# Pre - Feasibility Report on Silica Sand

## Process Technology Developed

by

**iNDEXTb**

in association with
INDIAN BUREAU OF MINES
Government of India

**iNDEXTb**
Industrial Extension Bureau
( A Govt. of Gujarat Organisation )
Block No. 18, 2nd floor
Udyog Bhavan
Gandhinagar- 382 011

# CONTENTS

# SALIENT DATA OF THE BENEFICIATION PROJECT

| | | | |
|---|---|---|---|
| 1. | PLANT LIFE (MINIMUM) | : | 15 YEARS |
| 2. | PLANT CAPACITY (2 SHIFT BASIS) | : | 100 M.T.P.D 30,000 M.T.P.Y. |
| 3. | PLANT AVAILABILITY | : | 300 DAYS |
| 4. | PRODUCTION SILICA SAND: | | 75 M.T.P.D. 22,000 M.T.P.Y.(APPR.) |
| 5. | FEED GRADE | : | $SiO_2$ : 94.14% $Fe_2O_3$: 0.45% |
| 6. | CONCENTRATE GRADE (-)30+120 # | : | $SiO_2$ : 99.40% $Fe_2O_3$: 0.044% |
| 7. | WT% YIELD | : | 75.0 |
| 8. | PROCESS | : | ATTRITION SCRUBBING, CLASSIFICATION, ROD MILLING, WET HIGH INTENSITY MAGNETIC SEPARATION, ROTARY SCREENING. |
| 9. | CAPITAL INVESTMENT | : | 2.75 CRORES |
| 10. | OPERATING COST | : | RS. 190/-/TONNE ORE MILLED, RS.250/-/TONNE CONC. – PRODUCED. |

# PART-I: BENEFICIATION

## SECTION I: PROCESS DESCRIPTION:

The following is the brief description of the processing concept:

### 1.1 ORE HANDLING AND STOCK PILE:

The Run of Mine Ore would be transported and stock piled near the Beneficiation Plant.

The stockpiled ore will be delivered to the fine ore bin through a belt conveyor, having tramp magnet over it.

The feeder will draw the material at controlled rates from the bin and feed the same, through a conveyor to the attrition scrubber.

The ancillary equipment and facilities will include dry automatic sampler, weightometer, dust collecting system/ventilation etc.

### 1.2 CONCENTRATION:

From ore bin, the ore will be drawn through a feeder at controlled rate and through a conveyor fed to the wet attrition scrubber. The wet scrubbed product would be fed to the spiral classifier. The classifier overflow, containing the clayey material and constituting the 'Reject-I' would be pumped to the tailing/reject pond/area. The classifier underflow, through a classifier, would be pushed to the rod mill, for its milling. The Rod milled product, through a pump, would be fed to the wet High Intensity Magnetic Separator. The Magnetic fraction, constituting Reject-II would be pushed to the tailing pond/reject area. The Non-magnetic fraction, through a pump, would be passed to the circular vibrating screen, which would deliver the final desired product(s).

### 1.3 PROCESS FLOWSHEET:

The Flow diagram and flowsheet alongwith material balance of the Beneficiation Plant are given as Annexures I, II & III.

## SECTION 2: PLANT DESIGN CRITERIA

| | | |
|---|---|---|
| PLANT LIFE – YEARS (MIN.) | : | 15 |
| NUMBER OF WORKING DAYS/YEAR | : | 300 |
| NUMBER OF OPERATING SHIFTS/DAY | : | 2 |
| NUMBER OF OPERATING HOURS/SHIFT | : | 8 |
| PLANT AVAILABILITY % | : | 90 |
| ACTUAL NUMBER OF WORKING HOURS | : | 14-15 |
| DESIGN DAILY MILLING (MTPD) RATE | : | 100 |
| DESIGN HOURLY MILLING (MTPH) RATE | : | 7 |
| SPECIFIC GRAVITY OF ORE SAMPLE | : | 2.9 |
| MILL HEAD GRADE – SiO2 | : | 94.14 |
| CONCENTRATE GRADE ((-)30+120) SiO2 | : | 99.40 |
| WT% YIELD | : | 75.0 |
| SILICA SAND CONC. PRODUCTION PER DAY (AVERAGE) – MTPD | : | 75 |

## SECTION 3: CONCEPTUAL MASSFLOW BALANCE:

### 3.1 GENERAL:

This section contains details of conceptual Mass Flow balance for the various circuits of the concentration section.

