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Report

on

Laboratory and pilot scale testwork with 8 t ROM iron ore sample from Blötberget deposit (Sweden)

for

Nordic Iron Ore AB
(Danderyd, Sweden)

Liebenburg-Othfresen, 2016, May 25th

Index

1. Introduction

On behalf of Nordic Iron Ore AB ("NIO"; Danderyd, Sweden), Studiengesellschaft für Eisenerzaufbereitung ("SGA") has performed laboratory and pilot scale testwork with an 8 t ROM iron ore sample from Blötberget deposit in Sweden.

The testwork comprised of

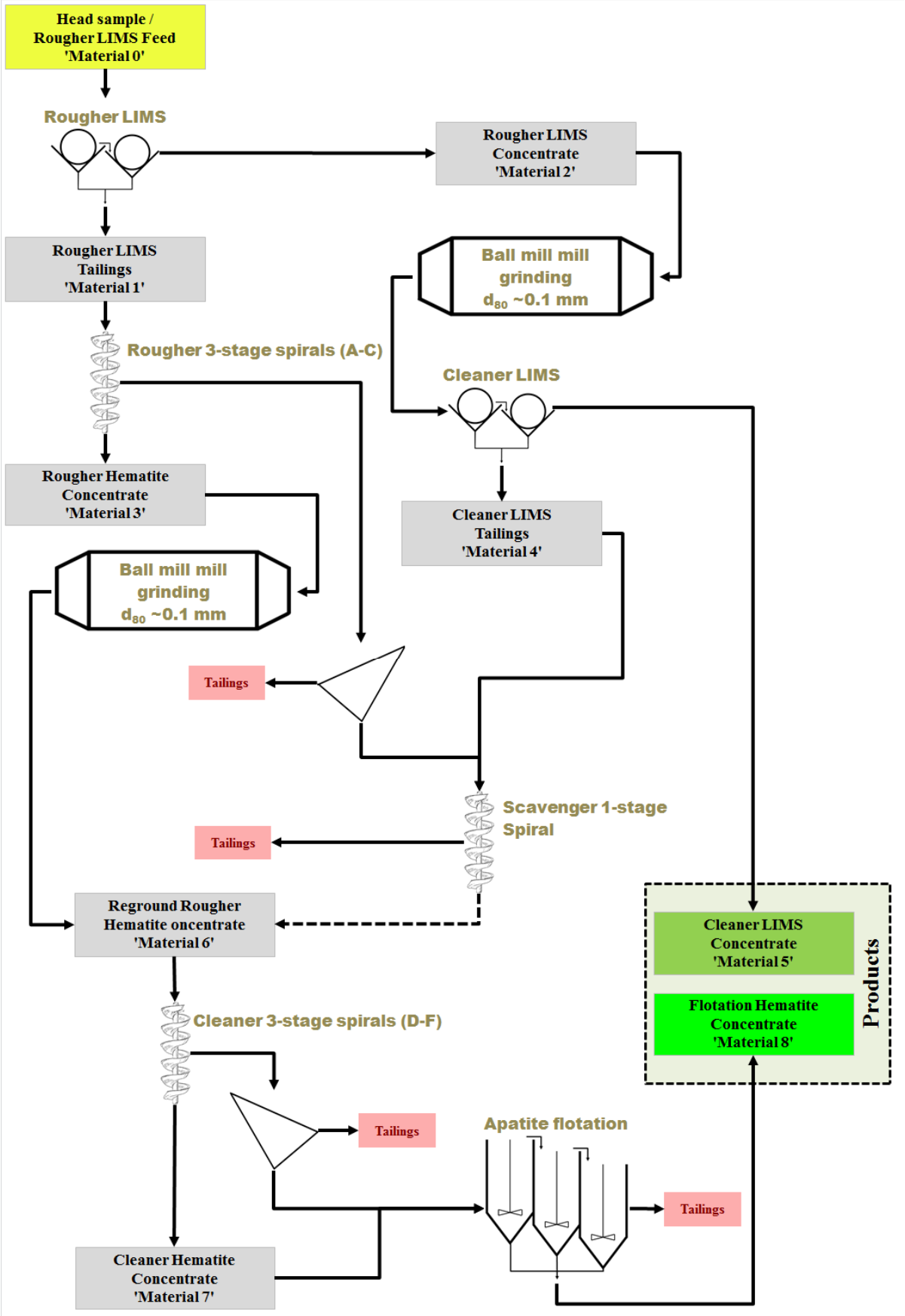
- receipt and preparation of three separate bulk sample materials
- the combination of these three ore types to produce a head sample representing the first five years of run of mine ('ROM') at Blötberget,
- pilot scale testwork for upgrading the iron content and reduce the phosphorus content and
- accompanying laboratory scale testwork.

In previous testwork a flowsheet for beneficiation of this ore had been developed. On the one hand this programme of work was expected to verify the suitability of that flowsheet, but the main purpose was to improve the iron recovery in the hematite recovery circuit.

The projects' intermediate and final results were discussed and mutually agreed between NIO, Tata Steel Consulting and SGA.

All findings and test results in this report refer to the tested sample only.

For a better understanding of the process flowsheet tested in pilot scale, a simplified preview of processes and material designations is given:



2. Delivered iron ore samples

On 28th October 2015, the first delivery with 16 big bags of Blötberget iron ore samples was received at SGA.

The delivery was spilt up as follows:

- 6 big bags ~6 t 'Guldkannan (GK)' / Magnetite
- 8 big bags ~8 t 'Hugget (HG)' / Hematite
- 2 big bags ~1.7 t 'Footwall (FW)' / Waste

The delivered ores were sized up to 500 mm. Each subsample was crushed individually using SGA's jaw crusher to <40 mm and subsequently homogenized and a sample for chemical analysis was split out. A short description of the jaw crusher is given in **Appendix E-1**.

The chemical analyses are listed in **Appendix 2-1**[1].

Guldkannan is a magnetitic type of crude ore with 33.9 % Fe_{tot} and 40.8 % Magnetite. The ratio of iron bound to magnetite and total iron content is at 87.1 %.[2]

Hugget is a crude ore with both magnetitic and hematitic portions, the iron content was found at 55.2 % Fe_{tot}, the Magnetite at 40.6 %. The ratio of iron bound to magnetite and total iron content is at 53.2 %. Accordingly, roughly a half of the iron can be recovered by low intensity magnetic separation.

Footwall showed low iron and magnetite content, i.e. 7.6 % Fe_{tot} and 4.7 % Magnetite.

With these three chemical compositions, the client instructed SGA to prepare a blend or composite sample according to the following proportions:

- 17.5 % 'Guldkannan (GK)' / Magnetite
- 52.5 % 'Hugget (HG)' / Hematite
- 30.0 % 'Footwall (FW)' / Waste

A 2 t sample, sized <40 mm, was combined accordingly, homogenized and sent to WEIR Minerals' test center (Cologne, Germany) for HPGR-testwork (High Pressure Grinding Rolls).

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[1] The numeration of appendices refers to the respective chapter in the report: Appendix 2 is linked to Chapter 2. The used equipment including its main characteristics is listed in Appendix E at the very end.

[2] The calculation of the percentage of iron bound to magnetite is as follows:

$$[\%\ Fe_{bound\ to\ magn.}/Fe_{tot}] = \frac{[\%\ [Fe_{bound\ to\ magn.}]}{[\%\ Fe_{tot}]} * 100\% = \frac{[\%\ Magn.] \cdot 0{,}72358}{[\%\ Fe_{tot}]}$$

However, to have sufficient head sample for all requested testwork at SGA, it became necessary to send additional 'Footwall (FW)' material. That second delivery was received at SGA on 22nd December 2015 and comprised of 3 big bags with a total of ~2.5 t.

To avoid unduly delays to the programme, SGA had already commencing crushing material from Guldkannan and Hugget individually to <1 mm. For this SGA's HPGR unit (**Appendix E-2**) and dry screen (**Appendix E-3**) was used. The ores were charged to HPGR in single pass at 3750 kN/m² and dry screened subsequently at 1 mm. The screen oversize was returned to the HPGR.

Upon receipt of the additional material, the footwall sample was crushed to <1 mm applying the same procedure.

All three samples were homogenized individually and weighed in according to the ratio mentioned above for final mix of head sample, representing Blötberget ROM.

The combination of the delivered subsamples is shown in **Appendix 2-2**.

The mixed head sample, 7900 kg in total, is designated as *'Material 0'* or as Rougher LIMS Feed according to the initial processing step.

3. Rougher stage low intensity magnetic separation

3.1. Rougher LIMS Feed

Chemical composition

The head sample – *Rougher LIMS Feed ('Material 0')* was analysed for its chemical composition, which is shown in **Appendix 3.1-1**.

The iron content was analysed to 37.6 % Fe_{tot}. Based on FeO content at 9.99 %, the theoretical magnetite content would be calculated to about 33.2 % Mag. Magnetite content was determined by Satmagan to 30.3 %, the lower value determined indicates that some FeO is bound to silicates. This might be proven by mineralogical survey of the material, which wasn't performed in this test programme.

From the determined magnetite content a ratio of $Fe_{bound\ to\ magnetite}/Fe_{tot}$ can be calculated to 58.3 %. That means that 58.3 % of the samples' iron is bound to magnetite and can be recovered mostly by low intensity magnetic separation after liberation grinding. The magnetite content gives an indication for the expected final weight recovery in multi-stage low intensity magnetic separation ("LIMS") after liberation grinding.

Silica was analysed for Rougher LIMS Feed to 35.35 % SiO_2 and alumina to 5.0 % Al_2O_3. Further, 1.25 % CaO and 1.77 % MgO were found. Loss on ignition (LOI) was at -0.38 %.[3]

Phosphorus content was at 0.236 % P, titanium dioxide at 0.185 % TiO_2 and Vanadium at 0.022 % V. P, TiO_2 and V have the tendency to concentrate in some or all of the final concentrates, therefore these elements are monitored throughout the project.

Alkalis were at 1.72 % Na_2O and 0.69 % K_2O, sulphur content was at 0.004 % S. The contents of the other analysed elements were low as well.

Size distribution

The result of the wet screen analysis is shown in **Appendix 3.1-2**.

The screening after HPGR at 1 mm resulted in only 6.0 % being larger than 0.63 mm. On the other hand only 18.4 % <0.040 mm were found. The d_{80}-value is calculated to 0.37 mm and the median size was at 0.15 mm.

[3] The given value is the weight loss during ignition. The weight gain caused by oxidation of magnetite had **not** been determined and separated. The negative value means that the weight gain caused by oxidation of magnetite is higher than the impurities being removed by ignition.

Davis Tube Tests

On client's request two Davis tube tests were performed. (Davis tube unit is described in **Appendix E-4**). One test was performed with the <1.0 mm sample. For the other one, the head sample was screened at 0.63 mm and oversize reground to <0.63 mm top size.

The results of both Davis Tube Tests are shown in **Appendix 3.1-3**.

The iron content of Davis tube concentrate was at 68.0 % Fe_{tot} for <1.0 mm and 68.7 % Fe_{tot} for <0.63 mm. The iron recovery was at 57.3 and 56.8 % Fe_{rec}, respectively. Silica was found at 3.5 and 3.13 % SiO_2. Accordingly 96.9 and 97.2 % of the silica were removed.

3.2. Rougher LIMS – Pilot scale test

Based on the suspicion that the ores from Blötberget would contain rather martite than hematite, it was suggested that a medium intensity magnetic separation ('MIMS') step be used in an attempt to reject tailings low in iron. Therefore a MIMS unit was put ahead the low intensity magnetic separation ('LIMS') for the rougher stage LIMS pilot scale test.

Hence the set-up for processing *Rougher LIMS Feed ('Material 0')* in pilot scale was as follows:

- 1-stage MIMS of *Rougher LIMS Feed ('Material 0')*
  (1 drum concurrent at 3500 Gauss; FST type; **Appendix E-5**)
- 3-stage LIMS of MIMS concentrate
  (1 drum counter-current at 1000 Gauss; Eriez type; **Appendix E-6**) and
  (2 drums counter-current at 600 Gauss; SALA type; **Appendix E-7**) [4]

Short to 7.9 t of ROM-sample (*Rougher LIMS Feed – 'Material 0'*) were processed in this pilot scale at 1800 kg/h. After reaching steady state, samples were taken and analysed for mass flow, size distribution and chemical composition. **Appendix 3.2-1** gives an overview on the flowsheet.

[4] The magnetic separators SGA used for pilot plant testing have the same diameter of 0.6, 0.9 and 1.2 m as industrial scale separators, therefore also the same configuration of the magnets. Only width is lower, industrial scale separators were manufactured up to 3.0 m of width, pilot plant units usually have a width of 0.4-0.2 m. Despite of this, the needed pulp flow from pilot units is still high, 8-15 m³/h. In case pulp density for feeding pilot scale units would be in the common range for an industrial one, about 400 kg_{solid}/m^3_{slurry}, solid feed rate would sum up to 3.2-6 t/h. These high quantities of material cannot be handled in pilot scale upstream or downstream, for example grinding devices.
When feeding pilot units of LIMS with only 0.5 t/h or less, a high flow rate has to be assured to avoid any sedimentation of solid in the course of separation. Because of this fact all pilot plant testwork of LIMS, not only at SGA, are operating with rather low pulp densities.
Several processing plants have been built based on SGA's findings from pilot plant testing and almost all of the values predicted for weight recoveries and grades could be reached.

Appendix 3.2-2 and **Appendix 3.2-3** show the detailed chemical and screen analyses of the different samples.

62.4 $\%_{v/o}$ of *Rougher LIMS Feed*'s weight was rejected by the MIMS unit (3500 Gauss). These tailings carried 37.4 $\%_{v/o}$ Fe_{rec} of the crude ores iron (22.5 % Fe_{tot}).[5] Hence, it must be concluded that the assumption that final tailings with sufficiently low Fe content could be rejected by MIMS was incorrect.

With the first LIMS unit (1000 Gauss) another 3.7 $\%_{v/o}$ of weight were rejected, with 19.8 % Fe_{tot}, 53.8 % SiO_2 and 0.46 % P.

The last rougher LIMS unit (600 Gauss) removed only little weight (0.5 $\%_{v/o}$) but improved the grade of the magnetite pre-concentrate from 67.2 to 67.9 % Fe_{tot}. The tailings from the last rougher unit contained 31.5 % Fe_{tot}, 37.6 % SiO_2 and 0.74 % P.

The three tailings combine for magnetite losses of 2.5 $\%_{v/o}$ $Magn._{rec}$ which is a typical value for a cobber magnetic separation stage.

All recovered tailings were combined and designated as *Rougher LIMS Tailings ('Material 1')*. As described in Chapter 4, this material was tested for further hematite recovery.

The magnetite concentrate from this process step is designated as *Rougher LIMS Concentrate ('Material 2')*. It was recovered at a weight recovery of 33.4 $\%_{v/o}$ based on crude ore (v/o).

Despite that '*Material 2'* is considered as a pre-concentrate, the grade was already quite high. The iron content was analysed to 67.9 % Fe_{tot}, which calculates to an iron recovery of 60.3 $\%_{v/o}$ Fe_{rec}. The magnetite content was determined by Satmagan to 90.5 %.

Silica was found at 3.67 % SiO_2. The phosphorus content was analysed to 0.070 % P. Titanium oxide was at 0.10 % TiO_2 and Vanadium at 0.050 % V.

The d_{80}-value of *Rougher LIMS Concentrate* was determined 0.455 mm. The specific surface was found at 295 Blaine.

The further testwork on Cleaner stage LIMS with *Rougher LIMS Concentrate ('Material 2')* is described in Chapter 5.

[5] The iron recovery (based on crude ore sample) in this report is always calculated as follows:

$$\%_{v/o}Fe_{rec} = \frac{\%_{v/o}[\text{combined weight recovery for all processing steps}] \cdot \%\, Fe_{tot}[\text{analysed for respective sample}]}{\%\, Fe_{tot}[from\ crude\ ore\ analysis]}$$

The magnetite, silica and Phosphorus recoveries are calculated concurringly.

4. Rougher stage spiral separation

4.1. Laboratory scale tests with Rougher LIMS Tailings - 'Material 1'

The Rougher *LIMS Tailings ('Material 1')* were combined from tailings from Rougher stage LIMS and represent 66.6 $\%_{v/o}$ of crude ore's weight. Before proceeding to a pilot scale test, the properties of Rougher *LIMS Tailings* were investigated in laboratory.

Chemical composition

The chemical composition of this material is given in **Appendix 4.1-1**.

The iron content was analysed to 24.6 % Fe_{tot}, which calculates to an iron recovery of 43.6 $\%_{v/o}$ Fe_{rec}. 1.1 % of magnetite were determined by Satmagan (2.4 $\%_{v/o}$ $Magn._{rec}$).

Further 49.7 % SiO_2, 0.24 % P, 0.20 % TiO_2 and 0.006 % V were determined.

Size distribution and screen metal analysis

Both, the size distribution and a screen metal analysis (size-by-size-assay) are displayed in **Appendix 4.1-2**.

The d_{80}-value is calculated to 0.36 mm and the median size to 0.165 mm. Specific density was determined to 3.20 g/cm³.

The size fraction <0.040mm, which must be considered as difficult to recover by spiral concentration, represented a mere 11.6 % of the weight, with an iron content of 19.4 % Fe_{tot}.

With exception of the >0.5 mm fraction, the iron content decreases and the silica increases for smaller particle sizes. The content of phosphorus increases distinctly towards the finer. Also titanium dioxide showed a slight increase. For vanadium no remarkable differences could be seen for the different particle sizes.

Shaking table test

A shaking table test was performed with '*Material 1'* to investigate the potential of gravity separation. For this test a 3.2 m by 1.3 m sized table (**Appendix E-8**) was used which gave in many cases a good estimate for a 3-stage spiral configuration (Rougher, cleaner, re-cleaner). The results for this tests are given in **Appendix 4.1-3.1** (weight recoveries and chemical analyses) and **Appendix 4.1-3.2** (size distributions).

In this test, four products were recovered: Concentrate going over the short edge at the end of the table, Middlings, Tailings 1 and Tailings 2 going over the long edge at the side.

A very high grade hematite concentrate was generated at a weight recovery of 15.2 % (or 10.1 $\%_{v/o}$ based on crude ore). The concentrate was composed of 67 % Fe_{tot} (18.6 $\%_{v/o}$ Fe_{rec}) and only 0.37 % SiO_2. Also the phosphorus content was advantageously low at 0.033 % P, further, 0.31 % TiO_2 and 0.011 % V were analysed. As mentioned above, this concentrate would be of favorable chemical quality and had a typical sizing for sinter concentrates.

A quarter of the feed (16.6 $\%_{v/o}$) was recovered to Middlings which carried with 18.9 $\%_{v/o}$ Fe_{rec} a significant portion of the crude ore's iron (42.8 % Fe_{tot}).

47.0 % of the feed or 31.3 $\%_{v/o}$ based on crude ore were rejected to Tailings 1. With an iron content of 4.1 % Fe_{tot}, an iron recovery of 3.4 $\%_{v/o}$ Fe_{rec} were discarded.

Mostly very fine particles were rejected to Tailings 2 (d_{80}-value at 0.041 mm) at a weight recovery of 12.8 % (8.6 $\%_{v/o}$). Due to the losses of fine sized hematite in this product, the iron content is with 9.9 % Fe_{tot} higher than in Tailings 2. Iron loss is calculated to 2.2 $\%_{v/o}$ Fe_{rec}.

Sink float analysis

The gravity separation was analysed in a more analytic approach by sink float analysis. The procedure is briefly described in **Appendix E-9**, the results are shown in **Appendix 4.1-4**.

It can be seen clearly that hematite is mostly liberated. The iron content for particles heavier than 3.3 kg/l was at 67.9 % Fe_{tot}, silica content was at 1.5 % SiO_2. It can be mentioned that 77.7% of the iron from *Rougher LIMS tailings ('Material 1')* reported to fractions with >3.3 kg/l and >0.063 mm, which favors recovery in a spiral separation circuit.

The iron content for particles lighter than 2.7 kg/l was at only 1.4 % Fe_{tot}.

Both, phosphorus and SiO_2, accumulated in the middle density fraction (2.7-3.3 kg/l).

WHIMS – Wet high intensity magnetic separation

A recovery of wet high intensity magnetic separation ('WHIMS') was tested on a laboratory scale. The applied equipment is introduced in **Appendix E-10**.

As can be seen in **Appendix 4.1-5**, only a low grade concentrate (55.7 % Fe_{tot}, 14.8 % SiO_2) could be generated. Accordingly, it was agreed with client that further investigations in this area were not warranted.

4.2. Rougher stage spiral separation - Pilot scale test

For the pilot scale test of rougher stage spiral separation, a set-up of three consecutive spirals was chosen. The 2nd Spiral B was fed with the concentrate from previous Spiral A, and Spiral C was fed with the concentrate from Spiral B. The spirals used are introduced in **Appendix E-11**.

It was agreed with the client to run the pilot scale test of rougher stage spiral separation in two phases:

1st phase: open spiral circuit rejecting tailings from all spirals (**Appendix 4.2-1**),

2nd phase: closed spiral circuit rejecting only the tailings from Spiral A (**Appendix 4.2-2**).

Furthermore, based on the experience that iron losses would occur mainly for smaller sized particles, it was agreed that the tailings from Spiral A were screened at 0.1 mm. For this, a Derrick screen DF 120 was used (**Appendix E-12**).

