Threshold value of Iron Ore

By: Dr A S Singh, Sr. Manager (Geology)
BACKGROUND

• “Threshold Value of Minerals” means limit prescribed by the Indian Bureau of Mines from time to time based on the beneficiability and or marketability of a mineral for a given region and a given time

• As per Gazette notification 16th Oct’2009-

• IRON ORE:

• 1. Hematitic iron ore : 45% Fe(Min)
• 2. Haematitic Siliceous Ore (For Ore of Goan Origin): 35% Fe (Min)
Overview of Bailadila Iron Ore Mines

"Bailadila" range of hills derives its name from the shape of the hills, which look like 'the hump of an ox'.

The range comprises of 14 Deposits, Deposit No.1 to 5 in Western ridge, Deposit No. 6 to 12 in the Eastern ridge and Deposit 13 & 14 being the southern closure of Bailadila Range.

<table>
<thead>
<tr>
<th></th>
<th>Dep.14</th>
<th>Dep.11C</th>
<th>Dep.11B</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINING OPERATIONS COMMENCEMENT YEAR</td>
<td>1968</td>
<td>1987</td>
<td>2015</td>
</tr>
<tr>
<td>PRODUCTION SINCE INCEPTION</td>
<td>161 MT</td>
<td>124 MT</td>
<td>14 LT</td>
</tr>
<tr>
<td>BENCH</td>
<td>SGH QTY(LT)</td>
<td>SGH Fe%</td>
<td>BGH QTY(LT)</td>
</tr>
<tr>
<td>--------</td>
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</tr>
<tr>
<td>Dep14</td>
<td>941.49</td>
<td>67.88</td>
<td>480.91</td>
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<tr>
<td>Dep.11C</td>
<td>90.47</td>
<td>67.99</td>
<td>967.19</td>
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<tr>
<td>Dep.11B</td>
<td>507.89</td>
<td>68.42</td>
<td>668.00</td>
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<tr>
<td>Total</td>
<td>1539.85</td>
<td>68.07</td>
<td>2116.11</td>
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<tr>
<th>INCIDENCE</th>
<th>%</th>
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<tr>
<td>Dep14</td>
<td>19.79</td>
<td>27.20</td>
<td>11.47</td>
<td>6.41</td>
<td>28.29</td>
<td>1.75</td>
<td>0.73</td>
<td>1.19</td>
<td>3.17</td>
<td>100.00</td>
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<td>Dep.11C</td>
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Steps/stages in Quality control

- Mine Planning and Excavation stage
- Ore Processing stage
- Stockpiling
- Loading stage
- Weekly Quality Review Meetings
- Corrective/Preventive Steps
- Updation of plans regularly
Flow Chart of Quality Control

MINE PLANNING & EXCAVATION

- Bore Hole Data
  - Ore Body Modelling & Slice and Grade Plans
  - Long Term Planning
  - Yearly Plan
  - Quarterly Plan

- Blast Hole Data
  - Monthly Plan
  - Weekly Excavation
  - Daily Excavation

ORE PROCESS

- ROM Sampling
  - Crushing Plant Feed
- ROM Sampling
  - Screening Plant Feed

- Lump Ore Sampling
  - Stockpile Grades
  - Lump Ore
  - Fine Ore
- Fine Ore Sampling

DESpatch

- Rake Sampling
  - Despatches Based on Stockpile Grades

Update, if any, based on face mapping and additional data during excavation.
PRESENT WORKING AT MINING & PROCESSING

- ADOPTED ZERO DISCHARGE FROM MINE AND BENEFICIATION PLANT HEAD.

- NO WET SCREENING.

- MAINTAIN ENVIRONMENTAL CONCERN.
PRESENT PRACTICAL CONSTRAINTS IN MINING & PROCESSING

- Threshold value of iron ore has been reduced by IBM from 55% Fe to 45% Fe.

- Ultimate pit limit extended substantially after deep hole drillings.

- Requires more space for handling waste and subgrade.
THE REMOTE LOCATION: MINE FOLLOW ZERO DISCHARGE POLICY AND THE FREIGHT CHARGES ON THE MINERAL IS VERY HIGH DUE TO REMOTE LOCATION.
## SUB GRADE STATUS AT MINE

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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>165000</td>
<td>140000</td>
<td>50000</td>
</tr>
<tr>
<td>Subgrade available</td>
<td>324000</td>
<td>265000</td>
<td>72000</td>
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</tbody>
</table>
## WASTE STATUS AT MINE

<table>
<thead>
<tr>
<th>Dep.14(MT)</th>
<th>Dep.14NMZ(MT)</th>
<th>Dep.11B(MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste in dumps</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
</table>
## Specifications of Bailadila ore

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>BAILA LUMP</th>
<th>BAILA ROM</th>
<th>SIIL CLO</th>
<th>DR CLO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe% (base)</td>
<td>65.5</td>
<td>65.5</td>
<td>65.5</td>
<td>67.0</td>
</tr>
</tbody>
</table>

### Baila fines

<table>
<thead>
<tr>
<th></th>
<th>EXPORT</th>
<th>VSP</th>
<th>ESSAR (FO + S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe% (base)</td>
<td>65.0</td>
<td>64.0</td>
<td>64.0</td>
</tr>
<tr>
<td>Size</td>
<td></td>
<td>(-) 10mm</td>
<td></td>
</tr>
</tbody>
</table>

INDUSTRY REQUIREMENT

• Quality of ore results in optimizing costs, improvement in productivity etc.