The data is provided as an indication of the likely flow rates to occur under normal operating conditions. In practice slight fluctuations around these levels may be anticipated.

### 3.2 MASS FLOW BALANCE:

The mass flow balance of the various circuits of the concentration section is presented in Table No.1. The overall water balance is presented in Table No.7.

**TABLE NO.1**
**MASS FLOW BALANCE**

| Sl.No. | Product | Dry Wt Tonnes/hr | Water $M^3$/hr | Pulp Tonnes/hr | % Solids | Wt% yield |
|---|---|---|---|---|---|---|
| 1. | Feed to Scrubber | 7.00 | 15.151 | 22.151 | 31.6 | 100.0 |
| 2. | Feed to classifier | 7.00 | 18.521 | 25.521 | 27.0 | 100.0 |
| 3. | Classifier O/F | 0.589 | 12.110 | 12.699 | 4.6 | 8.4 |
| 4. | Classifier U/F | 6.411 | 6.411 | 12.822 | 50.0 | 91.6 |
| 5. | Feed to Rod Mill | 6.411 | 6.411 | 12.822 | 50.0 | 91.6 |
| 6. | Rod Mill discharge | 6.411 | 6.411 | 12.822 | 50.0 | 91.6 |
| 7. | Feed to WHIMS | 6.411 | 63.273 | 69.684 | 9.2 | 91.6 |
| 8. | Magnetic fraction | 0.510 | 8.960 | 9.470 | 5.4 | 7.3 |
| 9. | Non-magnetic fraction | 5.901 | 54.313 | 60.214 | 9.8 | 84.3 |
| 10. | Feed to vibrating screen | 5.901 | 54.313 | 60.214 | 9.8 | 84.3 |
| 11. | Sieve analysis of Non-mag: | | | | | |
| | -30+80 mesh | 4.431 | 2.797 | 7.228 | 61.3 | 63.3 |
| | -80+100 mesh | 0.441 | 1.044 | 1.485 | 29.7 | 6.3 |
| | -100+120 mesh | 0.392 | 1.186 | 1.578 | 24.8 | 5.6 |
| | -120 mesh | 0.637 | 49.286 | 49.923 | 1.3 | 9.1 |

## SECTION 4: MAJOR PLANT MACHINERY

The major machinery for the Beneficiation plant would include:

| | | | | |
|---|---|---|---|---|
| 1. | BELT CONVEYOR(S): | | | |
| | (i) | for conveying stockpiled ore to fine ore bin | : | 1 No. |
| | (ii) | for conveying ore from ore feeder to attrition scrubber | : | 1 No. |
| | (iii) | for conveying classifier underflow to Rod Mill | : | 1 No. |
| 2. | ORE BIN | | : | 1 No. |
| 3. | BELT FEEDER | | : | 1 No. |
| 4. | ATTRITION SCRUBBER | | : | 1 No. |
| 5. | SPIRAL CLASSIFIER ( SIMPLEX) | | : | 1 No. |
| 6. | ROD MILL | | : | 1 No. |
| 7. | MAGNETIC SEPARATOR ( ERIEZ) | | : | 1 No. |
| 8. | VIBRATING SCREEN CIRCULAR | | : | 1 No. |
| 9. | PUMPS | | : | 18 Nos. |
| | (i) | OPERATING : 9 Nos | | |
| | (ii) | STANDBY : 9 Nos | | |

The details of Plant machinery/equipment are presented in Table No.2.