For Phase 2 with Tailings B and C being recirculated, the slurry density had to be reduced using a dewatering cyclone (which is mentioned in **Appendix E-11** as well). For operational reasons during Phase 2, the feed (*'Material 1'*) had to pass this cyclone, too.

About 3600 kg of *Rougher LIMS tailings ('Material 1')* were to be processed, conveying 66.6 $\%_{v/o}$ weight recovery and 43.6 $\%_{v/o}$ Fe_{rec} iron recovery (based on crude ore). The spiral circuit was fed at a rate of 1500 kg/h.

After adjusting the spirals' washing water and splitters for optimum separation with low iron losses to tailings, a washing water consumption of 3000 l/h was recorded for Spiral A and 1300 l/h each for Spirals B and C.

Phase 1 – Open spiral circuit

After about 30 minutes of stable operation in open circuit (Phase 1), samples were taken for the three spiral tailings and the concentrate from the last spiral. **Appendix 4.2-1.1** gives an overview on the flowsheet. **Appendix 4.2-1.2** and **Appendix 4.2-1.3** show the detailed chemical and screen analyses of the four obtained samples.

The recovered concentrate was analysed to an iron content of 65.9 % Fe. With a weight recovery of 20.3 $\%_{v/o}$ (30.5 % of feed rate), an iron recovery of 35.6 $\%_{v/o}$ Fe_{rec} is calculated.

The silica content was at 3.49 % SiO_2. Further 0.13 % P, 0.30 % TiO_2 and 0.01 % V were found.

The size distribution of that concentrate was slightly coarser than the feed (d_{80}-value at 0.397 mm, median size at 0.235 mm).

The tailings from first Spiral A were determined to a weight recovery of 36.8 $\%_{v/o}$ (55.2 % of the feed). The chemical analysis resulted in 4.4 % Fe and 72.6 % SiO_2.

In the other two Spirals B and C, 7.3 % and 2.8 % of the feed were rejected, that is 4.9 $\%_{v/o}$ and 1.8 $\%_{v/o}$ of the crude ore's weight, respectively. Iron content was found at 13.0 and 20.7 % Fe_{tot}, silica at 63.2 and 53.9 % SiO_2.

A sample from cyclone overflow was not taken at this occasion; the properties were taken over for balancing from Phase 2's sampling.

The iron losses from Tailings A to C and cyclone overflow combine for 7.0 $\%_{v/o}$ Fe_{rec}.

Phase 2 – Closed spiral circuit

After sampling for Phase 1, the set-up was quickly changed for recirculation of Tailings B and C from the latter two spirals to the feed of Spiral A. Process overview is given in **Appendix 4.2-2.1**.

The spirals' washing water and splitter settings were re-adjusted for minimizing iron losses. The water consumption of the spirals was finally the same as above (3000/1300/1300 l/h). Well before exhaustion of the fed *'Material 1'*, samples were taken from the process and analysed for weight and chemical composition. **Appendix 4.2-2.2** and **Appendix 4.2-2.3** show the detailed chemical and screen analyses of the samples.

The Tailings B and C were recirculated at a weight recovery of 7.4 and 4.3 % of feed rate (4.9 and 2.9 $\%_{v/o}$).

The first spiral rejected Tailings A at a weight of 65.4 % or 43.5 $\%_{v/o}$ based on crude ore. Iron content was analysed to 5.4 %, hence iron rejection of 6.3 $\%_{v/o}$ Fe_{rec} was calculated.

As mentioned above, the iron losses are connected primarily to fine sized particles. Hence Tailings A were screened on a Derrick screen DF 120 at 0.1 mm with a view to investigate a scavenger operation with screen underflow.

Tailings A <0.1 mm – screen underflow – were analysed to 9.35 % Fe, hence 4.3 $\%_{v/o}$ Fe_{rec} of the crude ore's iron could be recovered to this middlings product (weight recovery at 26.2 % or 17.5 $\%_{v/o}$). However, with phosphorus content of 0.54 % P a major portion of the crude ore's phosphorus accumulated in this product (39.9 $\%_{v/o}$ P_{rec}).

Tailings A >0.1 mm – screen overflow – were recovered at a weight of 39.4 % (26.2 $\%_{v/o}$ based on crude ore). The iron content was only at 3.15 % Fe, which calculates to 2.2 $\%_{v/o}$ Fe_{rec}. It was agreed to consider the screen overflow as final tailings.

The dewatering cyclone, which was needed for operational reasons in this pilot scale test, rejected 4.2 % of the feed (or 2.8 $\%_{v/o}$) together with the unwanted water flow. The iron content of the solids was analysed to 11. 5 % Fe which is calculated to iron recovery of 0.8 $\%_{v/o}$ Fe_{rec}. Again, the P-content is comparably high at 0.48 % P resulting in rather high 5.7 $\%_{v/o}$ P_{rec}. This material could be combined with Tailings A <0.1 mm for scavenger processing.

The concentrate (from Spiral C) was recovered at 30.2 %, that is 20.1 $\%_{v/o}$ based on crude ore. The chemical analysis revealed an already decent grade: The iron was at 66.2 % Fe (35.4 $\%_{v/o}$ Fe_{rec}). Silica content of 2.98 % is already lower than in many other sinter concentrates on the market. phosphorus content, however, is rather high at 0.15 % P and clearly above favorable levels for blast furnace processing route.

The size distribution of this concentrate was similar to the first one above (d_{80}-value at 0.380 mm, median size at 0.204 mm).

In respect of weight and iron recovery, open and closed circuit spiral operation show similar results. However, the grade of the concentrate was better in closed circuit operation.

The collected rougher spiral concentrates and middlings from screen underflow and cyclone overflow were stored for later testwork discussed in Chapters 6 and 7.

Combined rougher stage concentrates

As mentioned above, both concentrates, magnetite concentrate from rougher stage LIMS and hematite concentrate from rougher stage spirals, have shown a reasonably high Fe grade, fully or partly suitable for processing in blast furnace route.

For the scenario of a combined product, both concentrates were virtually mixed according to their respective weight recoveries. This calculation is shown in **Appendix 4.2-3**.

Again, the iron content calculated to 67.3 % and the silica content of ~3.4 % SiO_2 is well on par or better than many other sinter concentrates on the market.

But the combined P-content of 0.10 % P exceeds the phosphorus levels desired by most European still mills. These typically prefer concentrates with 0.05 % P or lower to avoid additional downstream processing costs for P-removal in the steel shop.

The higher magnetite content of 56.9 % results typically in a reduced productivity, but also in a reduced coke breeze consumption in the sinter plant.

5. Cleaner stage low intensity magnetic separation

5.1. Laboratory scale tests with Rougher LIMS concentrate - 'Material 2'

The *Rougher LIMS Concentrate ('Material 2')* was collected from Rougher stage LIMS and represents 33.4 $\%_{v/o}$ of crude ore's weight. Before proceeding to a pilot scale test, the properties of *Rougher LIMS Concentrate* were investigated at laboratory scale.

Chemical composition

The chemical composition of this material is given in **Appendix 5.1-1**.

The iron content was analysed to 67.1 % Fe_{tot}, which calculates to an iron recovery of 59.5 $\%_{v/o}$ Fe_{rec}. 89.6 % of magnetite were found (98.8 $\%_{v/o}$ $Magn._{rec}$).

Further 4.82 % SiO_2, 0.076 % P, 0.097 % TiO_2 and 0.048 % V were determined.

In comparison to the chemical composition of the Rougher LIMS Concentrate sample taken during pilot test, it can be noticed that the product pile is lower in iron and higher in silica. On the one hand, such a pile always contain of products from run-up and close-down phases which sometimes are worse than the steady state product. It is assumed also that the typical margin of results from sample taking, sample splitting and so added up unfavourably.

Size distribution

The size distribution is listed in **Appendix 5.1-2**. The d_{80}-value is calculated to 0.40 mm and the median size to 0.17 mm. Specific density was determined to 4.95 g/cm³.

Bond mill work index

The energy demand in ball mill grinding was estimated for *'Material 2'* by performing a Bond ball mill test at a cut size of 0.1 mm. The Bond mill work index was determined to 20.1 kWh/t. Detailed results are shown in **Appendix 5.1-3**, the Bond test equipment is briefly introduced in **Appendix E-13**.

Laboratory scale LIMS at 0.100 mm

For receiving an indication on the cleaner stage LIMS (Low Intensity Magnetic Separation), *'Material 2'* was ground in a laboratory scale rod mill (**Appendix E-14**) and subsequently

processed in laboratory scale LIMS unit with 1200 G ("Blue Ribbon", **Appendix E-15**). The results can be seen in **Appendix 5.1-4**.

The grinding in lab rod mill resulted in a d_{80}-value of 0.101 mm. The ground *'Material 2'* (Rougher LIMS concentrate) was processed for 3 stages. This methodology typically achieves concentrates similar to those produced from SGA's pilot scale Finisher LIMS units (at the same sizing).

At d_{80} of 0.101 mm and exceptionally high grade magnetite concentrate could be produced, at a weight recovery of 91.1 % or 30.4 $\%_{v/o}$.

The Fe-content was analysed to 71.39 % Fe, which calculates to an iron recovery of 57.8 % Fe_{rec}. The magnetite content was determined by Satmagan to 98.5 %, this calculates to a magnetite recovery of 98.9 $\%_{v/o}$ $Magn._{rec}$.[6]

The silica content was at only 0.52 % SiO_2. Also phosphorus was very low at 0.019 % P. Titanium dioxide was found at 0.085 % TiO_2, vanadium at 0.055 % V.

This concentrate has a very high grade and shall be well suitable for processing in direct reduction route.

The weight rejection of tailings was at 8.9 % of the feed (3.0 $\%_{v/o}$ based on crude ore).

5.2. Cleaner LIMS - Pilot scale test

About 2 t of *Rougher LIMS concentrate ('Material 2')* was processed in pilot scale test of cleaner stage LIMS.

For this pilot scale test a Derrick screen (**Appendix E-12**) with a DF 74 screen panel (~0.15 mm) was used for screening the feed. The screen overflow >0.15 mm was reground in a ball mill with a net power of 5.5 kW (**Appendix E-16**).[7] The ball mill discharge was recirculated to the screen.

The screen underflow <0.15 mm was separated in 2 LIMS-units at 600 and 500 Gauss, arranged in series, which are introduced in **Appendix E-7** (2 drums counter-current at 600 Gauss; SALA type) and **Appendix E-17** (2 drums counter-current at 500 Gauss; Thune type).

[6] This value is higher than for the feed (98.7 % versus 98.9 $\%_{v/o}$ $Magn._{rec}$). This can be explained by the reduced accuracy of Satmagan for contents close to 100 %.

[7] The ball mill rotation was at 72 % $N_{critical}$.
The slurry density in the mill was determined to ~1050 kg_{solid}/m^3_{slurry}. This is lower than aspired but a result of minimum slurry flow and the comparably low mill feed (screen overflow).

Feed rate of *Rougher LIMS Concentrate ('Material 2')* was set to 542 kg/h in order to adjust specific grinding energy to 10.1 kWh/t (net power consumption of ball mill was at 5.47 kW).

After reaching steady state, samples were taken and analysed for mass flow, size distribution and chemical composition. **Appendix 5.2-1** gives an overview on the flowsheet. **Appendix 5.2-2** and **Appendix 5.2-3** show the detailed chemical and screen analyses of the different samples.

About 69 % of the feed (23 $\%_{v/o}$) reported to the Derrick screen overflow (DF 74, ~0.15 mm). The screen overflow >0.15 mm with a d_{80}-value of 0.65 mm was ground by ball mill to d_{80} of 0.066 mm.

Screen underflow <0.15 mm was found slightly coarser than typical for this screen panel. D_{80}-value was determined by screen analysis to 0.141 mm.

The first LIMS-unit (2 drums, 600 Gauss) removed 8.1 % of the feed (2.7 $\%_{v/o}$ based on crude ore feed). The iron content of these Cleaner 1+2 tailings was at 27.5 % Fe, accordingly 2.0 $\%_{v/o}$ Fe_{rec} were rejected.

The magnetite content of these tailings was at 11.9 %. This is considered as higher than typical for this kind of equipment set-up.[8] The magnetite rejection is calculated to 1.1 $\%_{v/o}$ $Magn._{rec}$ – not being untypically high. It is assumed that few factors as for example lower slurry density in pilot scale operation will not take effect in industrial operation, hence fewer losses are expected.

The concentrate from Cleaner LIMS 1+2 was analysed to 70.4 % Fe_{tot} and 1.32 % SiO_2.

The subsequent Cleaner LIMS 3+4 rejected another 0.3 % of the feed or 0.1 $\%_{v/o}$ based on crude ore feed. With an iron content of 51.5 % Fe_{tot}, an iron rejection of 0.1 $\%_{v/o}$ Fe_{rec} is calculated. The magnetite content of 52.7 % results in a rejection of 0.2 $\%_{v/o}$ $Magn._{rec}$.

Cleaner LIMS concentrate ('Material 6') is the final magnetite product from the process and it was recovered at a rate of 91.6 %, that is 30.6 $\%_{v/o}$ of the crude ore feed. The iron content was analysed at 70.6 % Fe_{tot}, which means an iron recovery of 57.4$\%_{v/o}$ Fe_{rec}. Satmagan determined 93.9 % magnetite; hence a magnetite recovery of 94.8 $\%_{v/o}$ $Mag._{rec}$ is calculated. This overall magnetite recovery at ~95 $\%_{v/o}$ $Mag._{rec}$ is at a typical level, especially if the high grade is taken into consideration.

The silica content was analysed to 1.15 % SiO_2. Phosphorus content was at only 0.033 % P. Furthermore, 0.084 % TiO_2 and 0.057 % V were found.

[8] Many other pilot scale testing using this or similar kind of set-up show – typically at a slightly finer sizing – 2 to 8 % magnetite in these tailings. (The tailings from the subsequent 500 Gauss-unit are again very typical in regard of magnetite content and mass rejection.)

The screen analysis resulted in a d_{80}-value of 0.131 mm and a median size of 0.052 mm, 31.3 % of particles smaller 0.025 mm were found. Specific surface was determined to 830 Blaine, specific density to 5.09 g/cm³.

A pile of about 1750 kg of *Cleaner LIMS concentrate ('Material 6')* were collected, homogenized and sampled. The full chemical analysis is listed in **Appendix 5.2-4**, the size distribution in **Appendix 5.2-5**.[9]

The iron content of the product pile was 70.5 % Fe_{tot}, the magnetite content was at 93.6 %. 1.31 % SiO_2, 0.24 % Al_2O_3, 0.21 % CaO and 0.21 % MgO combined for the gangue. The LOI was negative at -3.08 % due to oxidation of magnetite.

Phosphorus was analysed to 0.039 % P, favorably low. All other impurities including 0.002 % S and 0.036 % Na_2O+K_2O were satisfactorily low. Titaniumdioxide was found at 0.083 %, vanadium at 0.054 %.

This magnetite concentrate is of such high grade that it is even eligible for iron making in direct reduction route. Hence it will be attractive to steel producers as well who are looking to increase the iron content of the ferrous burden thereby reducing slag volume, reductant rate and increasing the productivity of the blast furnace. As for every other concentrate, the portion in sinter mixture will be limited due to sizing in order to avoid detrimental impacts on the sinter operation such as sinter strength, permeability and production rate.

The d_{80}-value of the product pile was at 0.141 mm, the median size d_{50} at 0.057 mm. The specific surface was determined to 965 Blaine. The specific density was at 5.10 g/cm³.

6. Regrinding of rougher stage spiral concentrates

The *Rougher hematite concentrate ('Material 3')* was subjected to a stage of regrinding with the aim of improving liberation between the hematite and the gangue minerals, apatite in particular

For the pilot scale test, *'Material 3'* was fed to a Derrick screen (**Appendix E-18**) which was equipped with a screen panel DF 74 (0.15 mm). The screen overflow >0.15 mm was reground in

[9] A screen metal analysis was requested at a later point in this project, it is listed in **Appendix 5.2-6**.

SGA's small ball mill (**Appendix E-19**). [10] With the feed rate of 200 kg/h, a specific grinding energy of 10.0 kW/t is calculated.

Prior to exhaustion of feed material, samples were taken and assessed for size distribution and mass flow. **Appendix 6-1** shows an overview for this pilot scale test and **Appendix 6-2** lists the size distributions.

Based on feed rate, 68.4 % were held back by the screen and directed to the ball mill. The regrinding reduced the d_{80}-value from 0.42 mm (screen overflow) to 0.078 mm (mill discharge).

The screen underflow, however, was coarser than anticipated and the d_{80}-value at 0.151 mm was untypically high and not smaller than the opening of the screen. A reason for this might be the slightly longer than square-shaped slots in the screen panel. An underestimation of the needed grinding energy was also identified as contributing factor.

For complementing the available information, it was agreed to include a Bond ball mill test with *'Material 3'*. The Bond ball mill was determined to 25.2 kWh/t (cut size 0.1 mm, **Appendix 6-3**), about 25 % higher than for the *Rougher LIMS Concentrate - 'Material 2'*.

7. Scavenger stage processing

As mentioned earlier, an important objective of this test program was to minimize iron losses. Accordingly, some tests were performed to investigate possibilities for reclaiming additional magnetite and, in particular, hematite.

7.1. Laboratory scale test with rougher stage spiral tailings

As discussed in Chapter 4.2, *Tailings A <0.1 mm* (from first rougher stage spiral) were considered worthwhile for scavenger processing, as they are carrying 4.7 $\%_{v/o}$ Fe_{rec} of crude ore's iron. For this, some explorative laboratory scale tests were performed.

Wet high intensity magnetic separation (WHIMS)

The high intensity magnetic separation was performed in laboratory scale (**Appendix E-10**), the test results are listed in **Appendix 7.1-1**.

[10] The ball mill rotation was at 74.3 % $N_{critical}$.
The slurry density in the mill was determined to ~1030 kg_{solid}/m^3_{slurry}. This is lower than aspired but a result of minimum slurry flow and the comparably low mill feed (screen overflow).

About 10 % of the charge were recovered to the WHIMS concentrate which contained 51.7 % Fe_{tot}. Accordingly, a good half of the iron could be recovered (52.9 % Fe_{rec}, 2.5 $\%_{v/o}$ Fe_{rec}). Silica content was analysed to 15.3 %. Phosphorus was rather higher at 0.84 % P.

Another 5 % of feed went to middlings with 18.3 % Fe_{tot} – 0.4 $\%_{v/o}$ Fe_{rec}. Almost 85 % of feed ended up in tailings with 1.8 $\%_{v/o}$ Fe_{rec} iron losses.

Upstream separation

A hindered settling, or upstream separation, test was carried out on the *Tailings A <0.1 mm* using a laboratory scale column, see **Appendix E-20**. It became apparent during the test that the size range of the feed material was much too wide for effective separation to occur. Due to the size effect, no separation could be effected between large, light gangue particles and small, heavy hematite. Therefore the test was aborted. In **Appendix 7.1-2** the mass balance and a photo of the dried products are shown. It is easy to see by the colors that no significant enrichment had taken place.

Shaking table test

Further, the *Tailings A <0.1 mm* were subjected to a shaking table test (**Appendix E-8**). A shaking table test typically provides a useful guidance for a material's amenability to spiral separation. The results are shown in **Appendix 7.1-3.1 and 3.2**.

As this feed material is rather fine sized and light weighted compared to hematite, the adjusting range of the splitter between concentrate and middlings turned out to be not sufficient as a consequence, a small portion of material could not be directed into the concentrate where it should have gone, but ended up in middlings. Hence it should be kept in mind that weight recovery of concentrates could have been better. Nevertheless, 6.3 % of feed (1.1 $\%_{v/o}$) were recovered to concentrate which had a decent grade with 62.2 % Fe_{tot} and 5.3 % SiO_2, considering that feed was at 10.1 % Fe_{tot} and 66.0 % SiO_2. Iron recovery was calculated to 1.8 $\%_{v/o}$ Fe_{rec}. Again, the phosphorus content was rather higher at 0.58 % P.

The majority of the feed was recovered to middlings (78.2 % or 13.7 $\%_{v/o}$). Middlings' iron content was analysed to 6.1 % Fe_{tot} (2.2 $\%_{v/o}$ Fe_{rec}). Considering that also some of these 6.1 % Fe_{tot} had been contributed by material which should have been directed to concentrate (see remark above), this middlings product must be considered as final tailings.

The tailings from this shaking table test were analysed to 8.0 % Fe_{tot}, higher than for the middlings. With the weight recovery of 15.5 % (2.7 $\%_{v/o}$) the iron loss is calculated to

0.6 $\%_{v/o}$ Fe_{rec}. It should be mentioned that the iron losses to this product derive from very fine sized hematite which is likely to be lost in any processing.

Comparison

Upstream separation did not yield positive results owing to the wide size distribution of the feed material.

The WHIMS (Wet High Intensity Magnetic Separation) resulted in a higher iron recovery (2.5 $\%_{v/o}$ Fe_{rec}) compared to shaking table separation (1.8 $\%_{v/o}$ Fe_{rec}), but the grade of WHIMS concentrate was clearly worse (51.7 % Fe_{tot} vs. 62.2 % Fe_{tot}). Both concentrates showed a relatively high P-content at 0.84 and 0.58 % P, respectively.

Considering that, as mentioned above, the iron recovery in gravity separation can be expected slightly better than the reported 1.8 % Fe_{tot} and that spirals are much cheaper to purchase and to operate than WHIMS-units, it was decided that the pilot scale test on scavenging shall be performed on spirals.

