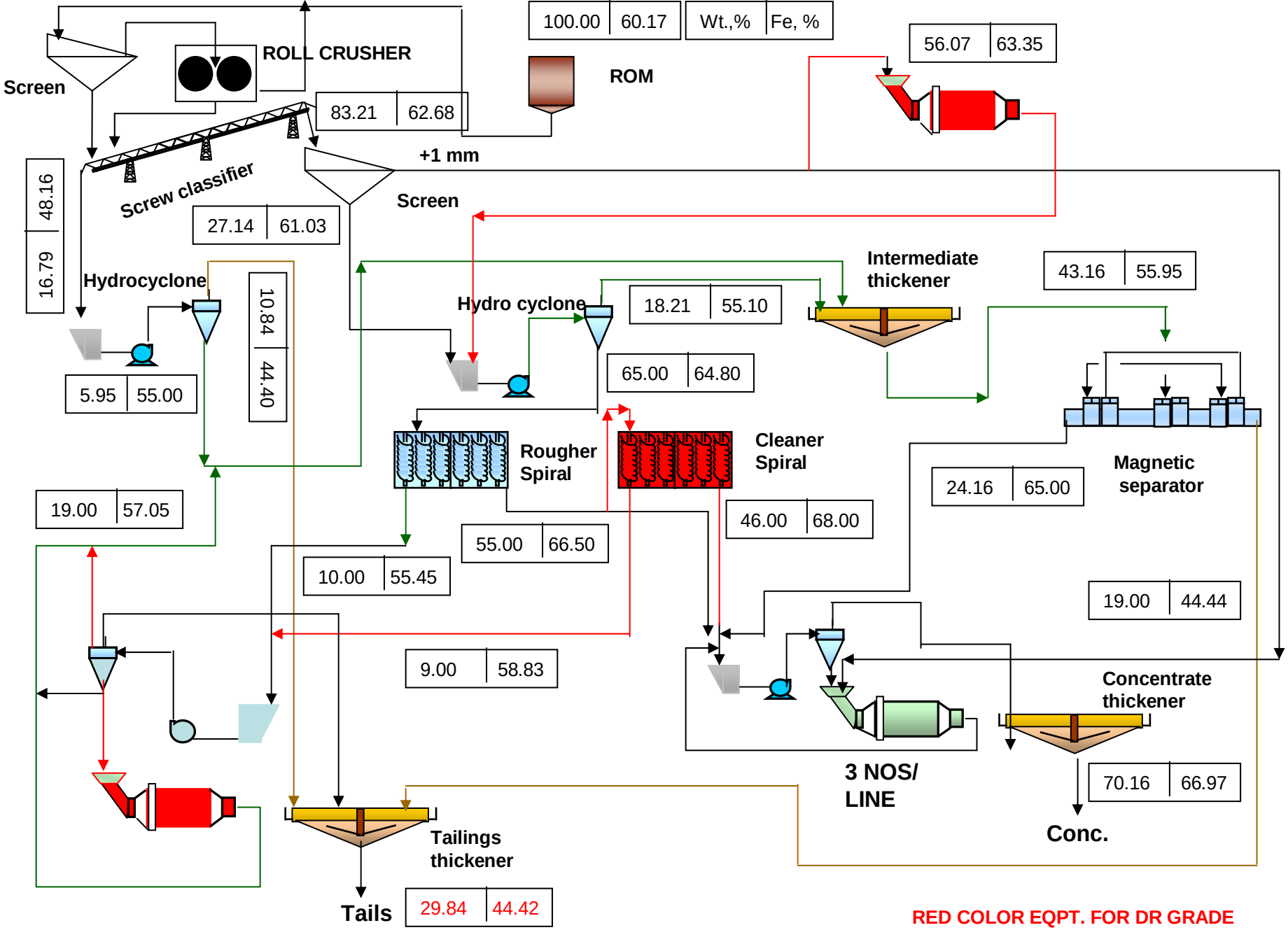

Fig. 3.3 Flowsheet for iron ore beneficiation – Scheme II

- **IRON ORE SLURRY/CONCENTRATE TRANSPORT:**
- **To further control cost ,Essar has planned about 8 MT concentrate transport by pipe lines from their Beneficiation plant at Dubna to Paradip through 20 inch Dia MS pipe lines over 263 kms by side of NH/state high way to Paradip for use in Pellet plant .The details of slurry transport is as under**
- **Pipe transport of Iron ore slurry**
- **Length-----253 Kms**
- **Route-Dubna/Pallasponga /Narayanpur /Dubri /Chandikhol /Partadip**
- **-Pipe dia---20 inch (OD), thickness-13.4 mm minim & 20 mm-max, Alloy steel pipes /carbon steel pipes**
- **-Some understanding has been developed for purchase of low grade Iron ore Fines from adjacent mines to supply at least 11-12 MTPA Fines**
- **-Pipe design-by PSI, USA, and Length of each pipe line-12m/piece**
- **-By side of State high way /National highway.10-20 meters from edge of road**
- **-Pipe joining-by welding, life of pipe---30 years, Pressure---144 Atmosphere**
- **-Water: solid (iron ore fines) ratio=66:34**
- **-Time for laying pipes---12 months**
- **-Cost of laying pipes ----1.2 Cores INR /km**
- **-Capacity of pipe range---12 MTPA**
- **-Water source—Baitarini River,7 kms from Dubna**
- **-Pumping---12 cusec for Beneficiation plant of 12 MTPY & Slurry pipe lines**
- **-Pipe laying has started & has put in 80 Kms pipes & expected to complete by 10/2010**