## TABLE NO.2
## LIST OF MAJOR EQUIPMENT/MACHINERY

| Sl.No | Equipment/ machinery | Qty. No(s) | Make | Size | H.P. | Price (Appr.) Rs./lakhs |
|---|---|---|---|---|---|---|
| 1. | Belt conveyor (for conveying stockpiled ore to F.O.B.) | 1 | Local | 450/400 MM width L:20 MM (Approx.) | 5 | 6.00 |
| 2. | Weigh Feeder | 1 | Local | Matching | - | 1.00 |
| 3. | Ore bin | 1 | Local | 2.18M x 4.36M x 6.54M | - | 2.00 |
| 4. | Belt feeder (variable speed) | 1 | Local (Denver type) | Matching | 1 | 2.00 |
| 5. | Belt conveyor (for conveying ore from belt ore feeder to attrition scrubber ) | 1 | Local | 375/450 M | 5 | 6.00 |
| 6. | Attrition scrubber | 1 | Local | L 2.5M<br>W 0.8 M<br>H 2.0 M | 20 | 12.00 |
| 7. | Spiral classifier (Simplex) | 1 | Local | 1800MM/75MM RPM ADJUSTABLE | 20 | 10.00 |
| 8. | Belt conveyor (for conveying C & U.F. to Rod Mill | 1 | Local | 375/450MM | 5 | 6.00 |
| 9. | Rod Mill | 1 | Local | 1500 MM x 2400 MM | 75 | 25.00 |
| 10. | Magnetic separator (Eriez Type: Model CF-100) | 1 | Local | Industrial Model | 5 | 15.00 |
| 11. | Vibrating screen circular | 1 | Pennwalt | Standard | 10 | 20.00 |
| 12. | Pumps | 18 | Local (Denver Type) | 150 x 150MM: 4 Nos<br>125 x1 25MM: 4 Nos<br>75 x 75MM: 2 Nos<br>50 x 50MM: 4 Nos<br>30 x 25MM: 4 Nos | 10<br>10<br>10<br>4<br>2 | 20.00 |
| | | | | TOTAL | 182 | 125.00 |

# PART-II : COST ESTIMATION

## SECTION 5: CAPITAL COSTS:

### 5.1 BASIS OF COSTS:

The costs of major machinery/equipment are based on the prevailed price as per reputed manufacturers of the country. The estimates for erection, piping, chutes, electricals, civils/structures are made on percentage basis of the equipment cost as are generally applicable for such plants.

Costs for land acquisition and development, mining and transportation, infrastructure facilities etc. are excluded from the purview of the report.

Interest on fixed capital and working capital is not taken into account as this will depend on the capital phasing of the overall project and the equity/debt ratio.

### 5.2 CAPITAL COST ESTIMATE:

The details of machinery/equipment costs, capital costs and capital investment are given in Table Nos. 2,3 & 4.

**TABLE NO.3**
**CAPITAL COST ESTIMATE**

| | | Rs, (lakhs) |
|---|---|---|
| 1. | Fixed capital cost | 250.00 |
| 2. | Working capital (10% of 1) | 25.00 |
| | Capital Investment: | 275.00 |

**TABLE NO.4**
**CAPITAL COST DETAILS**

| | | Rs. (lakhs) |
|---|---|---|
| 1. | Major equipment/machinery | 125.00 |
| 2. | Installation:<br>Erection, piping, chutes, electricals, civil (50% of 1) | 63.00 |
| 3. | Miscellaneous/contingencies (15% of 1) | 19.00 |
| 4. | Tailing Pond (10% of 1) | 13.00 |
| 5. | Plant building (20% 1) | 25.00 |
| | TOTAL<br>Say | 245.00<br>250.00 |

## SECTION 6: OPERATING COSTS:

### 6.1 BASIS OF COSTS:

The cost of mining and delivery of the ore upto the Processing Plant is not included.

The power cost is based on the unit rates as prevalent for the industrial use and taken @ Rs. 3/- per KWH. The rates of water are taken as per its industrial use @ Rs. 5/- per kilolitre.