7.2. Iron recovery in scavenger stage

The Cleaner LIMS pilot scale test (Chapter 5.2) was performed in parallel to the laboratory scale test on scavenger processing described above. It turned out that weight recovery and iron content of non-magnetics rejected in Cleaner stage LIMS was low, it was therefore agreed that these cleaner LIMS tails would be better fed into scavenger stage than to process them in cleaner stage spirals as initially intended. Consequently, the available *Tailings A <0.1 mm* and *Cleaner LIMS tailings* were mixed according to their weight recovery based on crude ore feed for generating the ***Scavenger stage feed***.

The chemical composition of both components as well as the mixed Scavenger stage feed are listed in **Appendix 7.2-1**. Scavenger stage feed represented 20.3 $\%_{v/o}$ of crude ore feed with 7.0 $\%_{v/o}$ Fe_{rec}, it contained 12.9 % Fe_{tot}, 62.5 % SiO_2 and 0.54 % P.

Due to the low available weight for scavenger stage feed (365 kg) it was not possible to run a full pilot scale test with three consecutive spirals. It was therefore decided to run this test on a single spiral which is briefly described in **Appendix E-21**. Feed rate was adjusted to 1000 kg/h.

The slurry was of more or less uniformly grey colour, which made it impossible to identify clear borders between better and worse material at the discharge of the spiral, hence the adjustment of

splitters became uncertain. A photo from the discharge is added to the result table in **Appendix 7.2-2.1**.

However, the result of this batch test was significantly worse than that of the previous shaking table test (which is supposed to be more selective on finest hematite particles). The scavenger Concentrate 1 was collected through the central outlets into the central column, it was analysed to (only) 41.0 % Fe_{tot}. The weight recovery was 8.7 % (1.8 $\%_{v/o}$). Accordingly, iron recovery is calculated to 1.9 $\%_{v/o}$ Fe_{rec}. SiO_2 was at 28.1 %

Only a very tiny weight was collected from the inner discharge of the spiral – Concentrate 2 that contained 32.0 % Fe_{tot} and 36.7 % SiO_2. Weight was determined to 0.5 % of feed – 0.1 $\%_{v/o}$ of crude ore feed.

Both concentrates were high in phosphorus, 0.94 and 1.35 % P, respectively.

The middlings of this batch test had a chemical composition similar to the feed and were determined to a weight recovery of 5.9 %, which is 1.2 $\%_{v/o}$. Consequently, the tailings were the largest product by far with 84.8 % weight recovery (17.2 $\%_{v/o}$). Iron content was at 9.6 % Fe_{tot}, accordingly 4.4 $\%_{v/o}$ Fe_{rec} were lost.

Appendix 7.2-2.2 lists the size distributions of the products. In summary, this single spiral batch test could not produce a scavenger concentrate with a sufficient grade; the iron recovery was, however, on the same level of ~2.0 $\%_{v/o}$ as the previous shaking table test. It is conceivable that three stage spiral operation might improve scavenger concentrates' grade to a certain degree.

After the insufficient result of the spiral batch test, more laboratory scale tests were performed with scavenger feed for investigating different approaches.

Screen metal analysis

At first, a screen metal analysis of scavenger stage feed was made to receive information on the distribution of hematite/iron, it is listed in **Appendix 7.2-3**.

D_{80} was at 0.108 mm, median size at 0.068 mm. It also can be seen that iron content increases for the finer particle sizes – the finer the size fractions, the higher the portion of hematite lost on rougher spirals.

Phosphorus is distributed more or less evenly between 0.54 % and 0.76 % P, only the largest size fraction showed a lower content at 0.31 % P.

Sink float analysis

The sink float analysis should investigate the grade of liberation or dissemination, hence whether a gravity separation can be successful at all.

As can be seen in **Appendix 7.2-4**, all products with a density of >3.3 kg/l display high iron contents (67.5-68.1 % Fe_{tot}) and low silica contents (0.9-1.8 % SiO_2); vice versa, the products with density <2.7 kg/l were low in iron (0.5-2.2 % Fe_{tot}) and very high in silica (75.0-81.3 % SiO_2). The >3.3 kg/l fractions also displayed comparatively high levels of titaniumdioxide, 0.45-0.72 % TiO_2.

However, only a low portion of 5.6% (by weight) of the fraction -1+0.1mm of the scavenger feed were found in the >3.3 kg/l product, hence potentially recoverable.

It can be concluded that in the previous scavenger test the gravity separation did not succeed despite a fully sufficient liberation, probably because of larger silicate particles interfering with the smaller hematite. Furthermore, it can be noticed that the majority of phosphorus accumulates in the 2.7-3.3 % kg/l density fraction.

Silica flotation

Also the applicability of silica flotation was tested, results are displayed in **Appendix 7.2-5**. The lab flotation cell is introduced in **Appendix E-22**.

After four stages of flotation with Flotigam EDA, only a twentieth of charged feed had remained in the cell. Iron content was at only 25.8 % Fe_{tot}.

It must be concluded that silica flotation is no option for scavenger processing.

Upstream separation after screening

Based on findings from screen metal analysis (**Appendix 7.2-3**), it was decided that screening of scavenger stage feed to <0.040 mm would remove more weight than iron and that a more narrow size distribution could improve performance in upstream separation (hindered settling). This was tested with a 1 kg-sample, the results are listed in **Appendix 7.2-6.1** for the first step of screening and in **Appendix 7.2-6.2** for upstream separation.

The screen underflow <0.40 mm (22.5 % / 4.6 $\%_{v/o}$ weight recovery) contained 30.5 % Fe_{tot} and carried 3.7 $\%_{v/o}$ Fe_{rec}.

The concentrate from upstream separation was determined to a weight recovery of 1.6 $\%_{v/o}$. Iron content was analysed to 54.8 % Fe_{tot}, which means an iron recovery of 2.4 % Fe_{rec}. Silica was at

14.7 % SiO_2. The phosphorus content was with 0.40 % P lower than for most of the other concentrates discussed in this chapter.

Summary

Summarizing all tests on scavenger operation within this chapter, it can be concluded that producing a scavenger concentrate with iron content on the level of 50-55 % Fe_{tot} is possible, up to 2.5 $\%_{v/o}$ Fe_{rec} could be recycled.

Silica flotation showed very little potential and is there not recommended to be pursued.

The option to charge such scavenger concentrate directly to apatite flotation or to mix it to the final product was also discussed with client. Since the scavenger concentrate is only a minor contribution, it may be blended, if necessary and possible, with the other concentrates to obtain a blend with acceptable iron and phosphorus contents.

For the subsequent stages of this testwork program, it was decided that no products from the scavenger testwork would be recycled, mainly because the concentrate available from spiral batch test was too low in iron (41 % Fe_{tot}) to be of advantage and too low in weight (1.8 $\%_{v/o}$) to have a significant impact on testwork.

8. Cleaner stage spiral separation

8.1. Laboratory scale tests with Reground rougher spiral concentrate - 'Material 6'

As mentioned above, it was decided that only *Reground rougher spiral concentrate ('Material 6')* was to be processed in cleaner stage spiral separation. A set of exploratory laboratory tests was undertaken ahead of the pilot test testwork. These are described in detail below.

Chemical composition

Appendix 8.1-1 lists the full chemical analysis of '*Material 6'*.

Iron was analysed to 66.2 % Fe_{tot}, magnetite was at 1.6 %. The gangue was composed of 3.04 % SiO_2, 0.61 % Al_2O_3, 0.55 % CaO and 0.20 % MgO.

Phosphorus content was at 0.149 %, TiO_2 was found at 0.30 % and vanadium at 0.010 %.

All other impurities measured were favorably low.

Screen metal analysis

As shown in **Appendix 8.1-2**, d_{80}-value was calculated to 0.148 and median size to 0.072 mm. The specific surface was determined at 780 Blaine. Specific density was at 5.07 g/cm³.

If the small fraction of largest particles 3.4 % >0.2 mm was disregarded, a clear trend for increasing iron content and decreasing silica content towards the finer could be found (64.4-67.9 % Fe_{tot}, 1.47-5.0 % SiO_2).

The size fractions 18.8 % 0.063-0.1 mm and 38.1 % 0.1-0.2 mm carried the majority of phosphorus. For the finer size fraction, P-content decreases from 0.088 to 0.053 % P.

TiO_2 and V are more or less evenly distributed.

Shaking table test

The results of shaking table test with *Reground rougher spiral concentrate* are given in **Appendix 8.1-3.1 and -3.2**.

Approximately two thirds of the feed were recovered to Concentrates 1 and 2 (10.7 $\%_{v/o}$ + 2.0 $\%_{v/o}$). The concentrates combine for an iron recovery of 23.3 $\%_{v/o}$ Fe_{rec}.

Especially the Concentrate 1, which was recovered over the short edge at the end of the table (see photo in **Appendix E-8**, revealed a very high grade with 69.2 % Fe_{tot}, 0.16 % SiO_2 and 0.020 % P.

The Concentrate 2 from the far end of the long table edge was analysed at 66.2 % Fe_{tot}, 2.46 % SiO_2 – still a favorable grade. The phosphorus content was, however, higher at 0.26 % P.

The middlings (16.7 % of feed, 3.3 $\%_{v/o}$ of crude ore) were at 55.1 % Fe_{tot} (4.9 % Fe_{rec}.). Silica was analysed to 14.15 % SiO_2, phosphorus to 0.58 % P.

With 20 % (4.0 $\%_{v/o}$) of tailings produced at 66.4 % Fe_{tot} it could be anticipated that high iron losses from small sized hematite were to be expected. The iron losses for these tailings were calculated to 7.1 $\%_{v/o}$ Fe_{rec}. Furthermore, 3.13 % SiO_2 and only 0.080 % P were analysed, indicating again that these tailings contain mainly fine sized hematite losses.

Based on the same assumption, middlings were screened for a visual assessment whether the iron accumulates in the finer size fractions. The size distribution of middlings is listed in **Appendix 8.1-3.2**.

Sink float analysis

A sink float analysis of '*Material 6'* revealed, as can be seen in **Appendix 8.1-4**, for both tested size fractions that particles with a density >3.3 kg/l were made of rather pure hematite with 0.3 % SiO_2 and 0.023-0.036 % P.

Only low or negligible amounts of particles with low density <2.7 kg/l were detected.

For particles with density between 2.7 and 3.3 kg/l the iron content was determined at 62.3 and 55.4 % Fe_{tot}, respectively. Phosphorus was at 0.87 and 0.57 % P.

8.2. Cleaner stage spiral separation - Pilot scale test

For the pilot scale test of cleaner stage spiral separation, the set-up of three consecutive spirals known from rougher stage pilot's Phase 2 was chosen. The second Spiral E was fed with the concentrate from previous Spiral D, and third Spiral F was fed with the concentrate from Spiral E. The Tailings from Spirals E and F were recirculated to Spiral D after passing a dewatering cyclone. Tailings from Spiral D and cyclone overflow were discharged to individual thickening cones. Spirals and dewatering cyclone are introduced in **Appendix E-11**.

About 900 kg of *Reground rougher spiral concentrate ('Material 6')* were to be processed, conveying 20.1 $\%_{v/o}$ weight recovery and 35.4 $\%_{v/o}$ Fe_{rec} iron recovery (based on crude ore). It was fed at a rate of 1500 kg/h.

After adjusting the spirals' washing water addition and splitters for optimum separation with low iron losses to tailings, the washing water consumption of 2500 l/h was recorded for Spiral D and 1300 l/h each for Spirals E and F.

Well before exhaustion of the fed *'Material 6'*, samples were taken from the process and analysed for weight and chemical and physical properties. Process overview is given in **Appendix 8.2-1**, detailed chemical and screen analyses of the samples are shown in **Appendix 8.2-2** and **Appendix 8.2-3**.

The Tailings E and F were recirculated at a weight recovery of 7.7 and 2.7 % of feed rate (1.5 and 0.5 $\%_{v/o}$), respectively.

The first spiral rejected Tailings D at a weight of 21.2 % or 4.3 $\%_{v/o}$ based on crude ore. Iron content was analysed to 63.27 %, hence iron losses were high at 7.2 $\%_{v/o}$ Fe_{rec}.

Silica was analysed to 6.24 % SiO_2. The P-Content was comparably low at 0.110 % P.

The dewatering cyclone, which was needed for operational reasons in this pilot scale test, rejected 7.2 % of feed (or 1.4 $\%_{v/o}$) together with the unwanted water flow. Iron content of solids was analysed to 66.62 % Fe_{tot} which is calculated to iron recovery of 2.6 $\%_{v/o}$ Fe_{rec}. Again, the P-content is comparably low at 0.077 % P.

The concentrate (from Spiral F) was recovered at 71.6 %, that is 14.4 $\%_{v/o}$ based on crude ore. The chemical analysis revealed an iron content of 66.85% Fe_{tot} (25.6 $\%_{v/o}$ Fe_{rec}). Silica content was reduced to 2.14 %, again lower than in many other sinter concentrates on the market. Phosphorus content, however, was increased by 0.04 to 0.190 % P (11.6 $\%_{v/o}$ P_{rec}) and clearly above favorable levels for blast furnace processing route.

As can be seen in **Appendix 8.2-3**, Tailings D and Cyclone overflow were very fine sized with d_{80}-values of 0.036 and 0.021 mm, respectively.

As mentioned above, the iron losses are connected primarily to fine sized particles. To receive more information on that, Tailings D, Cyclone overflow as well as recirculated Tailings E and F were assayed in screen metal analyses which are listed in **Appendices 8.2-4 to 7**. For all four (intermediate) products can be seen that the size fractions smaller 0.040 mm are low in SiO_2 and P.

About 550 kg of *Cleaner spiral concentrate ('Material 7')* were collected. The full chemical analysis and a screen metal analysis are given in **Appendix 9.1-1 and -2**, they are discussed in Chapter 9.1.

8.3. Iron recovery from Cleaner spiral tailings

As discussed above, high losses of iron occur on small sized particles. For investigating this two scenarios of screening off fines are calculated.

Scenario of screening Reground rougher spiral concentrate ('Material 6') at 0.040 mm

In **Appendix 8.3-1** is calculated (based on screen metal analysis of *Reground rougher spiral concentrate ('Material 6')*, **Appendix 8.1-2**) what kind of product would be generated if the feed to the spirals was screened at 0.040 mm.

The virtual screen underflow is calculated to 67.9 % Fe_{tot}, 1.5 % SiO_2 and only 0.063 % P. This concentrate would not necessarily need apatite flotation; in all other aspects this would be suitable for iron making.

This product would represent 9.2 $\%_{v/o}$ of the crude ore's weight and 16.6 $\%_{v/o}$ Fe_{rec} of the iron. It could even be used for iron making in direct reduction ('DR') route.

Another advantage of this scenario is that the operation of cleaner spirals will be much easier and iron losses also will decrease significantly. Possibly even the rejection of apatite already on spirals might improve.

Scenario of screening Tailings D at 0.063 mm

For the next scenario shown in **Appendix 8.3-2**, the *Tailings D* are virtually screened at 0.063 mm (based on respective screen metal analysis given in Appendix 8.2-4).

With this, only 6.1 % of the *Tailings D* weight was rejected to the screen overflow >0.063 mm, but the grade would improve distinctly. Silica was reduced from 6.2 to 2.7 % SiO_2, iron increased from 63.7 to 66.6 % Fe_{tot}. Also phosphorus decreased to 0.084 % P. Despite these clear improvements, the iron losses were at only 0.1 $\%_{v/o}$ Fe_{rec}.

Laboratory scale screening of Tailings D at 0.040 mm and upstream separation

As the first scenario was not available any more after the cleaner spiral pilot test has been performed, the second scenario was investigated further in laboratory scale. At first, Tailings D were screened at 0.040 mm. **Appendix 8.3-3.1** displays this on a calculatory basis.

The screen underflow <0.040 mm is calculated to a weight recovery of 89.2 % (3.8 $\%_{v/o}$) and a chemical composition with 66.9 % Fe_{tot}, 2.3 % SiO_2 and 0.075 % P.

The screen underflow <0.040 mm was subsequently tested in laboratory scale upstream column (**Appendix E-20**), the results are shown in **Appendix 8.3-3.2**.

The upstream water flow was increased in three stages from 0.40 over 0.62 to 2.64 mm/s with overflow from each stage collected separately.

With the first two stages at comparably low water velocity, 8.2 % of screen underflow has been removed. By this a decrease to ~1.6 % SiO_2 and ~0.06 % P is calculated (in the lower part of the table). Iron recovery at that point would be at 6.3 $\%_{v/o}$ Fe_{rec} (~67.7 % Fe_{tot}).

With the third stage at higher upstream, 58.9 % of the fed Tailings D <0.040 mm has been rejected. By this, the grade of the sediment/concentrate improved to (analysed) 68.4 % Fe_{tot}, 1.04 % SiO_2 and 0.046 % P. But the iron losses would increase significantly to 4.0 % Fe_{rec}.

With some more tests an optimum upstream water velocity could be found, somewhere in between 0.6 (Stage 2) and 2.6 mm/s (Stage 3), that would enable a good compromise between iron losses and recovered concentrate grade.

Pilot scale screening Tailings D at 0.053 mm

Before the subsequent pilot scale flotation it was agreed to perform the iron recovery from *Tailings D* by screening with a Derrick screen panel DF200 (0.053 mm). The mass balance and chemical analysis for this pilot scale batch test are shown in **Appendix 8.3-4.1**, screen analysis in **Appendix 8.3-4.2**.

With screen overflow – *Tailings D >0.053 mm* – 9.2 % of the feed (0.4 $\%_{v/o}$) were rejected. With an iron loss of 40.7 % Fe_{tot}, 0.4 $\%_{v/o}$ Fe_{rec} is calculated.

With screen underflow – *Tailings D <0.053 mm* – 90.8 % weight was recovered. D_{80}-value was determined at 0.036 mm, specific surface at 1160 Blaine. The iron content was analysed at 66.1 % Fe_{tot}, hence the iron recovery was at 6.8 % Fe_{rec}. Furthermore, the chemical analysis resulted in 3.49 % SiO_2 and 0.099 P.

The collected screen underflow should be recycled and combined for pilot scale flotation with concentrate and cyclone overflow from Cleaner spiral pilot scale test.

9. Flotation for apatite removal

The Blötberget ores contain a certain amount of apatite, a phosphorus bearing mineral, which tends to concentrate in the hematite processing line. The phosphorus content should be as low as possible for iron making due to inherent processing costs caused by downstream P-removal in steel shop. P-content in iron ores is preferred at 0.04 % P or lower. However, it should be noted that may Brazilian and Australian ores exceed these levels, and in consideration of the generally increasing P-content of iron ore supplies, a P-content of 0.05 % will likely find acceptance on the market.

The apatite removal during this project was performed by flotation using AkzoNobel's collector Atrac 1563.

9.1. Laboratory scale flotation tests for apatite removal

The initial phase of laboratory scale flotation tests was performed with *Cleaner spiral concentrate ('Material 7')*, the chemical analysis of the collected product pile is given in **Appendix 9.1-1**.

Iron was analysed to 66.7 % Fe_{tot}. The silica content was with 2.45 % SiO_2, 0.3 points higher than in the sample taken during pilot scale test. Gangue was composed also from 0.54 % Al_2O_3, O.6 % CaO and 0.19 % MgO. Phosphorus content was analysed to 0.175 % P. Furthermore 0.33 % TiO_2 and 0.011 % V were found. All other impurities were on favorably low levels.

The size distribution and screen metal analysis are given in **Appendix 9.1-2**. D_{80} was determined to 0.166 mm, median size to 0.099 mm. Specific surface was at 780 Blaine, specific density at 5.07 g/cm³.

The screen metal analysis shows that silica is carried mainly by particles >0.063 mm and super fines <0.025 mm. The same is true for phosphorus. TiO_2 and V are more or less evenly distributed.

Regarding apatite flotation, the following generalization for reagent regime and flotation procedure can be given:

- Initial conditioning with 500 g/t water glass (sodium silicate) for supporting desagglomeration,
- pH-value was never adjusted, it was raised though by sodium silicate addition to ~9.0 pH,
- 1st addition of apatite collector (~100 g/t Atrac 1563 from AkzoNobel) with conditioning,

- 1st flotation stage after frother addition (30 g/t MIBC)[11],
- 2nd addition of apatite collector (~50 g/t Atrac 1563), for most tests also some conditioning time was given,
- 2nd flotation stage after frother addition (30 g/t MIBC).

The actual flotation procedure is given in detail in the respective result table for each test.

The laboratory scale tests were performed in a 1 l flotation cell which is introduced in **Appendix E-22**.

The initial laboratory test, **Test #A1**, was carried out very early on in the programme using a sample of reground rougher spiral concentrate as feed material. At that point only *Reground rougher spiral concentrate ('Material 6')* was available. The main objective of this test was to develop an early understanding of the amenability of the hematite concentrate to flotation. Reagent regime and test procedure were selected on the basis of previous flotation testwork with Blötberget ore and best industry practice. The results are shown in **Appendix 9.1-3**. The procedure given in the upper part of result table summarizes, besides water glass conditioning, the total addition of 150 g/t apatite collector (Atrac 1563), and 60 g/t frother (MIBC). The cumulated flotation time was 5.5 minutes.

The flotation concentrate was recovered from flotation cell at 96.2 % weight recovery (13.9 $\%_{v/o}$). The phosphorus content of this concentrate was analysed to only 0.024 % P.

It can be seen in the calculations on the bottom part of **Appendix 9.1-3** that already three quarters of the phosphorus had been removed after the third stage of flotation (3.5 min) and the concentrate would have a satisfactory P-content of ~0.03 % P.