- **Contd-**
- **-11 MT Iron ore fines transportation by Rlys would have been a mammoth affairs, wagon availability, loading in time ,faster cycle time, fast transfer of loads& empty at exchange yard ,development of exchange yard for Rlys at Paradip,all these problems are skiped off**
- **About 80 kms of pipe lines is already laid ,both Pellet plant at Paradip & Beneficiation plant at Dubna are expected to be commissioned by ESSAR by 8 /2010**
- **Cost of Transport is expected to be only 20% of Rlys transport cost say at Rs.70.00 /tonne against Rly cost of > Rs.300/tonne.**
- **Iron ore processing & transport is being planned in a very eco-friendly manner**

Conclusion

- **The need of the hour is to develop such low grade deposits with large scale mechanised Iron ore production >10 MTPA with multi stage crushing,screening,beneficiation in wet circuit along with HGMS/WHIMS with filtration facilities for further recovery of Iron values from slime, recover nearly 85% of low grade Iron ore of 58-60% Fe**
- **this will conserve our Iron ore drastically ,our Iron ore Reserve may be increased by 20-30%**
- **Leading Iron ore producers in the world have increased their production capabilities to become more competitive through in-house rationalization & consolidation through mergers & acquisitions.**
- **Quick ML Sanction by Orissa / Jharkhand Govt., within 2 years ,EMP,EIA, Forestry clearance in 2 years and speedy mine development by 3-4 years and build capacity by 2012./Bigger (.5 MT) mines development be encouraged**
- **Due to Gas find in Paradip, Electric process of Steel making I.e. Beneficiate Fines from 58% to 65% Fe/ DR Pellets /BF route or Electric process of steel making can be solution for cheaper steel production from low grade iron ore. Good Power plant support by use of captive coal block mining in IB Valley/Orissa is essential**
- **India can not remain aloof from the events happening else where in the world**

- India has to take action by good political will to be globally competitive in quality, quantity & also meet increased domestic demands. Strong political will is required for speedy ML sanction,EMP,EIA clearance, Mines development
- Attract investment in infrastructure development in Rlys, Ports, power, and road. Deeper ports development be encouraged
- Mine owners to develop beneficiation & blending facilities in mines/small existing mines to be amalgamated to a group
- New technologies like direct reduction/direct smelting process to be encouraged for exploiting low grade ores
- Economics of marketing should be the deciding factor in Iron ore export/semi products-pig iron, sponge iron ,steel
- Solution-we have to decide whether we are going to participate in industry consolidation & lead it & define the industry or whether we are going to watch the industry consolidation around us & be a victim of that consolidation. The same holds good for India also.
- Increasing raw Coking coal availability with 15-17% ash in feed coal & development of new mines. This is possible now as the economy is opened upto Private Sector, Coal pricing is deregulated.

- Modification of existing Coking coal Washeries (CIL-20.10 MTPA & Other PSU & private-12.27 MTPA i.e. 32.37 MTPA) to improve capacity utilization as well as quality of washed coal to 17-18% ash
- increasing raw coal feed to Washeries by supplying low volatile medium coking coals of suitable quality. providing balancing facilities to improve washed coal production at 15-17 % ash
- Stabilization of newly commissioned washeries of CIL like Madhuban (2.5 MTPA-BCCL) & Kedla (2.6 MTPA CCL).
- 17.Encouraging for opening up Coking Coal Mines & coal washery installation & operation in private sectors & in Australia/South Africa with 8-9 % ash for suitable blending with Indian Coking coal at <15% ash for coke making
- With deli censing of Coal Mining in India, the situation in volume of coking coal supply with improved quality expected to improve by policy measures, like private/foreign companies participation in coal mining, coal washery installation/ operation / smoother process for low ash coal import.
- CDI coal is to be developed in India, suitable reserve is earmarked & coal mining carried out to supply to Indian Steel Sector

- Joint venture by Indian Steel Makers in development and operation of low ash coking coal mine in foreign countries will contain the cost of imported coal price. To be vigorously persued.Non coking coal washery of 70.35 MTPA for Sponge Iron / Cement plant /Power plants in operations are to be stabilized & new washeries are to be established to reduce ash content from 38-40% to say 25% to improve operational efficiency
- Conclusion-It is therefore necessary that with strong political will' state govt establish a Special Dept with Experts for close monitoring for land acquisition, grant of ML/PL/Forestry/EMP, EIA, R&R Policy finalisation by Liberalised methods (without compromise of various laws of land) to make it a SUCCESS STORY.
- •Mind sets of people/ professional approach in Govt dept in general needs change in Orissa & vigorous efforts are necessary if above dream plan is to be REAL
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