The estimated power cost is for the operation of major machinery/equipment in the plant. Care has been taken, by safety factor, for lighting.

The water requirements have been calculated for processing plant. Recirculation of water, after its recovery, has been taken care of. The requirement of personnel has been calculated and their wages taken as prevalent currently.

Depreciation at a uniform rate of 5% is taken.

### 6.2 OPERATING COST ESTIMATE:

The operating cost works out to be Rs. 190/- per tonne of ore milled/treated and Rs. 250/- tonne of finished product produced. The operating costs are presented in Table No.5. The details of operating cost are presented in Table No.6.

TABLE NO.5
OPERATING COST ESTIMATE

A. DIRECT OPERATING COST:

| | | Amount (Rs./Tonne milled) |
|---|---|---|
| i. | Electricity | 66.00 |
| ii. | Water | 25.00 |
| iii. | Grinding Media/Milling ore & other misc. items | 10.00 |
| iv. | Ore/Concentrate Handling | 5.00 |
| v. | Royalty | 1.00 |
| | | 107.00 |

B. FIXED OPERATING COST:

| | | |
|---|---|---|
| i. | Labour & Overheads | 50.00 |
| ii. | Maintenance shares | 10.00 |
| iii. | Depreciation (5%) | 10.00 |
| iv. | Internal services | 10.00 |
| v. | Plant Insurance (1%) | 1.00 |
| | | 81.00 |
| | **Total cost of Milling ore (A+B)** | **188.00** |
| | **The final cost of finished product (Silica sand conc.)** | **250.00** |

## TABLE NO.6
## OPERATING COST DETAILS

(I) MANPOWER:

| Sl.No. | Manpower | No. of posts | Wages (Rs/month) | (Rs./Annum) |
|---|---|---|---|---|
| 1. | Plant Manager | 1 | 12,000 | 1,44,000 |
| 2. | Shift Incharge | 3 | 24,000 | 2,88,000 |
| 3. | Mechanics | 3 | 15,000 | 1,80,000 |
| 4. | Electricians | 3 | 15,000 | 1,80,000 |
| 5. | PA to Manager | 1 | 7,000 | 84,000 |
| 6. | Helpers | 8 | 32,000 | 3,84,000 |
| 7. | Clerks | 2 | 10,000 | 1,20,000 |
| | Total | 21 | | 13,80,000 |

Labour Cost/Tonne milled: Rs. 46/-

(II) <u>POWER:</u>

TOTAL H.P. = 182

$$\frac{182 \times 0.746}{0.90 \times 7} = 21.55$$

Say 22 KWH/T ROM @ Rs. 3/-/KWT = Rs. 66/-/T Milled

## TABLE NO. 7
## WATER BALANCE

| Water in | | $M^3$/hr |
|---|---|---|
| 1. | Water addition into Attrition scrubber | 15.151 |
| 2. | Water addition in feed to classifier | 3.370 |
| 3. | Water addition into Rod mill discharge | 56.862 |
| | Total: | 75.383 |

| Water out | | |
|---|---|---|
| 1. | Classifier overflow (Reject I) | 12.110 |
| 2. | Magnetic fraction (Reject II) | 8.960 |
| 3. | -30 + 80 mesh fraction | 2.797 |
| 4. | -80 + 100 mesh fraction | 1.044 |
| 5. | -100 + 120 mesh fraction | 1.186 |
| 6. | -120 mesh fraction | 49.286 |
| | | 75.383 |

75% water can be reclaimed from the screen fractions i.e. 54.313x0.75 = 40.734

Therefore fresh water required/hr = 75.383 – 40.734

= 34.649

or say 35 $M^3$/hr
or say 280 $M^3$/2 shift basis of –8 hours

## ACKNOWLEDGEMENT

The authors wish to express their sincere thanks to Shri A.N. Bose, Controller General, Indian Bureau of Mines, Nagpur for his keen interest in the study.

Thanks are also due to Shri S.B. Borkar, Junior Technical Assistant (OD) for his assistance.