3.8 % (0.5 $\%_{v/o}$) of the weight was rejected with the froths. The iron losses to rejected froths were rather low at 0.2 $\%_{v/o}$ Fe_{rec} after third stage and at 0.8 $\%_{v/o}$ Fe_{rec} after the entire test. The concentrate's iron content was at 66.5 % Fe.

The silica content was analysed to 3.35 % SiO_2, about 0.3 points higher than the feed. This is caused by two effects which are also valid for other flotation tests in this project: The removed froths are low in silica (the Atrac collector did not show any affinity towards quartz or silicates), hence the recovered concentrate must increase in silica content, and 500 g/t water glass addition (sodium silicate) add also a small amount of silica and sodium to the concentrate.

The following **Test #A2 to #A5** used *Cleaner spiral concentrate ('Material 7')* as feed.

[11] MIBC is the abbreviation for **m**ethyl **i**so**b**utyl **c**arbinol (IUPAC name: 4-Methyl-2-pentanol).

For the next **Test #A2** the flotation time was reduced to 2.5 minutes, the collector addition was slightly increased to 165 g/t and frother was added only once.

As can be seen in **Appendix 9.1-4**, this resulted in a concentrate with only 0.017 % P (~0.075 % P after the first stage of 1.5 min). Iron losses were calculated to 1.0 $\%_{v/o}$ Fe_{rec}. Weight rejection was at 4.7 % (0.7 $\%_{v/o}$).

For **Test #A3** the flotation procedure was divided into smaller increments: After a first flotation stage of 1.5 min applying 60 g/t Atrac 1563, three more stages of 1.0 min and 20 g/t Atrac 1563 addition each followed. 20 g/t MIBC (frother) was given twice before first and third flotation stage. This is also shown in **Appendix 9.1-5**.

The weight rejection to froths was only at 1.5 % (0.2 $\%_{v/o}$). The phosphorus removal is more or less constant for the first three stages (2.2-3.1 $\%_{v/o}$ P_{rec}).

The concentrate produced was analysed to 0.037 % P. The loss of iron was extraordinarily low at 0.1 $\%_{v/o}$ Fe_{rec}.

The flotation procedure should be consolidated for **Test #A4** to only two flotation stages with 50 g/t Atrac 1563 and 1.5 min flotation time each. Frother addition was at 60 g/t in total.

The results from this test are shown in **Appendix 9.1-6**. However, the decrease of collector addition resulted in a worse P-removal, the recovered concentrate was analysed to 0.081 % P.

The weight of the froths was at 1.1 % (0.2 $\%_{v/o}$). Accordingly, the iron loss was low at 0.1 $\%_{v/o}$ Fe_{rec}.

The fifth **Test #A5** investigated apatite flotation in a single flotation stage (2.0 min, 100 g/t Atrac 1563, 30 g/t MIBC). As can be seen in **Appendix 9.1-7** and quite similar to the previous test, 0.2 $\%_{v/o}$ of the weight and 0.1 $\%_{v/o}$ Fe_{rec} of the iron were rejected. The concentrate was analysed to 0.078 % P.

The initial conditioning was performed at a higher slurry density than before (55.6 instead of previously used 35.7 % solids). An effect from the higher slurry density during conditioning could not be noticed.

Summarizing the previous laboratory scale flotation tests, a consumption of >100 g/t Atrac 1563 (collector) with >50 g/t MIBC (frother) and a flotation time of 3 minutes appeared most effective.

9.2. First pilot scale flotation test for apatite removal

As discussed in Chapter 8.3, *Tailings D <0.053 mm* and *cyclone overflow* from cleaner spirals should be recycled for reducing iron losses. Accordingly, these two middlings were combined with *Cleaner spiral concentrate ('Material 7')* according to their respective weight recovery. The combination of these three intermediate products, representing 19.7 $\%_{v/o}$ weight of the crude ore, was fed to pilot scale flotation test.

However, it was agreed with the client to allow a small deviation from the calculated feed composition (increase of proportion of cleaner spiral concentrate from theoretical 73 % 74.8 %) in order to maximize the material available for flotation. This is displayed together with the chemical analysis of *Flotation feed* in **Appendix 9.2-1**.

Flotation feed was analysed to 66.5 % Fe_{tot} which calculates to an iron recovery of 34.9 $\%_{v/o}$ Fe_{rec}. Silica was at 2.72 % SiO_2. Phosphorus was found at 0.157 % P. 0.31 % TiO_2 and 0.010 % V are again on the known level.

The pilot flotation test set-up was discussed and mutually agreed with the client.

Appendix 9.2-2 gives an overview of the first pilot scale flotation test, **Appendix 9.2-3** provides some details of the actual flotation procedure.

For operational reasons (required minimum slurry flow vs. available feed/test time), the slurry density had to be decreased to 24.2 % solids.

The initial conditioning with water glass (sodium silicate) was performed in an agitated vessel (**Appendix E-23**) for a retention time of 9.6 min.

For the flotation, all six pilot flotation cells were applied, they are briefly introduced in **Appendix E-24**.

According to general industry practice, the retention (or flotation) time was increased by a factor two at pilot scale (Note: the retention time for was rounded up due to volume of pilot flotation cells).

The initial addition of apatite collector Atrac 1563 was at 100 g/t. The collector was conditioned for 6.0 min (in two of the larger cells with agitation, but no air injection).

It followed the first flotation stage with 3.0 min retention time. Frother MIBC was added at 30 g/t to the cell's inlet.

The second flotation stage followed without conditioning where another 50 g/t Atrac 1563 and 30 g/t MIBC were added to the flotation cell's inlet. The second flotation stage was performed in three smaller cells which combine for a retention time of 3.6 min.

No pH-adjustment was applied, pH increased to 8.6 as a consequence of water glass addition and then decreased to 8.2 during the process.

Both, the removed froths and the recovered concentrate were collected in settling cones.

Before exhaustion of flotation feed, samples of Froth 1 (1st stage), Froth 2 (2nd stage) and concentrate were taken. Chemical compositions and balances are displayed in **Appendix 9.2-4**, size distributions of feed and concentrate are listed in **Appendix 9.2-5**.

The rejected froths were both low in weight and phosphorus content, especially when compared to the results of the laboratory testwork. Microscopic inspection of the concentrate suggested that the selectivity towards apatite in the first pilot test was far less than optimum.[12]

More important, the P-content of the concentrate was analysed to 0.139 % P, only 0.018 points lower than the feed.

Hence, the first pilot scale flotation must be considered as failed. It was concluded at the time that the feed material was very probably too coarse for effective flotation to occur. This view was supported by the following observations: The slurry flow was not able to transport all of the feed out of the flotation cells, a considerable amount of residual material was found in the cells upon completion of the test. Also, as mentioned above, larger greenish particles could not be found under microscope in froths samples, contrary to previous laboratory scale tests' froths. Last but not least, a screen metal analysis of the recovered flotation concentrate (see **Appendix 9.2-6**) shows that the P-content in the size fractions >0.063 mm could not be lowered sufficiently.

9.3. Laboratory scale tests for apatite removal

A series of laboratory flotation was undertaken to investigate further the cause of the unsatisfactory pilot scale flotation testwork. **Test #A6** repeated the pilot flotation procedure in laboratory scale (including the use of 1:2 retention time ratio between laboratory and pilot scale) with flotation concentrate from first pilot scale test. The results are shown in **Appendix 9.3-1**.

[12] The color of apatite is transparent-to-translucent/green/sometimes yellow, described here as "greenish". This matches with many particles known from microscopic surveys in binocular during this project that are consequently suspected as apatite.

In this laboratory scale test, the phosphorus content decreased to 0.057 % P already after the first flotation stage (1.5 min) –from an initial 0.130 % P. The concentrate was analysed after the second flotation stage (another 1.5 min) to 0.033 % P.

Hence two conclusions can be drawn from this test: First, the phosphate minerals (apatite) respond to the applied reagent regime and process conditions - at least in laboratory scale. And second, another flotation can be done on the flotation concentrate from first pilot scale test.

To investigate the effect of particle size upon the flotation performance, a further two laboratory tests were performed after regrinding the flotation concentrate from first pilot scale test (d_{80}-value of 0.152 mm).

For **Test #A7**, the flotation concentrate was ground for 10 min in lab rod mill resulting in a d_{80}-value of 0.12 mm. The results of lab flotation test with this reground feed are shown in **Appendix 9.3-2**.

Using the same flotation procedure but finer sizing, the P-content in concentrate decreased to 0.026 % P (compared to 0.033 % P in Test #A6's concentrate). Weight and iron rejection increased only very slightly and were based on crude ore feed on the same level at 0.3 $\%_{v/o}$ and 0.4 $\%_{v/o}$ Fe_{rec}, respectively.

For **Test #A8**, the feed size was decreased further by subjecting the pilot flotation concentrate to 25 min of regrinding using a laboratory rod mill. The d_{80}-value was determined as 0.083mm. The laboratory scale flotation **Test #A8** is shown in **Appendix 9.3-3**.

Test #A8 produced a concentrate with a P-content of only 0.011 % P. The iron content was analysed to 66.9 % Fe_{tot} which means an iron recovery of 33.8 % Fe_{rec}. Weight and iron losses were still satisfactorily low albeit slightly higher than observed in tests #A6 and #A7. There is clear evidence of a slight increase in losses as the particle size of the feed decreases.

9.4. Second pilot scale flotation test for apatite removal

On the basis of the findings of laboratory tests #A6-A8, it was mutually agreed to undertake a further pilot flotation test using the conditions of Test #A8, i.e. aim for a feed with a d80 of ~0.080mm. This test was fed with recombined products from the first, failed pilot test.

As can be seen in **Appendix 9.4-1**, the product piles of concentrate and froths as well as the remainders recovered from the cells were recombined in a proportion aiming to match the chemical composition of first test feed as closely.

The recombined feed was reground before processing by flotation using SGA's HIG tower mill, it is introduced in **Appendix E-25**. To avoid overgrinding, and specifically to minimise the increase in ultrafine particles <0.040mm, the HIG tower mill was run out of high efficient conditions. Therefore the grinding media charge was decreased from the typical 60% to 25% of the mill volume and it was shifted slightly to a coarser than typical size distribution. As main measure for removing finer sized particles from the HIG tower mill, slurry flow rate was increased to 12 l/min (720 l/h). Accordingly the slurry density quite low at 417 kg_{solid}/m^3_{slurry}.

The mill is supposed to reach static state after 3-4 retention times (6-8 min). For adjusting the needed grinding energy (by changing rotational speed), samples of mill discharge were taken very early during the test and assessed for size distribution These samples displayed d_{80}-values in line with expectations, 0.080-0.095 mm.

Specific grinding energy was finally determined to 10.1 kWh/t. The mill was operated in open circuit in line with the subsequent flotation plant. Water was added to the mill charge to adjust the slurry flow; this resulted in an average 27.2 % solids in the feed to flotation.

The process overview is given in **Appendix 9.4-2**, details on flotation are listed in **Appendix 9.4-3**.

The process conditions of the second pilot flotation tests followed in essence those of the first test: Initial addition of apatite collector Atrac 1563 at 100 g/t with conditioning for 6.0 min (in two flotation cells with agitation, but no air injection). Followed by the first flotation stage with 3.0 min retention time, frother MIBC was added at 30 g/t to the cell's inlet. The second flotation stage followed without conditioning, another 50 g/t Atrac 1563 and 30 g/t MIBC were added to the flotation cell's inlet. The second flotation stage was performed in three cells which combine to a retention time of 3.6 min.

Prior to exhaustion of recombined flotation feed, samples were taken. The chemical analyses and mass balances are shown in **Appendix 9.4-4**, size distributions in **Appendix 9.4-5**.

It must be noted that the size analysis of mill discharge resulted in a coarser sizing than anticipated by earlier 'check' samples and coarser than targeted. D_{80} was calculated to 0.106 mm. The median size d_{50} was at 0.057 mm, hence at the very minimum, overgrinding of the flotation feed was avoided.

The flotation removed 1.3 % (0.3 $\%_{v/o}$) of the weight with Froth 1 and another 0.3 % (0.1 $\%_{v/o}$) with Froth 2. The P-content (5.6 % and 4.1 %) of these froths as well as their weight were not as high as in the previous laboratory scale tests. The iron loss was calculated to 0.5 $\%_{v/o}$ Fe_{rec}.

As a result, the P-content of the concentrate sample again fell short of those achieved in the previous laboratory tests, #A6-A8. The chemical analysis resulted in 0.083 % P. Although this result is already a considerable improvement over the first pilot test, this phosphorus content is above desired levels for iron making.

98.4 % of the feed (19.4 $\%_{v/o}$) were recovered as flotation concentrate.

The concentrate's iron content was analysed to 66.4 % Fe_{tot} (34.3 $\%_{v/o}$ Fe_{rec}), silica content to 2.92 % SiO_2. Besides, 0.31 % TiO_2 and 0.010 % V were found. Evidently, the apatite removal in the second pilot flotation test was still far less than optimum. Screen metal analyses of the mill discharge (i.e. feed to second pilot flotation) and the flotation concentrate, given in **Appendices 9.4-6 and -7**, show that the P-content in the finer sized fractions was reduced sufficiently, however not in the coarser ones.

Another laboratory scale **Test #A9** was performed on a subsample of the feed to the second pilot flotation to confirm also that insufficient P-reduction is mainly caused by froth behaviour in pilot scale and not by insufficient liberation of the apatite from the iron oxide minerals. The flotation procedure replicated exactly the one from pilot scale testing, that means that also the slurry density was lower at 27.1 % solids and that the second Atrac conditioning was omitted. The results are shown in **Appendix 9.4-8**.

The phosphorus content of the concentrate was at 0.022 % P, as could be expected well in between the previous Tests #A7 and #A8 with coarser and finer sizing, respectively.

The iron losses in Test #A9 were very much higher when compared to all previous tests.[13]

The difficulties in transition from laboratory scale to pilot scale were discussed with experts from AkzoNobel, the supplier of Atrac 1563. They confirmed the suspicion that the structural strength of the froth is not sufficient to lift larger particles for more than a lab cell's overflow. AkzoNobel's reference application on industrial apatite flotation of iron ore (a Swedish Magnetite) is performed at much finer size – pelletizing fineness. Some alternative reagents were proposed with the aim of achieving a stronger froth structure. However, there was insufficient time and sample to investigate this issue further.

375 kg of flotation concentrate product pile were recovered from the test. This product pile is designated as ***Flotation Hematite Concentrate ('Material 8')***.

[13] This couldn't be followed up due to constrains in time and available sample. It is assumed that this was caused by the presence of superfine limonite particles which formed during drying of the mill discharge sample..

The full chemical analysis of that final concentrate is listed in **Appendix 9.4-9**. Iron content was at 66.45 % Fe_{tot}. Magnetite content was determined by Satmagan to 1.7 %. The gangue was composed of 3.0 % SiO_2, 0.6 % Al_2O_3, 0.4 % CaO and 0.2 % MgO.

Phosphorus content of the product pile was analysed to 0.096 % P.

Sodium oxide was increased and analysed to 0.091 % Na_2O, probably by water glass conditioning.

All other analysed impurities were on a preferably low level, including 0.008 % S, 0.020 % K_2O and 0.015 % Mn. The contents of titanium dioxide and vanadium were at 0.31 % TiO_2 and 0.011 % V, respectively.

As can be seen in **Appendix 9.4-10**, the sizing of the product pile was with 0.116 mm d_{80}, 0.060 mm d_{50} and 760 Blaine, slightly coarser than the sample taken during the pilot test. This is also the reason for the slightly worse grade.

This hematite concentrate is well on par or better than many other sinter concentrates on the market, only the phosphorus content must be considered as higher than desired. It is assumed that such concentrate will be accepted as sinterfeed as long as the portion in the ore mix is not too high.

If the two pilot concentrates were blended according to their respective weights, a ***Combined final concentrate*** assaying 69.0 % Fe_{tot} and 1.84 % SiO_2 would be obtained (**Appendix 9.4-11**). This is well on par or better than most other sinter concentrates on the market.

Although the combined P-content of 0.052 % P is slightly higher than desired for iron making (due to inherent processing costs caused by downstream P-removal in steel shop), it is not assumed to be critical. However, it should be noted that may Brazilian and Australian ores exceed these levels, and in consideration of the generally increasing P-content of iron ore supplies, a P-content of 0.05 % will likely find acceptance on the market.

The higher magnetite content of 58.1 % results typically in a reduced productivity, but also in a reduced coke breeze consumption in the sinter plant.

As for every other concentrate, the portion in sinter mixture will be limited due to its sizing and the inherent effect on sinter productivity.

10. Summary

On behalf of Nordic Iron Ore AB ("NIO"; Danderyd, Sweden), Studiengesellschaft für Eisenerzaufbereitung ("SGA") has performed laboratory and pilot scale testwork with an 8 t ROM iron ore sample from Blötberget deposit in Sweden.

The testwork comprised of

- receipt and preparation of three separate bulk sample materials
- the combination of these three ore types to produce a head sample representing the first five years of run of mine ('ROM') at Blötberget,
- pilot scale testwork for upgrading the iron content and reduce the phosphorus content and
- accompanying laboratory scale testwork.

In previous testwork a flowsheet for beneficiation of this ore had been developed. On the one hand this programme of work was expected to verify the suitability of that flowsheet, but the main purpose was to improve the iron recovery in the hematite recovery circuit.

The projects' intermediate and final results were discussed and mutually agreed between NIO, Tata Steel Consulting and SGA.

All findings and test results in this report refer to the tested head sample only.

The chemical composition of head sample – *Rougher LIMS Feed ('Material 0')* – revealed an iron content of 37.6 % Fe_{tot} and a magnetite content of 30.3 %. Silica was analysed to 35.35 % SiO_2. Titanium dioxide was at 0.185 % TiO_2 and Vanadium at 0.022 % V.

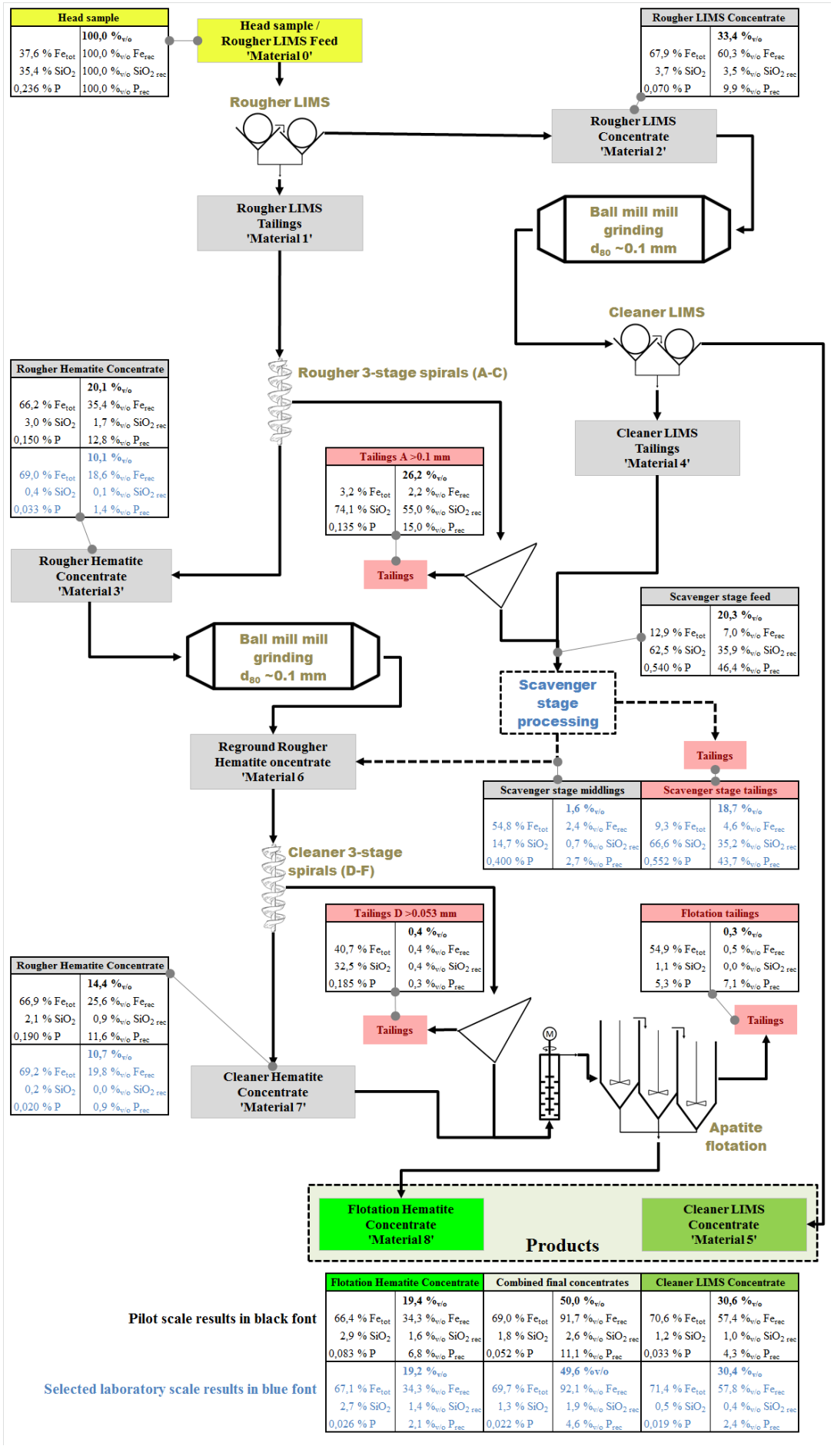
Further, phosphorus content was analysed for the head sample to 0.236 % P. As established during the testwork, this Blötberget ore sample contained a certain amount of apatite, a calcium phosphate containing mineral. The phosphorus content in iron ore products should be as low as possible for iron making due to inherent processing costs caused by downstream P-removal in steel shop. P-content in iron ores is preferred at 0.04 % P or lower. However, it should be noted that may Brazilian and Australian ores exceed these levels, and in consideration of the generally increasing P-content of iron ore supplies, a P-content of 0.05 % will likely find acceptance on the market.