• In iron ore, key chemical parameters are Fe, SiO$_2$, Al$_2$O$_3$ & P apart from LOI, moisture, trace elements

• Ideal physical properties allow all zones to perform satisfactorily their respective functions as distributors of gas, heat etc in the furnace

• Consistency in quality is a key factor compared resource position
INDUSTRY REQUIREMENT

• Chemical Properties (High Iron content & Low Gangue)
• Physical Properties (Close size Range, High TI & Low Al)
• Metallurgical Properties (Good reducibility and Metallization, Low RDI etc.)
INDUSTRY REQUIREMENT

• For any industry the requirement of raw material is strictly based on the Process Design and End Product

• Therefore, quality norms/requirements of raw materials are not uniform and demand is for consistent ore quality

• Tolerance of deviation in quality should be within the accepted norms of standard deviation
## INDUSTRY REQUIREMENT

<table>
<thead>
<tr>
<th>Radical</th>
<th>Blast Furnace</th>
<th>Steel Making</th>
<th>Sintering</th>
<th>Pelletisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe % (min)</td>
<td>64</td>
<td>62-68</td>
<td>63-64</td>
<td>63-64</td>
</tr>
<tr>
<td>SiO2% (max)</td>
<td>2-2.5</td>
<td>2-3</td>
<td>2.5-3</td>
<td>2.5-3</td>
</tr>
<tr>
<td>Al2O3% (max)</td>
<td>2-2.5</td>
<td>2-3</td>
<td>2.5-3</td>
<td>2.5-3</td>
</tr>
<tr>
<td>Al2O3: SiO2 (max)</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>S% (MAX)</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P% (max)</td>
<td>0.03</td>
<td>0.03-0.1</td>
<td></td>
<td>0.08</td>
</tr>
<tr>
<td>SIZE</td>
<td>10-40mm (lumps) sinters, pellets (15mm)</td>
<td>50-150</td>
<td>-10+0.15</td>
<td>-325# (85% min)</td>
</tr>
</tbody>
</table>
Silica

Alumina

Silica +Alumina is demand to maintain below 5%, which are very hardly being maintain as per requirement of customer specification.

LOI

At present level of threshold value the LOI comes between 3-3.5 %. The customer requirement is below 3% which is creating some problem with customers.
NMDC: VISION PLAN – 100 MT

PRODUCTION CAPACITY ENHANCEMENT PLAN –
30 MTPA FROM KIRANDUL COMPLEX.
ACHIEVING 10 MT PRODUCTION FROM EACH DEPOSIT BY THE YEAR 2024-25.
TARGETED PER DAY PRODUCTION FROM THREE MINES ~ 98000 TONNES.
View of Dep. 14 Mine
Typical cross section of Dep14 Bailadila Iron Ore Mines
View of Dep. 11C Mine
Typical cross section of Dep14NMZ Bailadila Iron Ore Mines
Typical cross section of Dep14NMZ Bailadila Iron Ore Mines
Typical BH 402 m of Dep14NMZ Bailadila Iron Ore Mines

The BH data at Dep.14NMZ
Typical cross section of Dep11B Bailadila Iron Ore Mines
The Natural Cut-off in iron ore

1. 58% Fe (include SGH, BGH, BD, Laterite, Limonite, Ocherous)
2. 55% Fe (Includes low grade Laterite, Ocherous, flaky ore)
3. 45% Fe (include Siliceous Blue dust, enriched BHQ)
4. 32% Fe (include BHQ and ferruginous shale)
5. 25% Fe (include ferruginous shale)
The Natural Cutoff in iron ore

1. Iron Ore (SGH, BGH, BD, Laterite, Limonite, Ocherous low grade Laterite, Ocherous, flakey ore Siliceous Blue dust, enriched BHQ), Fe is free at 100#

2. 45% Fe

3. BHQ, Fe is at interlocking with host rock

4. Shale
As received sample
Ground to -100#
Desliming with Hydrocyclone
Cyclone U/F
Cyclone O/F
Rougher tabling test -1
Conc-1
Middling
Tails-1
Rougher tabling test -2
Conc-2
Tails
Wet LIMS
LIMS Mag
LIMS Non-Mag
Ground to -200#
Froth Flotation

BHQ Characterization

Test Scheme -1 of Beneficiation studies of BHQ
EFFECT ON CHANGE IN CUT-OFF

1. Ore Type incidence
2. Reserve
3. Average grade of the total ore
4. Mining
5. Beneficiation
6. Steel industry
7. Quality of end product
APPROACH

NMDC approach is towards maximum utilization of natural resources and to achieve this we have set a research and development wing at R&D Hyderabad. The further research for utilization of low grade ore / waste is being under development.
CONCLUSION

1) BHQ contain Hematite with varying composition of martite and Quartz as major gangue mineral

2) The Fe contains of hematite is at interlocking with gangue minerals.

3) The concentrate of 65.90% Fe with 24.82% yield could be achieved in laboratory by the process of Wilfley table, LIMS and Froth Flotation which is not economically viable.

4) The studies shows that the characterization of BHQ (mother rock of iron ore) is not similar to the other iron ore.
5) The inclusion of BHQ in ore by blending will lead the tail
generation and spoil the quality of Iron ore without gaining
much Fe for utilization in steel industry.

6) The extraction of Fe from BHQ requires separate process of
handling and beneficiation process.

7) Thus the present threshold value (45% Fe) in the Iron ore
Mining at Bailadila Sector is at its natural position.

8) Further lowering the threshold value will lead the tail
generation with more than 80% of its iron value.

9) Lowering threshold value from 45% Fe will result lowering of
Average iron grade of production material and enhance the
other accessories, SiO₂, Al₂O₃ and LOI which will invite
marketability issues and grade problems for customers also.

10) NMDC opines that 45% threshold value of Fe for hematite ore
is optimum.