The phosphate minerals appear to be more intimately associated with hematite (martite) than with magnetite. Its removal from the hematite concentrate was performed by flotation using AkzoNobel's collector Atrac 1563.

About 7900 kg head sample, crushed in SGA's HPGR to <1 mm, were tested in laboratory and pilot scale for the following processing steps:

- Rougher stage low intensity magnetic separation ('LIMS')
  with head sample – *Rougher LIMS Feed ('Material 0')*
- Rougher stage spiral separation with *LIMS Tailings ('Material 1')*
- Cleaner stage LIMS with *Rougher LIMS Concentrate ('Material 2')*
- Regrinding of *Rougher hematite concentrate ('Material 3')*
- Scavenger stage processing with *Tailings A <0.1 mm* from rougher stage spiral separation and *Cleaner LIMS Tailings*
- Cleaner stage spiral separation with *Reground rougher spiral concentrate ('Material 6')*
- Removal of phosphorus (apatite) from *Cleaner spiral concentrate ('Material 7')* by reverse froth flotation

On the following page, the pilot scale results and some selected results from laboratory scale are summarized on a flowsheet.



	Flotation Hematite Concentrate		Combined final concentrates		Cleaner LIMS Concentrate	
Pilot scale results in black font		19,4 %w/o		50,0 %w/o		30,6 %w/o
	66,4 % Fetot	34,3 %w/o Fe rec	69,0 % Fetot	91,7 %w/o Fe rec	70,6 % Fetot	57,4 %w/o Fe rec
	2,9 % SiO2	1,6 %w/o SiO2 rec	1,8 % SiO2	2,6 %w/o SiO2 rec	1,2 % SiO2	1,0 %w/o SiO2 rec
	0,083 % P	6,8 %w/o P rec	0,052 % P	11,1 %w/o P rec	0,033 % P	4,3 %w/o P rec
Selected laboratory scale results in blue font		19,2 %w/o		49,6 %v/o		30,4 %w/o
	67,1 % Fetot	34,3 %w/o Fe rec	69,7 % Fetot	92,1 %w/o Fe rec	71,4 % Fetot	57,8 %w/o Fe rec
	2,7 % SiO2	1,4 %w/o SiO2 rec	1,3 % SiO2	1,9 %w/o SiO2 rec	0,5 % SiO2	0,4 %w/o SiO2 rec
	0,026 % P	2,1 %w/o P rec	0,022 % P	4,6 %w/o P rec	0,019 % P	2,4 %w/o P rec

A more detailed balance for this flowsheet was assembled by Tata Steel Consulting which is displayed in **Appendix 10-1**.

Both rougher stage concentrates, magnetite concentrate from rougher stage LIMS and hematite concentrate from rougher stage spiral separation, have shown a reasonably high Fe grade, fully or partly suitable for processing in blast furnace route. For the scenario of a combined rougher stage product, both concentrates were virtually mixed according to their respective weight recoveries. The iron content is calculated to 67.3 % and silica content to ~3.4 % SiO_2, that is well on par or better than many other sinter concentrates on the market. But the combined P-content of 0.10 % P exceeds the phosphorus levels desired by most European still mills. These typically prefer concentrates with 0.05 % P or lower to avoid additional downstream processing costs for P-removal in the steel shop.

For the tests on scavenger processing, *Tailings A <0.1 mm* from rougher stage spiral separation and *Cleaner LIMS Tailings* were combined. From all tests on scavenger processing, it can be concluded that producing a scavenger concentrate with iron content on the level of 50-55 % Fe_{tot} is possible, up to 2.5 $\%_{v/o}$ Fe_{rec} could be recycled. The option to charge such scavenger concentrate directly to apatite flotation or to mix it to the final product was also discussed with client's experts. This might be possible as weight recovery is comparably low, hence deterioration of product grade. For the successive testwork was decided that no products from scavenger testwork were to be recycled.

Shaking table tests anticipating both, rougher and cleaner spiral separation, produced very high grade hematite concentrate at a weight recovery of 10.1-10.7 $\%_{v/o}$ based on crude ore. The concentrates were composed of 69.0-69.2 % Fe_{tot} (18.6-19.8 $\%_{v/o}$ Fe_{rec}) and only 0.37-0.16 % SiO_2. Also the phosphorus content was advantageously low at 0.033-0.020 % P. Such concentrate would be near to perfect chemical quality.

Cleaner LIMS concentrate *('Material 5')* is the final magnetite product from the process and it was recovered in pilot scale testing at 30.6 $\%_{v/o}$ of crude ore feed. The iron content was analysed to 70.6 % Fe_{tot}, which means an iron recovery of 57.4$\%_{v/o}$ Fe_{rec}. Satmagan determined 93.9 % magnetite; hence a magnetite recovery of 94.8 $\%_{v/o}$ $Mag._{rec}$ is calculated. This overall magnetite recovery at ~95 $\%_{v/o}$ $Mag._{rec}$ is at a typical level, especially if the high grade is taken into consideration.

The silica content was analysed to 1.15 % SiO_2. Phosphorus content was favorably low at 0.033 % P. The produced pile *Cleaner LIMS concentrate ('Material 5')* was analysed to

0.24 % Al_2O_3, 0.21 % CaO and 0.21 % MgO. All other impurities including 0.002 % S and 0.036 % Na_2O+K_2O were preferably low. The d_{80}-value of the product pile was at 0.141 mm, the specific surface was determined to 965 Blaine.

This magnetite concentrate is of such high grade that it is even eligible for iron making in direct reduction route. Hence it will be attractive to steel producers as well who are looking to increase the iron content of the ferrous burden thereby reducing slag volume, reductant rate and increasing the productivity of the blast furnace. As for every other concentrate, the portion in sinter mixture will be limited due to sizing in order to avoid detrimental impacts on the sinter operation such as sinter strength, permeability and production rate.

The apatite accumulated on the hematite upgrading part of the flowsheet and was removed by flotation using AkzoNobel's collector Atrac 1563. Despite favorable results in laboratory scale, where P-content could be lowered easily below 0.040 % P, it came to difficulties during pilot scale tests in removing coarser apatite particles. As a result, the P-content of the concentrate sample was with 0.083 % P not as low as required. Nevertheless, ***Flotation Hematite Concentrate*** *('Material 8')* was recovered at 19.4 $\%_{v/o}$ weight recovery and it showed an iron content of 66.4 % Fe_{tot}, hence 34.3 $\%_{v/o}$ Fe_{rec} of the crude ore's iron were recovered. Silica content was at 2.92 % SiO_2.

The chemical analysis of the product pile of that final concentrate resulted in a gangue composition of 3.0 % SiO_2, 0.6 % Al_2O_3, 0.4 % CaO and 0.2 % MgO. Beside 0.091 % Na_2O, all other analysed impurities were on a preferably low level, including 0.008 % S, 0.020 % K_2O and 0.015 % Mn. The d_{80}-value was at 0.116 mm, specific surface at 760 Blaine.

This hematite concentrate is well on par or better than many other sinter concentrates on the market, only the phosphorus content must be considered as higher than desired. On the other hand, a number of Australian or Brazilian ores show P-contents as high or sometimes even higher than that. It is assumed that such concentrate will be gladly accepted as sinterfeed as long as the portion in the ore mix is not too high.

If both pilot scale concentrates, *Cleaner LIMS concentrate ('Material 5')* and *Flotation Hematite Concentrate ('Material 8')*, were mixed on paper according to their respective weight recoveries for a ***Combined final concentrate***, the iron content would be calculated to 69.0 % Fe_{tot} and silica content to 1.84 % SiO_2, well on par or better than most other sinter concentrates on the market. Although the combined P-content of 0.052 % P is slightly higher than desired for iron making, it

is not assumed to be critical. The higher magnetite content of 58.1 % results typically in a reduced productivity, but also in a reduced coke breeze consumption in the sinter plant.

In the result overview few pages above, two final concentrates from laboratory scale tests are displayed as well: on the one hand a LIMS concentrate produced at a finer grinding and on the other hand a flotation hematite concentrate where apatite removal worked sufficiently. If such concentrates were combined, 69.0 % Fe_{tot}, 1.3 % SiO_2 and 0.022 % P could be anticipated. Such sinter concentrate would fully match, if not exceed the requirements for high efficient iron making.

The weight recovery combined for magnetite concentrate and flotation hematite concentrate was at 50.0 $\%_{v/o}$, accordingly one half of crude ore feed was recovered. The iron recovery combines for 91.7 $\%_{v/o}$ Fe_{rec}, exceeding somewhat the initial expectation of 90 $\%_{v/o}$ Fe_{rec}. Additionally ~2.5 $\%_{v/o}$ Fe_{rec} are anticipated to be recycled to processing from scavenging; it can be expected that at least a part of that will last to the final concentrate and improve iron recovery slightly.

TiO_2 and V were monitored throughout the project, a significant accumulation could not be noticed.

With the exception of few phosphorus contents which shall be controllable by blending, it can be stated, that all intermediate and final iron ore concentrates recovered in this project with this Blötberget ore sample are fully suitable for sintering process and high efficient iron making in blast furnace route, hence will be gladly accepted on the market. The portion in sinter mixture will be limited as for every other concentrate, due to its sizing and the inherent effect on sinter productivity.

Nordic Iron Ore AB

Blötberget - 3 ROM sub-samples (18 t total, 2015)

Sample preparation

Chemical analysis of three delivered sub-samples

Designation	Guldkannan (Magnetite)	Hugget (Hematite)	Footwall (Waste)
SGA-No.	7450/1 <40	7450/2 <40	7450/3 <40
Weight [kg]	5955	7948	1706
Fe_{tot} [%]	**33,85**	**55,15**	**7,55**
FeO [%]	-	-	-
SiO_2 [%]	32,00	18,05	69,40
Al_2O_3 [%]	-	-	-
CaO [%]	-	-	-
MgO [%]	-	-	-
P [%]	0,960	0,100	0,027
S [%]	**-**	**-**	**-**
Na_2O [%]	-	-	-
K_2O [%]	-	-	-
Mn [%]	-	-	-
TiO_2 [%]	0,41	0,105	0,2
V [%]	0,085	0,0065	0,001
L.O.I. [%]	-	-	-
Magnetite by Satmagan [%]	**40,8**	**40,6**	**4,7**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot} [%]	87,1	53,2	45,0

Nordic Iron Ore AB

Blötberget - 3 ROM sub-samples (18 t total, 2015)

Sample preparation

Mixing of delivered sub-samples

Designation	Guldkannan (Magnetite)	Hugget (Hematite)	Footwall (Waste)	Total
SGA-No.	7450/1 <1	7450/2 <1	7450/3&4 <1	7451
Target [%]	**17,5**	**52,5**	**30,0**	100,0
Weight [kg]	1383	4148	2370	7900
				Calc. Analysis
Fe_{tot} [%]	33,85	55,15	7,55	37,14
SiO_2 [%]	32,00	18,05	69,40	35,90
P [%]	0,960	0,100	0,027	0,229
TiO_2 [%]	0,410	0,105	0,200	0,187
V [%]	0,085	0,007	0,001	0,019
Magn. by Satm. [%]	40,8	40,6	4,7	29,9
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot} [%]	87,1	53,2	45,0	56,7

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher LIMS Feed - 'Material 0'

Chemical analysis of

Rougher LIMS Feed - 'Material 0'

Fe_{tot} [%]	**37,6**		
FeO [%]	9,99		
SiO_2 [%]	35,35		
Al_2O_3 [%]	5,0	Cr [%]	0,0084
CaO [%]	1,25	Co [%]	<0,0005
MgO [%]	1,77	Ni [%]	<0,0005
P [%]	0,236	Cu [%]	<0,0005
S [%]	0,004	Zn [%]	0,0013
Na_2O [%]	1,72	Pb [%]	0,004
K_2O [%]	0,69	As [%]	<0,0005
Mn [%]	0,035	Cd [%]	<0,0005
TiO_2 [%]	0,185	Tl [%]	<0,001
V [%]	0,022	SrO [%]	0,003
L.O.I. [%]	- 0,38	BaO [%]	0,015

Magnetite by Satmagan [%]	**30,3**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot} [%]	58,3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

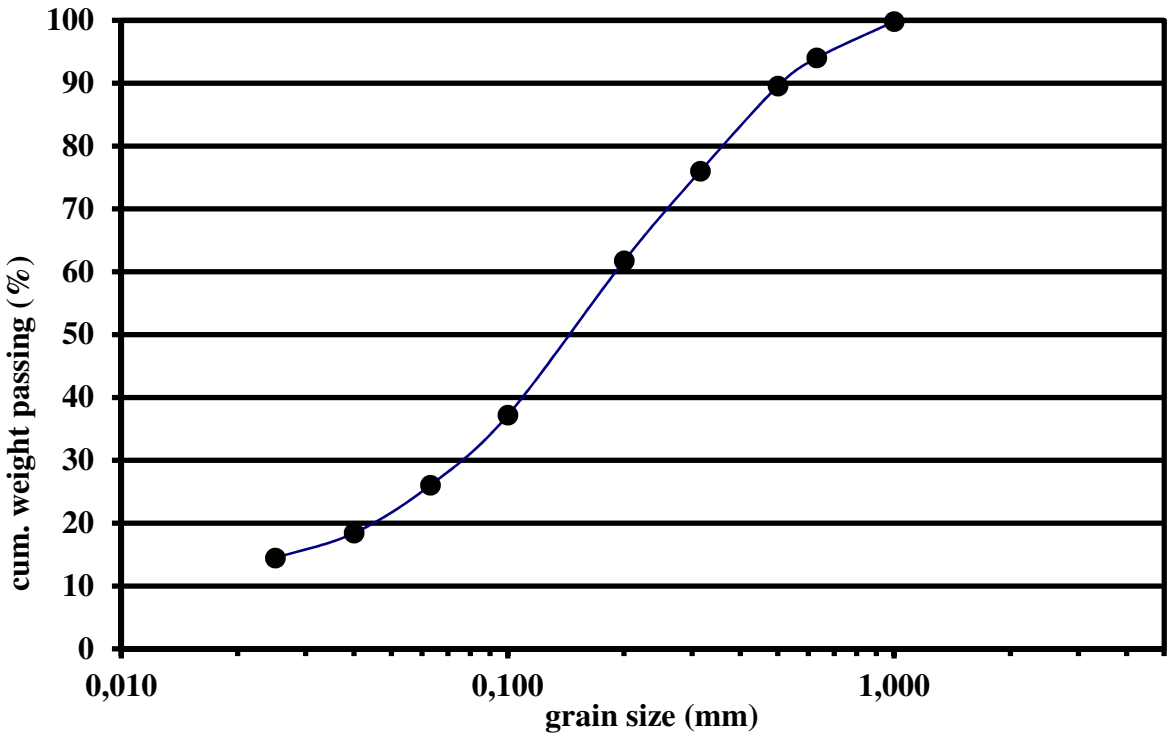
Rougher LIMS Feed - 'Material 0'

Screen analysis of

Rougher LIMS Feed - 'Material 0'

Size mm			Weight %	/	Passing cum. %
	+	1,0	0,2	/	99,8
1,0	-	0,63	5,8	/	94,0
0,63	-	0,5	4,5	/	89,5
0,5	-	0,315	13,5	/	76,0
0,315	-	0,2	14,3	/	61,7
0,2	-	0,1	24,5	/	37,2
0,1	-	0,063	11,2	/	26,0
0,063	-	0,04	7,6	/	18,4
0,04	-	0,025	4,0	/	14,5
0,025	-	0	14,5	/	0,0
Calculated total			100,0		

d_{80}	[mm]	0,37
d_{50}	[mm]	0,15



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher LIMS Feed - 'Material 0'

Davis Tube Test

with Rougher LIMS Feed - 'Material 0'

Top size		<1.0 mm *	<0.63 mm
	Feed	Concentrate	Concentrate
Weight [%]	100	31,7	31,1
Fe_{tot} [%]	37,60	68,00	68,65
Fe_{rec} [%]	100	57,3	56,8
Magnetite by Satmagan [%]	30,3	92,9	93,3
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot} [%]	58,3	98,8	98,3
$Magn._{rec}$ [%]	100	97,2	95,8
SiO_2 [%]	35,35	3,50	3,13
$SiO_{2\ rec}$ [%]	100	3,1	2,8
P [%]	0,236	0,061	0,060
TiO_2 [%]	0,185	0,102	0,097
V [%]	0,022	0,053	0,053

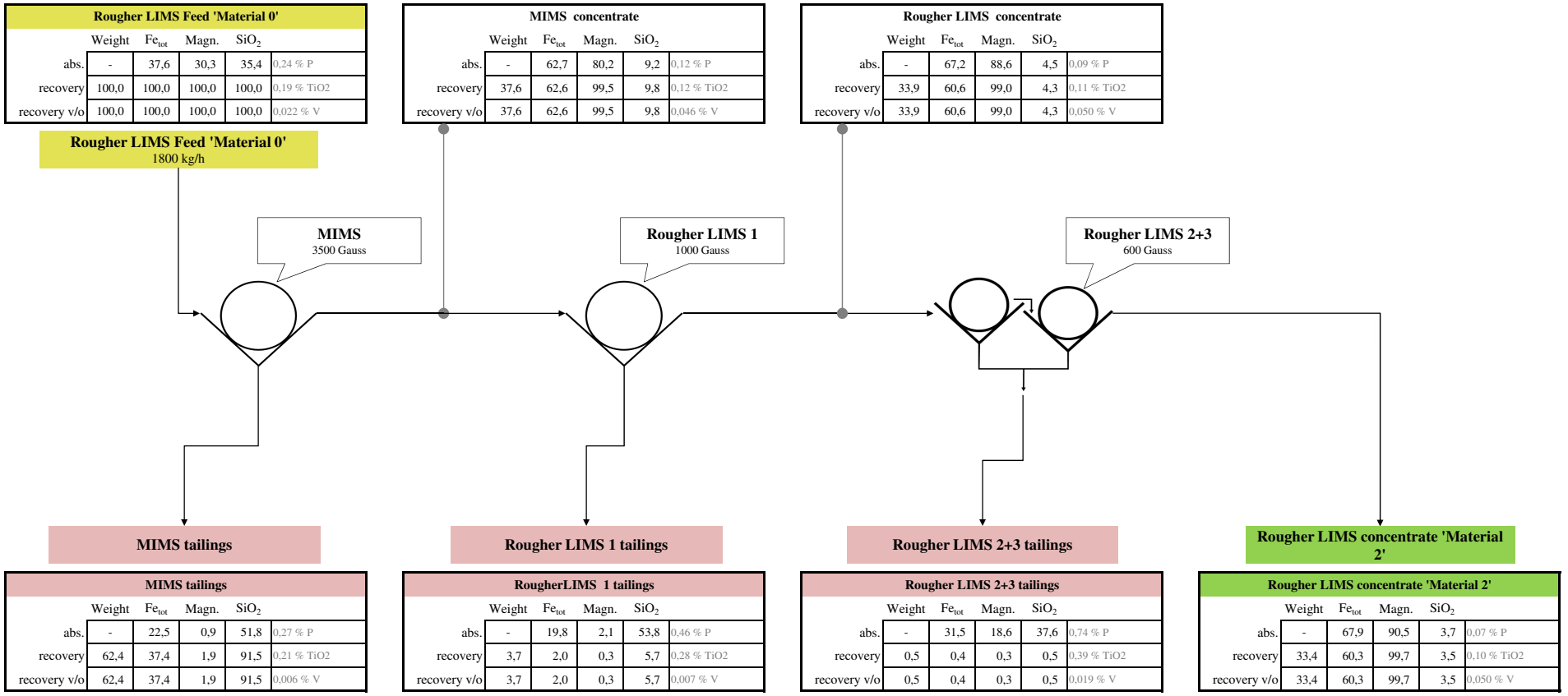
* - Top size <1.0 mm is the LIMS-Feed 'Material 0' without any regrinding.

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher LIMS - Pilot scale test

Process overview



Rougher LIMS Feed 'Material 0'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	37,6	30,3	35,4	0,24 % P
recovery	100,0	100,0	100,0	100,0	0,19 % TiO2
recovery v/o	100,0	100,0	100,0	100,0	0,022 % V

MIMS concentrate

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	62,7	80,2	9,2	0,12 % P
recovery	37,6	62,6	99,5	9,8	0,12 % TiO2
recovery v/o	37,6	62,6	99,5	9,8	0,046 % V

Rougher LIMS concentrate

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	67,2	88,6	4,5	0,09 % P
recovery	33,9	60,6	99,0	4,3	0,11 % TiO2
recovery v/o	33,9	60,6	99,0	4,3	0,050 % V

MIMS tailings

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	22,5	0,9	51,8	0,27 % P
recovery	62,4	37,4	1,9	91,5	0,21 % TiO2
recovery v/o	62,4	37,4	1,9	91,5	0,006 % V

RougherLIMS 1 tailings

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	19,8	2,1	53,8	0,46 % P
recovery	3,7	2,0	0,3	5,7	0,28 % TiO2
recovery v/o	3,7	2,0	0,3	5,7	0,007 % V

Rougher LIMS 2+3 tailings

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	31,5	18,6	37,6	0,74 % P
recovery	0,5	0,4	0,3	0,5	0,39 % TiO2
recovery v/o	0,5	0,4	0,3	0,5	0,019 % V

Rougher LIMS concentrate 'Material 2'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	67,9	90,5	3,7	0,07 % P
recovery	33,4	60,3	99,7	3,5	0,10 % TiO2
recovery v/o	33,4	60,3	99,7	3,5	0,050 % V

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Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher LIMS - Pilot scale test

Chemical analysis of samples taken during test

(Feed rate @ 1800 kg/h, MIMS @ 3500 Gauss, Rougher LIMS 1 @ 1000 Gauss, Rougher LIMS 2+3 @ 600 Gauss)

		Feed	Products				Calc. balance	Intermediate products	
		Rougher LIMS Feed 'Material 0'	Rougher LIMS concentrate 'Material 2'	Rougher LIMS 2+3 tailings	Rougher LIMS 1 tailings	MIMS tailings		Rougher LIMS 1 concentrate	MIMS concentrate
Weight	[%]	100,0	**33,4**	**0,5**	**3,7**	**62,4**	**100,0**	33,9	37,6
Weight	[$\%_{v/o}$]	100,0	**33,4**	**0,5**	**3,7**	**62,4**	**100,0**	33,9	37,6
Fe_{tot}	[%]	37,60	**67,90**	**31,45**	**19,80**	**22,50**	**37,60**	67,23	62,65
Fe_{rec}	[%]	100,0	**60,3**	**0,4**	**2,0**	**37,3**	**100,0**	60,6	62,6
Fe_{rec}	[%]	100,0	**60,3**	**0,4**	**2,0**	**37,4**	**100,0**	60,6	62,6
Fe_{rec}	[$\%_{v/o}$]	100,0	**60,3**	**0,4**	**2,0**	**37,4**	**100,0**	60,6	62,6
Magn. by Satm.	[%]	30,3	**90,5**	**18,6**	**2,1**	**0,9**	**30,9**	88,6	80,2
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	58,3	**96,4**	**42,8**	**7,7**	**2,9**	**59,5**	95,3	92,6
$Magn._{rec}$	[%]	97,9	**97,6**	**0,3**	**0,3**	**1,8**	**100,0**	97,0	97,4
$Magn._{rec}$	[%]	100,0	**99,7**	**0,3**	**0,3**	**1,9**	**102,1**	99,0	99,5
$Magn._{rec}$	[$\%_{v/o}$]	100,0	**99,7**	**0,3**	**0,3**	**1,9**	**102,1**	99,0	99,5
SiO_2	[%]	35,35	**3,67**	**37,60**	**53,80**	**51,80**	**35,73**	4,47	9,24
$SiO_{2\ rec}$	[%]	98,9	**3,4**	**0,5**	**5,6**	**90,5**	**100,0**	4,2	9,7
$SiO_{2\ rec}$	[%]	100,0	**3,5**	**0,5**	**5,7**	**91,5**	**101,1**	4,3	9,8
$SiO_{2\ rec}$	[$\%_{v/o}$]	100,0	**3,5**	**0,5**	**5,7**	**91,5**	**101,1**	4,3	9,8
P	[%]	0,24	**0,070**	**0,74**	**0,46**	**0,27**	**0,21**	0,09	0,12
P_{rec}	[%]	112,8	**11,2**	**1,7**	**8,1**	**79,1**	**100,0**	14,1	21,0
P_{rec}	[%]	100,0	**9,9**	**1,5**	**7,2**	**70,1**	**88,6**	12,5	18,6
P_{rec}	[$\%_{v/o}$]	100,0	**9,9**	**1,5**	**7,2**	**70,1**	**88,6**	12,5	18,6
TiO_2	[%]	0,19	**0,10**	**0,39**	**0,28**	**0,21**	**0,17**	0,11	0,12
V	[%]	0,022	**0,050**	**0,019**	**0,007**	**0,006**	**0,020**	0,050	0,046
d_{80}	[mm]	0,369	**0,455**	**0,306**	**0,297**	**0,337**	**0,375**	-	-
d_{50}	[mm]	0,152	**0,192**	**0,099**	**0,094**	**0,155**	**0,165**	-	-
Spec. Surface	[Blaine]	-	**295**	**1035**	**1205**	**605**	**526**	-	-
Spec. Weight	[g/cm³]	-	**4,93**	**3,43**	**3,08**	**3,14**	**3,74**	-	-

SGA-sample no.: 7451/1-1/1ff

Appendix 3.2-2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher LIMS - Pilot scale test

Size distribution of samples taken during test

Size mm	Feed Weight / Passing [%] / [cum. %]	Rougher LIMS concentrate 'Material 2' Weight / Passing [%] / [cum. %]	Rougher LIMS 2+3 tailings Weight / Passing [%] / [cum. %]	Rougher LIMS 1 tailings Weight / Passing [%] / [cum. %]	MIMS tailings Weight / Passing [%] / [cum. %]	Rougher LIMS 1 concentrate Weight / Passing [%] / [cum. %]	MIMS concentrate Weight / Passing [%] / [cum. %]
+ 1,0	0,2 / 99,8	0,2 / 99,8	0,3 / 99,7	0,7 / 99,3	0,3 / 99,7	-	-
1,0 - 0,63	5,8 / 94,0	8,0 / 91,8	3,7 / 96,0	5,8 / 93,5	5,0 / 94,7	-	-
0,63 - 0,5	4,5 / 89,5	7,7 / 84,1	4,5 / 91,6	4,4 / 89,1	4,6 / 90,1	-	-
0,5 - 0,315	13,5 / 76,0	16,8 / 67,3	10,8 / 80,7	7,9 / 81,2	11,5 / 78,6	-	-
0,315 - 0,2	14,3 / 61,7	15,5 / 51,7	9,2 / 71,5	7,9 / 73,3	17,1 / 61,6	-	-
0,2 - 0,1	24,5 / 37,2	22,3 / 29,4	21,3 / 50,2	21,1 / 52,2	25,8 / 35,8	-	-
0,1 - 0,063	11,2 / 26,0	9,7 / 19,7	9,1 / 41,1	14,3 / 37,9	12,6 / 23,2	-	-
0,063 - 0,04	7,6 / 18,4	6,8 / 12,9	6,9 / 34,2	10,8 / 27,1	8,3 / 14,9	-	-
0,04 - 0,025	4,0 / 14,5	4,4 / 8,5	5,6 / 28,6	6,9 / 20,3	3,5 / 11,4	-	-
0,025 - 0	14,5 / 0,0	8,5 / 0,0	28,6 / 0,0	20,3 / 0,0	11,4 / 0,0	-	-
	100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -	-	-
d_{80} [mm]	0,369	0,455	0,306	0,297	0,337	-	-
d_{50} [mm]	0,152	0,192	0,099	0,094	0,155	-	-
Spec. Surface [Blaine]	-	295	1035	1205	605	-	-
Spec. Weight [g/cm³]	-	4,93	3,43	3,08	3,14	-	-

SGA-sample no.: 7451/1-1/1ff

Appendix 3.2-3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Tailings - 'Material 1'

Chemical analysis of

Rougher LIMS Tailings - 'Material 1'

Fe_{tot} [%]	**24,6**
FeO [%]	-
SiO_2 [%]	49,7
Al_2O_3 [%]	-
CaO [%]	-
MgO [%]	-
P [%]	0,240
S [%]	-
Na_2O [%]	-
K_2O [%]	-
Mn [%]	-
TiO_2 [%]	0,2
V [%]	0,006
L.O.I. [%]	-

Magnetite by Satmagan [%]	**1,1**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot} [%]	3,2

Nordic Iron Ore AB

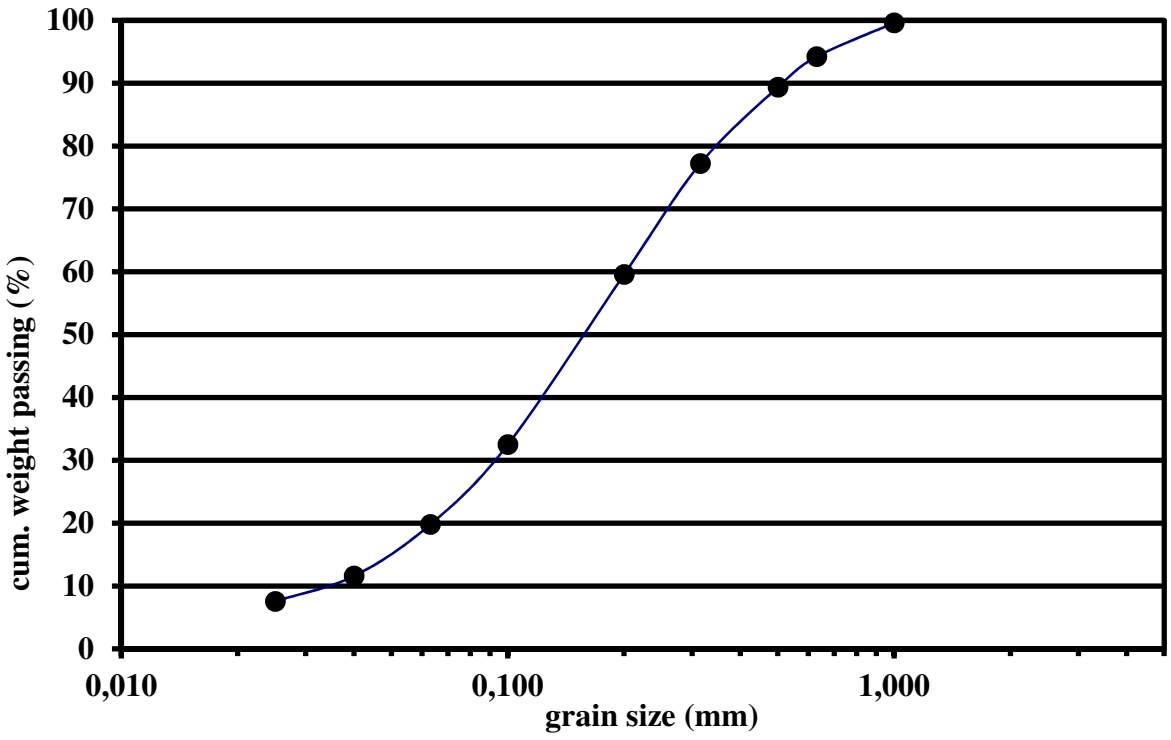
Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Tailings - 'Material 1'

Screen metal analysis of Rougher LIMS Tailings - 'Material 1'

Size mm	Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
+ 1,0	0,4 / 99,6					
1,0 - 0,63	5,4 / 94,2	22,7	50,9	0,042	0,170	0,0049
0,63 - 0,5	4,9 / 89,4					
0,5 - 0,315	12,2 / 77,2	35,7	39,2	0,045	0,180	0,0071
0,315 - 0,2	17,6 / 59,6	34,0	41,2	0,069	0,185	0,0070
0,2 - 0,1	27,1 / 32,5	21,0	54,6	0,185	0,175	0,0058
0,1 - 0,063	12,7 / 19,8	18,0	57,8	0,440	0,200	0,0056
0,063 - 0,04	8,2 / 11,6	16,9	57,1	0,610	0,235	0,0057
0,04 - 0,025	4,0 / 7,6	19,4	51,6	0,650	0,310	0,0072
0,025 - 0	7,6 / 0,0					
Calculated total	100,0	24,3	50,2	0,254	0,201	0,0062

d_{80} [mm]	0,357	Blaine [cm²/g]	405
d_{50} [mm]	0,165	Specific density [g/cm³]	3,20



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Tailings - 'Material 1'

Shaking table test

with Rougher LIMS Tailings - 'Material 1'

		Feed	Products				Calc. balance
		Rougher LIMS Tailings 'Material 1'	Concentrate	Middlings	Tailings 1	Tailings 2	
Weight	**[%]**	100,0	**15,2**	**25,0**	**47,0**	**12,8**	**100,0**
Weight	**[$\%_{v/o}$]**	66,6	**10,1**	**16,6**	**31,3**	**8,6**	**66,6**
Fe_{tot}	[%]	24,60	**68,95**	**42,80**	**4,10**	**9,85**	**24,36**
Fe_{rec}	[%]	101,0	**43,0**	**43,9**	**7,9**	**5,2**	**100,0**
Fe_{rec}	[%]	100,0	**42,6**	**43,4**	**7,8**	**5,1**	**99,0**
Fe_{rec}	[$\%_{v/o}$]	43,6	**18,6**	**18,9**	**3,4**	**2,2**	**43,2**
Magn. by Satm.	[%]	1,1	**1,3**	**1,4**	**0,9**	**1,8**	**1,2**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	3,2	**1,4**	**2,3**	**16,1**	**13,2**	**3,6**
$Magn._{rec}$	[%]	91,4	**16,8**	**28,6**	**35,5**	**19,1**	**100,0**
$Magn._{rec}$	[%]	100,0	**18,3**	**31,3**	**38,9**	**20,9**	**109,4**
$Magn._{rec}$	[$\%_{v/o}$]	2,4	**0,4**	**0,8**	**0,9**	**0,5**	**2,6**
SiO_2	[%]	49,70	**0,37**	**29,10**	**74,10**	**60,60**	**49,92**
$SiO_{2\ rec}$	[%]	99,6	**0,1**	**14,6**	**69,7**	**15,6**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**0,1**	**14,6**	**70,0**	**15,7**	**100,4**
$SiO_{2\ rec}$	[$\%_{v/o}$]	93,6	**0,1**	**13,7**	**65,6**	**14,7**	**94,0**
P	[%]	0,240	**0,033**	**0,405**	**0,140**	**0,440**	**0,228**
P_{rec}	[%]	105,1	**2,2**	**44,3**	**28,8**	**24,7**	**100,0**
P_{rec}	[%]	100,0	**2,1**	**42,1**	**27,4**	**23,5**	**95,2**
P_{rec}	[$\%_{v/o}$]	67,7	**1,4**	**28,5**	**18,6**	**15,9**	**64,5**
TiO_2	[%]	0,200	**0,310**	**0,230**	**0,130**	**0,260**	**0,199**
V	[%]	0,006	**0,011**	**0,008**	**0,002**	**0,006**	**0,005**
d_{80}	[mm]	0,357	**0,238**	**0,459**	**0,422**	**0,041**	**0,354**
d_{50}	[mm]	0,165	**0,159**	**0,263**	**0,174**	**0,019**	**0,174**
Spec. Surface	[Blaine]	-	**-**	**-**	**-**	**-**	**-**
Spec. Weight	[g/cm³]	-	**-**	**-**	**-**	**-**	**-**

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Tailings - 'Material 1'

Size distribution of products from shaking table test with 'Material 1'

Size mm	Feed	Concentrate	Middlings	Tailings 1	Tailings 2
	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]
+ 1,0	0,4 / 99,6	0,0 / 100,0	0,4 / 99,6	0,5 / 99,5	0,0 / 100,0
1,0 - 0,63	5,4 / 94,2	0,2 / 99,8	6,0 / 93,6	8,1 / 91,3	0,0 / 100,0
0,63 - 0,5	4,9 / 89,4	0,4 / 99,4	7,5 / 86,1	6,2 / 85,2	0,1 / 99,9
0,5 - 0,315	12,2 / 77,2	2,2 / 97,2	27,4 / 58,7	12,2 / 73,0	0,3 / 99,5
0,315 - 0,2	17,6 / 59,6	25,7 / 71,5	19,1 / 39,6	15,3 / 57,7	0,7 / 98,8
0,2 - 0,1	27,1 / 32,5	52,0 / 19,5	19,5 / 20,1	29,7 / 27,9	4,2 / 94,6
0,1 - 0,063	12,7 / 19,8	17,0 / 2,6	11,2 / 8,8	15,8 / 12,2	8,6 / 85,9
0,063 - 0,04	8,2 / 11,6	2,5 / 0,1	5,4 / 3,4	7,1 / 5,1	6,2 / 79,8
0,04 - 0,025	4,0 / 7,6	0,1 / 0,1	1,0 / 2,5	1,3 / 3,8	15,1 / 64,7
0,025 - 0	7,6 / 0,0	0,1 / 0,0	2,5 / 0,0	3,8 / 0,0	64,7 / 0,0
	100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,357	0,238	0,459	0,422	0,041
d_{50} [mm]	0,165	0,159	0,263	0,174	0,019
Spec. Surface [Blaine]	-	-	-	-	-
Spec. Weight [g/cm³]	-	-	-	-	-

SGA-sample no.: 7451/1-1/1ff

Appendix 4.1-3.2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Tailings - 'Material 1'

Sink float analysis

with Rougher LIMS Tailings - 'Material 1'

Screen metal Analysis

mm			Weight	/	Passing	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]		[cum. %]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	+	1,0	0,4	/	99,6	22,7		0,4	50,9	0,042	0,170	0,0049
1,0	-	0,1	67,1	/	32,5	27,3		75,3	47,7	0,107	0,178	0,0062
0,1	-	0,063	12,7	/	19,8	18,0		9,4	57,8	0,440	0,200	0,0056
0,063	-	0,04	8,2	/	11,6	16,9		5,7	57,1	0,610	0,235	0,0057
0,04	-	0,0	11,6	/	0,0	19,4		9,2	51,6	0,650	0,310	0,0072
			100,0			24,3		100,0	50,2	0,254	0,201	0,0062
d_{80} [µm] =		357	Analysis of basis			24,6			49,7	0,240	0,200	0,0060

Sink float analyses

Fraction > 0,1 mm

kg/l			weight	v/o	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	36,1	24,4	68,0	91,6	69,3	1,6	0,033	0,285	0,0120
3,3	-	2,7	9,7	6,5	16,6	6,0	4,5	42,6	0,980	0,380	0,0100
	<	2,7	54,2	36,6	1,2	2,4	1,8	78,8	0,180	0,084	0,0030
			100,0	67,5	26,8	100,0	75,7	47,4	0,204	0,185	0,0069

Fraction 0,1 - 0,063 mm

kg/l			weight	v/o	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	24,0	3,1	67,1	89,1	8,4	1,4	0,174	0,530	0,0070
3,3	-	2,7	11,9	1,5	10,2	6,7	0,6	54,0	2,320	0,280	0,0080
	<	2,7	64,1	8,2	1,2	4,2	0,4	79,5	0,015	0,060	0,0020
			100,0	12,7	18,1	100,0	9,4	57,7	0,327	0,199	0,0039

Fraction 0,063 - 0,04 mm

kg/l			weight	v/o	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	19,1	1,6	68,6	78,4	4,4	0,6	0,069	0,480	0,0130
3,3	-	2,7	4,3	0,4	28,5	7,4	0,4	24,5	2,780	0,460	0,0110
	<	2,7	76,6	6,3	3,1	14,2	0,8	71,3	0,850	0,145	0,0050
			100,0	8,2	16,7	100,0	5,7	55,8	0,784	0,222	0,0068

Summary of Fractions >0,04 mm

kg/l			v/o	Fe	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	29,0	67,9	82,1	1,5	0,050	0,321	0,0115
3,3	-	2,7	8,4	15,9	5,6	43,9	1,297	0,365	0,0097
	<	2,7	51,0	1,4	3,0	78,0	0,236	0,088	0,0031
			88,4	24,6	90,8	49,7	0,276	0,191	0,0065

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Tailings - 'Material 1'

Lab scale tests - Wet high intensity magnetic separation (WHIMS)

with Rougher LIMS Tailings - 'Material 1'

		Feed	Products			Calc. balance
		Rougher LIMS Tailings 'Material 1'	Concentrate	Middlings	Tailings	
Weight	[%]	100,0	**39,5**	**5,7**	**54,7**	**100,0**
Weight	[$\%_{v/o}$]	66,6	**26,3**	**3,8**	**36,4**	**66,6**
Fe_{tot}	[%]	24,60	**55,70**	**14,75**	**3,90**	**25,00**
Fe_{rec}	[%]	98,4	**88,1**	**3,4**	**8,5**	**100,0**
Fe_{rec}	[%]	100,0	**89,5**	**3,4**	**8,7**	**101,6**
Fe_{rec}	[$\%_{v/o}$]	43,6	**39,0**	**1,5**	**3,8**	**44,3**
Magn. by Satm.	[%]	1,1	**2,0**	**1,2**	**<0,9**	**-**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	3,2	**2,6**	**5,9**	**-**	**-**
$Magn._{rec}$	[%]	-	**-**	**-**	**-**	**-**
$Magn._{rec}$	[%]	-	**-**	**-**	**-**	**-**
$Magn._{rec}$	[$\%_{v/o}$]	2,4	**1,7**	**0,2**	**-**	**-**
SiO_2	[%]	49,70	**14,70**	**61,60**	**74,10**	**49,90**
$SiO_{2\ rec}$	[%]	99,6	**11,6**	**7,1**	**81,3**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**11,7**	**7,1**	**81,6**	**100,4**
$SiO_{2\ rec}$	[$\%_{v/o}$]	93,6	**10,9**	**6,7**	**76,4**	**94,0**
P	[%]	0,240	**0,150**	**0,210**	**0,265**	**0,216**
P_{rec}	[%]	110,9	**27,4**	**5,6**	**67,0**	**100,0**
P_{rec}	[%]	100,0	**24,7**	**5,0**	**60,4**	**90,2**
P_{rec}	[$\%_{v/o}$]	67,7	**16,7**	**3,4**	**40,9**	**61,1**
TiO_2	[%]	0,200	**0,305**	**0,190**	**0,130**	**0,203**
V	[%]	0,006	**0,011**	**0,006**	**0,004**	**0,007**
d_{80}	[mm]	0,357	-	-	-	-
d_{50}	[mm]	0,165	-	-	-	-
Spec. Surface	[Blaine]	-	-	-	-	-
Spec. Weight	[g/cm³]	-	-	-	-	-

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Process overview - Phase 1, open spiral circuit

(Reduced sampling)

Rougher LIMS Tailings 'Material 1'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	24,6	1,1	49,7	0,24 % P
recovery	100,0	100,0	100,0	100,0	0,20 % TiO2
recovery v/o	66,6	43,6	2,4	93,6	0,006 % V

Rougher LIMS Tailings 'Material 1'
1500 kg/h

PUMP

Dewatering cyclone

Cyclone overflow

Cyclone overflow

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	11,5	2,8	57,6	0,48 % P
recovery	4,2	1,9	10,6	4,8	0,31 % TiO2
recovery v/o	2,8	0,8	0,3	4,5	0,007 % V

3000 l/h
washing water

Spiral A
Rougher

Tailings A

Tailings A

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	4,4	1,1	72,6	0,22 % P
recovery	55,2	9,9	55,2	80,7	0,14 % TiO2
recovery v/o	36,8	4,3	1,3	75,5	0,003 % V

1300 l/h
washing water

Spiral B
Cleaner

Tailings B

Tailings B

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	13,0	1,2	63,2	0,62 % P
recovery	7,3	3,9	8,0	9,3	0,18 % TiO2
recovery v/o	4,9	1,7	0,2	8,7	0,004 % V

1300 l/h
washing water

Spiral C
Re-cleaner

Rougher Hematite concentrate 'Material 3'

Tailings C

Rougher Hematite concentrate 'Material 3'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	65,9	1,3	3,5	0,13 % P
recovery	30,5	81,7	36,1	2,1	0,30 % TiO2
recovery v/o	20,3	35,6	0,9	2,0	0,011 % V

Tailings C

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	20,7	1,4	53,9	0,64 % P
recovery	2,8	2,3	3,5	3,0	0,22 % TiO2
recovery v/o	1,8	1,0	0,1	2,8	0,005 % V

SGA-sample no.: 7451/1-1/1ff

Appendix 4.2-1.1

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Chemical analysis of samples taken for open circuit operation

Phase 1, open spiral circuit (Feed rate @ 1500 kg/h; reduced sampling)

		Feed	Products					Calc. balance
		Rougher LIMS Tailings 'Material 1'	R. Hematite concentrate 'Material 3'	Tailings A	Tailings B	Tailings C	Cyclone overflow *	
Weight	[%]	100,0	**30,5**	**55,2**	**7,3**	**2,8**	**4,2**	**100,0**
Weight	[$\%_{v/o}$]	66,6	**20,3**	**36,8**	**4,9**	**1,8**	**2,8**	**66,6**
Fe_{tot}	[%]	24,60	**65,90**	**4,40**	**12,95**	**20,70**	**11,45**	**24,54**
Fe_{rec}	[%]	100,3	**81,9**	**9,9**	**3,9**	**2,3**	**1,9**	**100,0**
Fe_{rec}	[%]	100,0	**81,7**	**9,9**	**3,9**	**2,3**	**1,9**	**99,7**
Fe_{rec}	[$\%_{v/o}$]	43,6	**35,6**	**4,3**	**1,7**	**1,0**	**0,8**	**43,5**
Magn. by Satm.	[%]	1,1	**1,3**	**1,1**	**1,2**	**1,4**	**2,8**	**1,2**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	3,2	**1,4**	**18,1**	**6,7**	**4,9**	**17,7**	**3,7**
$Magn._{rec}$	[%]	100,0	**36,1**	**55,2**	**8,0**	**3,5**	**10,6**	**113,4**
$Magn._{rec}$	[%]	100,0	**36,1**	**55,2**	**8,0**	**3,5**	**10,6**	**113,4**
$Magn._{rec}$	[$\%_{v/o}$]	2,4	**0,9**	**1,3**	**0,2**	**0,1**	**0,3**	**2,7**
SiO_2	[%]	49,70	**3,49**	**72,60**	**63,20**	**53,90**	**57,60**	**49,68**
$SiO_{2\ rec}$	[%]	100,0	**2,1**	**80,7**	**9,3**	**3,0**	**4,8**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**2,1**	**80,7**	**9,3**	**3,0**	**4,8**	**100,0**
$SiO_{2\ rec}$	[$\%_{v/o}$]	93,6	**2,0**	**75,5**	**8,7**	**2,8**	**4,5**	**93,6**
P	[%]	0,24	**0,13**	**0,22**	**0,62**	**0,64**	**0,48**	**0,24**
P_{rec}	[%]	98,9	**15,7**	**50,0**	**18,7**	**7,3**	**8,3**	**100,0**
P_{rec}	[%]	100,0	**15,9**	**50,6**	**18,9**	**7,4**	**8,3**	**101,2**
P_{rec}	[$\%_{v/o}$]	67,7	**10,8**	**34,3**	**12,8**	**5,0**	**5,7**	**68,5**
TiO_2	[%]	0,20	**0,30**	**0,14**	**0,18**	**0,22**	**0,31**	**0,20**
V	[%]	0,006	**0,011**	**0,003**	**0,004**	**0,005**	**0,007**	**0,005**
d_{80}	[mm]	0,357	**0,397**	**0,375**	**0,188**	**0,364**	-	-
d_{50}	[mm]	0,165	**0,235**	**0,155**	**0,106**	**0,125**	-	-
Spec. Surface	[Blaine]	405	**110**	-	-	-	-	-
Spec. Weight	[g/cm³]	3,20	**5,04**	-	-	-	-	-

* - sample weight and properties taken over from closed circuit evaluation (Appendix 4.2-2.2)

SGA-sample no.: 7451/1-1/1ff

Appendix 4.2-1.2

Studiengesellschaft für Eisenerzaufbereitung SGA

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Size distribution of samples taken during test (Phase 1, open spiral circuit)

Size mm	Feed Weight / Passing [%] / [cum. %]	R. Hematite concentrate 'Material 3' Weight / Passing [%] / [cum. %]	Tailings A Weight / Passing [%] / [cum. %]	Tailings B Weight / Passing [%] / [cum. %]	Tailings C Weight / Passing [%] / [cum. %]
+ 1,0	0,4 / 99,6	0,1 / 100,0	0,7 / 99,3	0,5 / 99,5	0,5 / 99,6
1,0 - 0,63	5,4 / 94,2	2,7 / 97,3	6,7 / 92,6	3,2 / 96,3	6,8 / 92,8
0,63 - 0,5	4,9 / 89,4	4,2 / 93,2	5,1 / 87,5	2,3 / 94,1	5,8 / 87,1
0,5 - 0,315	12,2 / 77,2	23,7 / 69,5	11,1 / 76,4	3,6 / 90,5	9,6 / 77,5
0,315 - 0,2	17,6 / 59,6	28,1 / 41,4	12,8 / 63,6	6,2 / 84,2	4,9 / 72,6
0,2 - 0,1	27,1 / 32,5	29,4 / 12,0	30,0 / 33,6	36,3 / 48,0	29,9 / 42,7
0,1 - 0,063	12,7 / 19,8	9,5 / 2,5	14,8 / 18,8	23,9 / 24,0	23,1 / 19,6
0,063 - 0,04	8,2 / 11,6	1,8 / 0,8	9,5 / 9,3	13,5 / 10,5	12,0 / 7,7
0,04 - 0,025	4,0 / 7,6	0,4 / 0,4	4,4 / 4,9	4,6 / 6,0	4,3 / 3,4
0,025 - 0	7,6 / 0,0	0,4 / 0,0	4,9 / 0,0	6,0 / 0,0	3,4 / 0,0
	100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,357	0,397	0,375	0,188	0,364
d_{50} [mm]	0,165	0,235	0,155	0,106	0,125
Spec. Surface [Blaine]	405	110	-	-	-
Spec. Weight [g/cm³]	3,20	5,04	-	-	-

SGA-sample no.: 7451/1-1/1ff

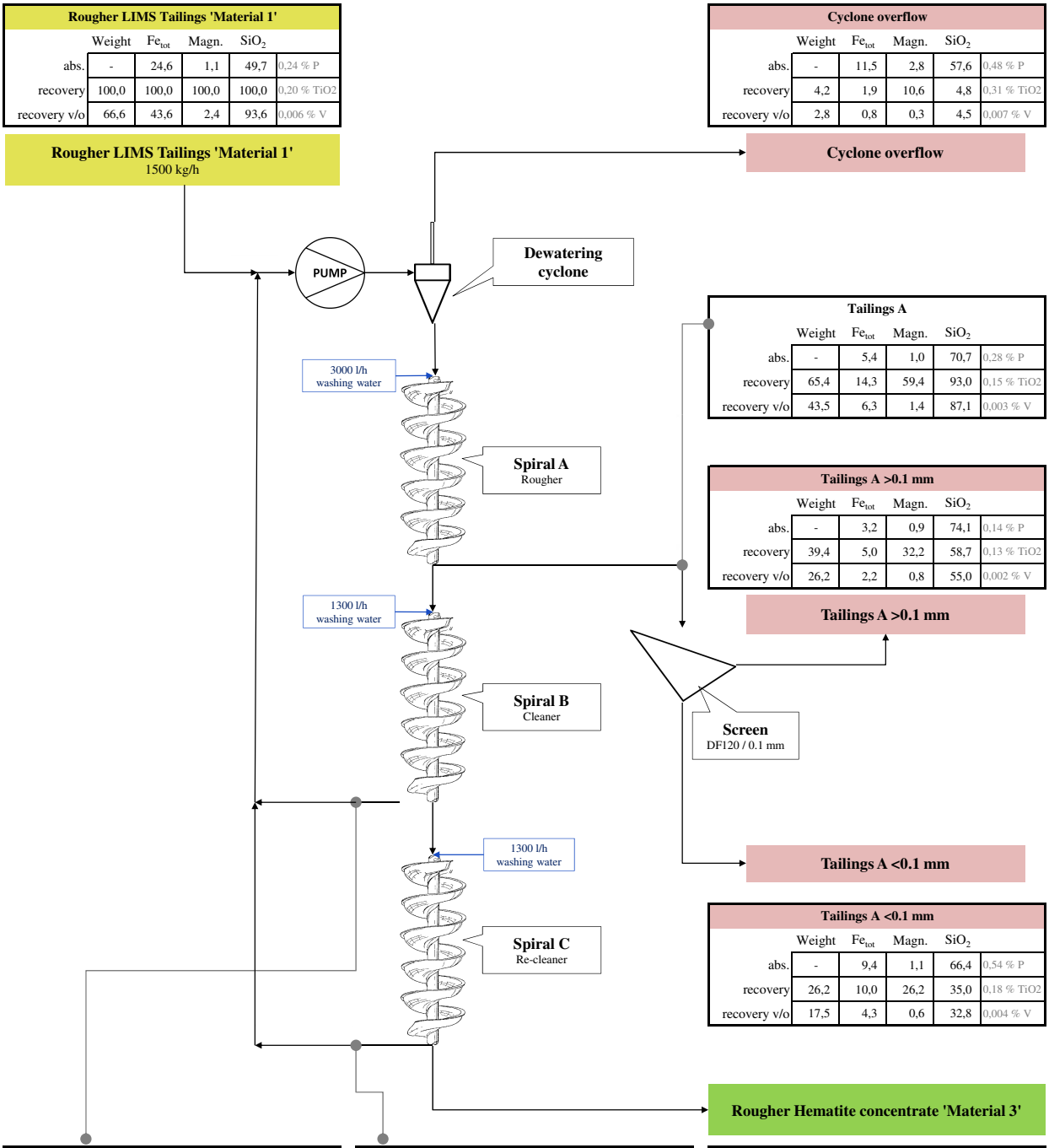
Appendix 4.2-1.3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Process overview - Phase 2, closed spiral circuit



Rougher LIMS Tailings 'Material 1'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	24,6	1,1	49,7	0,24 % P
recovery	100,0	100,0	100,0	100,0	0,20 % TiO2
recovery v/o	66,6	43,6	2,4	93,6	0,006 % V

Cyclone overflow

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	11,5	2,8	57,6	0,48 % P
recovery	4,2	1,9	10,6	4,8	0,31 % TiO2
recovery v/o	2,8	0,8	0,3	4,5	0,007 % V

Tailings A

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	5,4	1,0	70,7	0,28 % P
recovery	65,4	14,3	59,4	93,0	0,15 % TiO2
recovery v/o	43,5	6,3	1,4	87,1	0,003 % V

Tailings A >0.1 mm

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	3,2	0,9	74,1	0,14 % P
recovery	39,4	5,0	32,2	58,7	0,13 % TiO2
recovery v/o	26,2	2,2	0,8	55,0	0,002 % V

Tailings A <0.1 mm

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	9,4	1,1	66,4	0,54 % P
recovery	26,2	10,0	26,2	35,0	0,18 % TiO2
recovery v/o	17,5	4,3	0,6	32,8	0,004 % V

Tailings B

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	16,9	1,4	58,2	0,60 % P
recovery	7,4	5,1	9,4	8,6	0,20 % TiO2
recovery v/o	4,9	2,2	0,2	8,1	0,004 % V

Tailings C

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	24,6	1,7	59,4	0,73 % P
recovery	4,3	4,3	6,7	5,2	0,24 % TiO2
recovery v/o	2,9	1,9	0,2	4,8	0,006 % V

Rougher Hematite concentrate 'Material 3'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	66,2	1,2	3,0	0,15 % P
recovery	30,2	81,3	32,9	1,8	0,30 % TiO2
recovery v/o	20,1	35,4	0,8	1,7	0,010 % V

SGA-sample no.: 7451/2-1/1ff

Appendix 4.2-2.1

Studiengesellschaft für Eisenerzaufbereitung SGA

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Chemical analysis of samples taken during test

Phase 2, closed spiral circuit (Feed rate @ 1500 kg/h, Derrick screen DF 120 (~0.1 mm))

		Feed	Products				Calc. balance	Intermediate products		
		Rougher LIMS Tailings 'Material 1'	R. Hematite concentrate 'Material 3'	Tailings A <0.1 mm	Tailings A >0.1 mm	Cyclone overflow		Tailings A	Tailings B	Tailings C
Weight	**[%]**	100,0	**30,2**	**26,2**	**39,4**	**4,2**	**100,0**	65,4	7,4	4,3
Weight	**[%$_{v/o}$]**	66,6	**20,1**	**17,5**	**26,2**	**2,8**	**66,6**	43,5	4,9	2,9
Fe_{tot}	[%]	24,60	**66,20**	**9,35**	**3,15**	**11,45**	**24,16**	5,40	16,85	24,60
Fe_{rec}	[%]	101,8	**82,7**	**10,1**	**5,1**	**2,0**	**100,0**	14,6	5,1	4,4
Fe_{rec}	[%]	100,0	**81,3**	**10,0**	**5,0**	**1,9**	**98,2**	14,3	5,1	4,3
Fe_{rec}	[%$_{v/o}$]	43,6	**35,4**	**4,3**	**2,2**	**0,8**	**42,8**	6,3	2,2	1,9
Magn. by Satm.	[%]	1,1	**1,2**	**1,1**	**0,9**	**2,8**	**1,1**	1,0	1,4	1,7
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	3,2	**1,3**	**8,5**	**20,7**	**17,7**	**3,4**	13,4	6,0	5,0
$Magn._{rec}$	[%]	98,0	**32,3**	**25,7**	**31,6**	**10,4**	**100,0**	58,2	9,2	6,5
$Magn._{rec}$	[%]	100,0	**32,9**	**26,2**	**32,2**	**10,6**	**102,0**	59,4	9,4	6,7
$Magn._{rec}$	[%$_{v/o}$]	2,4	**0,8**	**0,6**	**0,8**	**0,3**	**2,5**	1,4	0,2	0,2
SiO_2	[%]	49,70	**2,98**	**66,40**	**74,10**	**57,60**	**49,90**	70,70	58,20	59,40
$SiO_{2\ rec}$	[%]	99,6	**1,8**	**34,9**	**58,5**	**4,8**	**100,0**	92,6	8,6	5,1
$SiO_{2\ rec}$	[%]	100,0	**1,8**	**35,0**	**58,7**	**4,8**	**100,4**	93,0	8,6	5,2
$SiO_{2\ rec}$	[%$_{v/o}$]	93,6	**1,7**	**32,8**	**55,0**	**4,5**	**94,0**	87,1	8,1	4,8
P	[%]	0,24	**0,15**	**0,54**	**0,14**	**0,48**	**0,26**	0,28	0,60	0,73
P_{rec}	[%]	92,3	**17,4**	**54,4**	**20,5**	**7,7**	**100,0**	69,1	17,0	12,1
P_{rec}	[%]	100,0	**18,9**	**59,0**	**22,2**	**8,3**	**108,3**	74,9	18,5	13,1
P_{rec}	[%$_{v/o}$]	67,7	**12,8**	**39,9**	**15,0**	**5,7**	**73,4**	50,7	12,5	8,9
TiO_2	[%]	0,20	**0,30**	**0,18**	**0,13**	**0,31**	**0,20**	0,15	0,20	0,24
V	[%]	0,006	**0,010**	**0,004**	**0,002**	**0,007**	**0,005**	0,003	0,004	0,006
d_{80}	[mm]	0,357	**0,380**	**0,106**	**0,519**	-	-	0,390	-	-
d_{50}	[mm]	0,165	**0,204**	**0,066**	**0,238**	-	-	0,151	-	-
Spec. Surface	[Blaine]	405	**115**	**610**	**205**	-	-	347	-	-
Spec. Weight	[g/cm³]	3,20	**5,05**	**2,87**	**2,72**	-	-	2,77	-	-

SGA-sample no.: 7451/2-1/1ff

Appendix 4.2-2.2

Studiengesellschaft für Eisenerzaufbereitung SGA

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Size distribution of samples taken during test (Phase 2, closed spiral circuit)

Size mm	Feed	R. Hematite concentrate 'Material 3'	Tailings A <0.1 mm	Tailings A >0.1 mm	Cyclone overflow	Tailings A	Tailings B	Tailings C
	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]
+ 1,0	0,4 / 99,6	0,0 / 100,0	0,0 / 100,0	0,7 / 99,3	-	0,5 / 99,5	0,2 / 99,8	0,3 / 99,7
1,0 - 0,63	5,4 / 94,2	2,0 / 98,0	0,0 / 100,0	12,1 / 87,2	-	7,9 / 91,7	7,1 / 92,7	14,8 / 84,9
0,63 - 0,5	4,9 / 89,4	3,9 / 94,1	0,0 / 100,0	8,5 / 78,8	-	4,6 / 87,0	5,3 / 87,4	9,2 / 75,7
0,5 - 0,315	12,2 / 77,2	21,7 / 72,4	0,0 / 100,0	16,0 / 62,8	-	11,8 / 75,2	3,7 / 83,7	10,0 / 65,7
0,315 - 0,2	17,6 / 59,6	23,2 / 49,2	0,1 / 99,9	19,0 / 43,7	-	12,0 / 63,2	4,9 / 78,8	5,0 / 60,7
0,2 - 0,1	27,1 / 32,5	32,7 / 16,5	21,1 / 78,8	31,9 / 11,8	-	27,0 / 36,2	31,7 / 47,1	24,3 / 36,4
0,1 - 0,063	12,7 / 19,8	12,7 / 3,9	31,4 / 47,4	5,8 / 6,0	-	17,1 / 19,1	21,4 / 25,7	18,7 / 17,7
0,063 - 0,04	8,2 / 11,6	2,8 / 1,1	23,4 / 24,0	2,7 / 3,3	-	9,4 / 9,7	15,2 / 10,5	11,5 / 6,2
0,04 - 0,025	4,0 / 7,6	0,6 / 0,5	5,5 / 18,5	0,9 / 2,4	-	3,1 / 6,6	4,4 / 6,1	3,1 / 3,1
0,025 - 0	7,6 / 0,0	0,5 / 0,0	18,5 / 0,0	2,4 / 0,0	-	6,6 / 0,0	6,1 / 0,0	3,1 / 0,0
	100,0 / -	100,0 / -	100,0 / -	100,0 / -	-	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,357	0,380	0,106	0,519	-	0,390	0,228	0,560
d_{50} [mm]	0,165	0,204	0,066	0,238	-	0,151	0,109	0,156
Spec. Surface [Blaine]	405	115	610	205	-	347	-	-
Spec. Weight [g/cm³]	3,20	5,05	2,87	2,72	-	2,77	-	-

SGA-sample no.: 7451/2-1/1ff

Appendix 4.2-2.3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Rougher stage spiral separation - Pilot scale test

Combined Rougher concentrates

		Feed	Products		Calc. balance
		ROM sample	Rougher LIMS Concentrate 'Material 2'	Rougher Spiral Concentrate 'Material 3'	
Weight	**[%]**	-	**62,4**	**37,6**	**100,0**
Weight	**[%$_{v/o}$]**	100,0	**33,4**	**20,1**	**53,5**
Fe_{tot}	[%]	37,60	**67,90**	**66,20**	**67,26**
Fe_{rec}	[%]	-	**63,0**	**37,0**	**100,0**
Fe_{rec}	[%]	-	**-**	**-**	**-**
Fe_{rec}	[%$_{v/o}$]	100,0	**60,3**	**35,4**	**95,7**
Magn. by Satm.	[%]	30,3	**90,5**	**1,2**	**56,9**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	-	**96,4**	**1,3**	**61,2**
$Magn._{rec}$	[%]	-	**99,2**	**0,8**	**100,0**
$Magn._{rec}$	[%]	-	**-**	**-**	**-**
$Magn._{rec}$	[%$_{v/o}$]	100,0	**99,7**	**0,8**	**100,5**
SiO_2	[%]	35,35	**3,67**	**2,98**	**3,41**
$SiO_{2\ rec}$	[%]	-	**67,2**	**32,8**	**100,0**
$SiO_{2\ rec}$	[%]	-	**-**	**-**	**-**
$SiO_{2\ rec}$	[%$_{v/o}$]	100,0	**3,5**	**1,7**	**5,2**
P	[%]	0,236	**0,070**	**0,150**	**0,100**
P_{rec}	[%]	-	**43,7**	**56,3**	**100,0**
P_{rec}	[%]	-	**-**	**-**	**-**
P_{rec}	[%$_{v/o}$]	100,0	**9,9**	**12,8**	**22,7**
TiO_2	[%]	0,185	**0,098**	**0,300**	**0,174**
V	[%]	0,022	**0,050**	**0,010**	**0,035**
d_{80}	[mm]	-	**0,455**	**0,380**	**0,427**
d_{50}	[mm]	-	**0,192**	**0,204**	**0,197**
Spec. Surface	[Blaine]	-	**295**	**115**	**227**
Spec. Weight	[g/cm³]	-	**4,93**	**5,05**	**4,98**

SGA-sample no.: 7451/1-1/1ff

Appendix 4.2-3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Concentrate - 'Material 2'

Chemical analysis of

Rougher LIMS Conentrate - 'Material 2'

Fe_{tot} [%]	**67,05**
FeO [%]	-
SiO_2 [%]	4,82
Al_2O_3 [%]	-
CaO [%]	-
MgO [%]	-
P [%]	0,076
S [%]	-
Na_2O [%]	-
K_2O [%]	-
Mn [%]	-
TiO_2 [%]	0,097
V [%]	0,048
L.O.I. [%]	-

Magnetite by Satmagan [%]	**89,6**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot} [%]	96,6

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

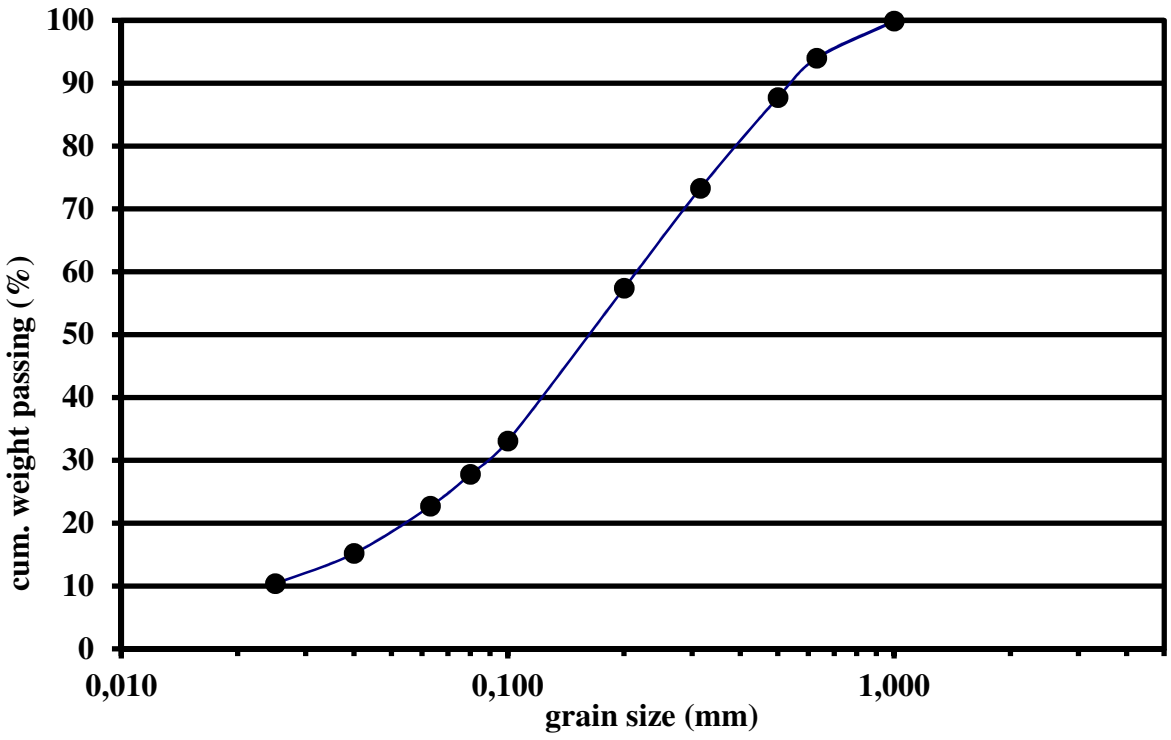
Lab scale tests with Rougher LIMS Concentrate - 'Material 2'

Screen metal analysis of

Rougher LIMS Conentrate - 'Material 2'

Size mm			Weight %	/	Passing cum. %
	+	1,0	0,1	/	99,9
1,0	-	0,63	5,9	/	94,0
0,63	-	0,5	6,3	/	87,7
0,5	-	0,315	14,4	/	73,3
0,315	-	0,2	15,9	/	57,4
0,2	-	0,1	24,3	/	33,1
0,1	-	0,08	5,3	/	27,8
0,08	-	0,063	5,1	/	22,7
0,063	-	0,04	7,5	/	15,2
0,04	-	0,025	4,8	/	10,4
0,025	-	0	10,4	/	0,0
Calculated total			100,0		

d_{80}	[mm]	0,401	Blaine	[cm²/g]	300,00
d_{50}	[mm]	0,170	Specific density	[g/cm³]	4,95



Studiengesellschaft für Eisenerzaufbereitung SGA

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Concentrate - 'Material 2'

Bond Ball Mill Grindability Test with Rougher LIMS Conentrate - 'Material 2'

Cut size 100 µm - 250 % circulation load

Size mm	Feed % / % passing	Mill discharge % / % passing	Product <100 µm % / % passing
+ 3,15	0,0 / 100,0	0,0 / 100,0	
3,15 - 1,6	0,0 / 100,0	0,0 / 100,0	
1,6 - 0,63	6,0 / 94,0	0,0 / 100,0	
0,63 - 0,315	20,7 / 73,3	0,0 / 100,0	
0,315 - 0,16	24,2 / 49,1	17,0 / 83,0	
0,16 - 0,1	16,0 / 33,1	49,3 / 33,8	1,1 / 98,9
0,1 - 0,08	5,3 / 27,8	7,3 / 26,4	13,5 / 85,5
0,08 - 0,063	5,1 / 22,7	6,9 / 19,5	22,6 / 62,9
0,063 - 0,04	7,5 / 15,2	7,2 / 12,3	23,1 / 39,8
0,04 - 0,025	4,8 / 10,4	4,1 / 8,2	11,5 / 28,3
0,025 - 0	10,4 / 0,0	8,2 / 0,0	28,3 / 0,0

Weight of the mill feed (700 cm³): **1511,1 g** P_i - Grinding fineness of the test: **100 µm**

Cycle	Material <100 µm charged (g)	Material <100 µm discharged (g)	Net product <100 µm (g)	Mill revolutions (rev)	Production rate (g/rev)
1	755	791	35	100	0,35
2	262	781	519	400	1,30
3	258	671	412	303	1,36
4	222	657	435	316	1,38
5	218	649	432	316	1,37
6	215	661	446	320	1,39
7					

P - d_{80} of Product = 76 µm

F - d_{80} of Feed = 401 µm

G - Production rate = 1,38 g/rev

$$W_{iB} = \frac{4.9}{P_i^{0.23} \cdot G^{0.82} \cdot (P_i^{-0.5} - F^{-0.5})} = \textbf{20,14 kWh/t}$$

(metric system)

SGA-sample no.: 7451/200

Appendix 5.1-3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Rougher LIMS Concentrate - 'Material 2'

Lab scale low intensity magnetic separation

with Rougher LIMS Conentrate - 'Material 2'

3-stage @ 1200 Gauss; after lab rod mill grinding to d_{80} of ~0.1 mm

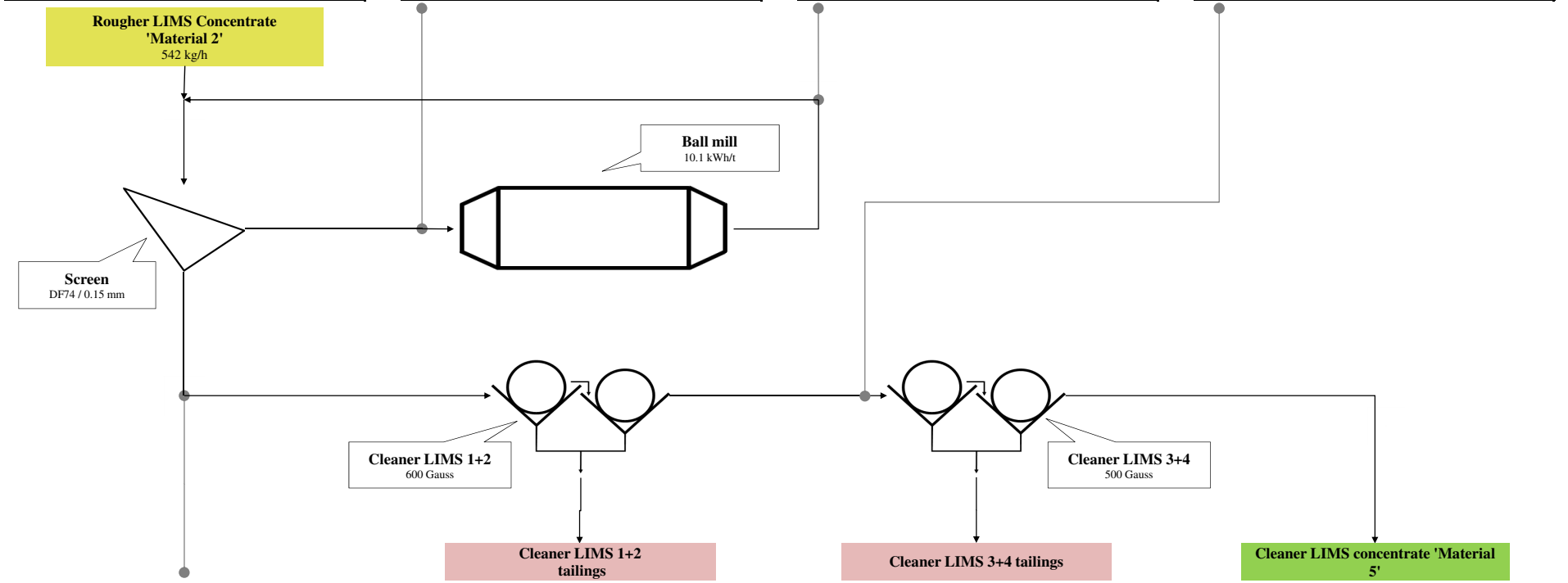
		Feed	Products		Calc. balance
		Rougher LIMS Concentrate 'Material 2'	**Concentrate**	Tailings 1	
Weight	**[%]**	100,0	**91,1**	8,9	100,0
Weight	**[$\%_{v/o}$]**	33,4	**30,4**	3,0	33,4
Fe_{tot}	[%]	67,05	**71,39**	23,20	67,10
Fe_{rec}	[%]	99,9	**96,9**	3,1	100,0
Fe_{rec}	[%]	100,0	**97,0**	3,1	100,1
Fe_{rec}	[$\%_{v/o}$]	59,5	**57,8**	1,8	59,6
Magn. by Satm.	[%]	89,6	**98,5**	2,8	90,0
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	96,6	**99,8**	8,7	97,0
$Magn._{rec}$	[%]	99,6	**99,7**	0,3	100,0
$Magn._{rec}$	[%]	100,0	**100,1**	0,3	100,4
$Magn._{rec}$	[$\%_{v/o}$]	98,7	**98,9**	0,3	99,2
SiO_2	[%]	4,82	**0,52**	48,20	4,76
$SiO_{2\ rec}$	[%]	101,2	**9,9**	90,1	100,0
$SiO_{2\ rec}$	[%]	100,0	**9,8**	89,0	98,8
$SiO_{2\ rec}$	[$\%_{v/o}$]	4,6	**0,4**	4,1	4,5
P	[%]	0,076	**0,019**	0,805	0,089
P_{rec}	[%]	85,4	**19,5**	80,5	100,0
P_{rec}	[%]	100,0	**22,8**	94,3	117,0
P_{rec}	[$\%_{v/o}$]	10,8	**2,4**	10,1	12,6
TiO_2	[%]	0,097	**0,085**	0,430	0,116
V	[%]	0,048	**0,055**	0,011	0,051
d_{80}	[mm]	0,101	**0,097**	-	-
d_{50}	[mm]	0,062	**0,064**	-	-
Spec. Surface	[Blaine]	-	**-**	-	-
Spec. Weight	[g/cm³]	-	**-**	-	-

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner LIMS - Pilot scale test

Process overview



Rougher LIMS Concentrate 'Material 2'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	67,1	89,6	4,8	0,076 % P
recovery	100,0	100,0	100,0	100,0	0,097 % TiO2
recovery v/o	33,4	59,5	98,7	4,6	0,048 % V

Screen overflow >0.150 mm

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	65,1	84,8	7,0	0,075 % P
recovery	69,6	67,6	65,9	101,6	0,083 % TiO2
recovery v/o	23,3	40,3	65,1	4,6	0,028 % V

Ball mill discharge

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	65,8	84,8	6,1	0,067 % P
recovery	69,0	67,7	65,3	87,5	0,081 % TiO2
recovery v/o	23,0	40,3	64,5	4,0	0,029 % V

Cleaner 2 LIMS concentrate

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	70,4	94,0	1,3	0,042 % P
recovery	92,2	96,8	96,7	25,2	0,092 % TiO2
recovery v/o	30,8	57,6	95,5	1,1	0,056 % V

Screen underflow <0.150 mm

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	67,1	86,2	4,8	0,078 % P
recovery	100,0	100,1	96,2	98,5	0,105 % TiO2
recovery v/o	33,4	59,6	95,0	4,5	0,055 % V

Cleaner LIMS 1+2 tailings

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	27,5	11,9	44,8	0,525 % P
recovery	8,1	3,3	1,1	75,3	0,360 % TiO2
recovery v/o	2,7	2,0	1,1	3,4	0,012 % V

Cleaner LIMS 3+4 tailings

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	51,5	52,7	16,6	0,480 % P
recovery	0,3	0,2	0,2	1,0	0,420 % TiO2
recovery v/o	0,1	0,1	0,2	0,0	0,038 % V

Cleaner LIMS concentrate 'Material 5'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	70,6	93,9	1,2	0,033 % P
recovery	91,6	96,4	96,0	21,9	0,084 % TiO2
recovery v/o	30,6	57,4	94,8	1,0	0,057 % V

SGA-sample no.: 7451/3-1/1ff

Appendix 5.2-1

Studiengesellschaft für Eisenerzaufbereitung SGA

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner LIMS - Pilot scale test

Chemical analysis of samples taken during test

(Feed rate @ 542 kg/h, Derrick screen DF74, Cleaner LIMS 1+2 @ 600 Gauss, Cleaner LIMS 3+4 @ 500 Gauss)

		Feed	Products			Calc. balance	Intermediate products			
		Rougher LIMS Concentrate 'Material 2'	Cleaner LIMS concentrate 'Material 5'	Cleaner LIMS 3+4 tailings	Cleaner LIMS 1+2 tailings		Cleaner LIMS 2 concentrate	Screen underflow <0.150 mm	Screen overflow >0.150 mm	Ball mill discharge
Weight	**[%]**	100,0	**91,6**	**0,3**	**8,1**	**100,0**	92,2	100,0	69,6	69,0
Weight	**[%$_{v/o}$]**	33,4	**30,6**	**0,1**	**2,7**	**33,4**	30,8	33,4	23,3	23,0
Fe_{tot}	[%]	67,05	**70,55**	**51,45**	**27,50**	**67,00**	70,40	67,10	65,11	65,83
Fe_{rec}	[%]	100,1	**96,4**	**0,2**	**3,3**	**100,0**	96,9	100,1	67,7	67,8
Fe_{rec}	[%]	100,0	**96,4**	**0,2**	**3,3**	**99,9**	96,8	100,1	67,6	67,7
Fe_{rec}	[%$_{v/o}$]	59,5	**57,4**	**0,1**	**2,0**	**59,5**	57,6	59,6	40,3	40,3
Magn. by Satm.	[%]	89,6	**93,9**	**52,7**	**11,9**	**87,1**	94,0	86,2	84,8	84,8
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	96,6	**96,2**	**74,1**	**31,3**	**94,0**	96,5	92,9	94,2	93,2
$Magn._{rec}$	[%]	102,8	**98,7**	**0,2**	**1,1**	**100,0**	99,5	98,9	67,8	67,2
$Magn._{rec}$	[%]	100,0	**96,0**	**0,2**	**1,1**	**97,2**	96,7	96,2	65,9	65,3
$Magn._{rec}$	[%$_{v/o}$]	98,7	**94,8**	**0,2**	**1,1**	**96,0**	95,5	95,0	65,1	64,5
SiO_2	[%]	4,82	**1,15**	**16,60**	**44,80**	**4,73**	1,32	4,75	7,03	6,11
$SiO_{2\ rec}$	[%]	101,9	**22,3**	**1,0**	**76,7**	**100,0**	25,7	100,4	103,5	89,1
$SiO_{2\ rec}$	[%]	100,0	**21,9**	**1,0**	**75,3**	**98,2**	25,2	98,5	101,6	87,5
$SiO_{2\ rec}$	[%$_{v/o}$]	4,6	**1,0**	**0,0**	**3,4**	**4,5**	1,1	4,5	4,6	4,0
P	[%]	0,076	**0,033**	**0,48**	**0,53**	**0,074**	0,042	0,078	0,075	0,067
P_{rec}	[%]	102,5	**40,8**	**1,9**	**57,3**	**100,0**	52,2	105,2	70,4	62,3
P_{rec}	[%]	100,0	**39,8**	**1,9**	**56,0**	**97,6**	51,0	102,6	68,7	60,8
P_{rec}	[%$_{v/o}$]	10,8	**4,3**	**0,2**	**6,0**	**10,5**	5,5	11,0	7,4	6,5
TiO_2	[%]	0,097	**0,084**	**0,42**	**0,36**	**0,107**	0,092	0,105	0,083	0,081
V	[%]	0,048	**0,057**	**0,038**	**0,012**	**0,053**	0,056	0,055	0,028	0,029
d_{80}	[mm]	0,401	**0,131**	-	0,114	-	0,139	0,141	0,653	0,066
d_{50}	[mm]	0,170	**0,052**	-	0,055	-	0,055	0,059	0,435	0,027
Spec. Surface	[Blaine]	300	**830**	-	-	-	-	-	-	-
Spec. Weight	[g/cm³]	4,95	**5,09**	-	-	-	-	-	-	-

SGA-sample no.: 7451/3-1/1ff

Appendix 5.2-2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner LIMS - Pilot scale test

Size distribution of samples taken during test

Size mm	Feed	Cleaner LIMS concentrate 'Material 5'	Cleaner LIMS 3+4 tailings	Cleaner LIMS 1+2 tailings	Cleaner LIMS 2 concentrate	Screen underflow <0.150 mm	Screen overflow >0.150 mm	Ball mill discharge
	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]
+ 1,0	0,1 / 99,9	0,0 / 100,0	Sample too few for sctreen analysis	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,5 / 99,5	0,0 / 100,0
1,0 - 0,63	5,9 / 94,0	0,0 / 100,0		0,3 / 99,7	0,0 / 100,0	0,0 / 100,0	20,8 / 78,7	0,0 / 100,0
0,63 - 0,5	6,3 / 87,7	0,0 / 100,0		0,2 / 99,5	0,0 / 100,0	0,0 / 100,0	16,4 / 62,3	0,1 / 99,9
0,5 - 0,315	14,4 / 73,3	0,1 / 99,9		0,6 / 98,8	0,1 / 99,9	0,1 / 99,9	34,7 / 27,6	0,3 / 99,6
0,315 - 0,2	15,9 / 57,4	3,3 / 96,6		1,7 / 97,1	3,1 / 96,7	3,9 / 96,0	25,8 / 1,8	1,2 / 98,5
0,2 - 0,1	24,3 / 33,1	24,2 / 72,5		19,8 / 77,3	27,3 / 69,4	27,1 / 68,8	0,8 / 1,0	7,3 / 91,2
0,1 - 0,063	10,4 / 22,7	15,4 / 57,1		19,8 / 57,5	15,0 / 54,4	16,0 / 52,8	0,0 / 0,9	12,1 / 79,1
0,063 - 0,04	7,5 / 15,2	14,4 / 42,7		22,1 / 35,4	13,4 / 41,0	15,8 / 37,0	0,0 / 0,9	16,3 / 62,8
0,04 - 0,025	4,8 / 10,4	11,4 / 31,3		9,9 / 25,5	11,0 / 30,0	9,4 / 27,6	0,0 / 0,8	15,0 / 47,8
0,025 - 0	10,4 / 0,0	31,3 / 0,0		25,5 / 0,0	30,0 / 0,0	27,6 / 0,0	0,8 / 0,0	47,8 / 0,0
	100,0 / -	100,0 / -		100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,401	0,131	-	0,114	0,139	0,141	0,653	0,066
d_{50} [mm]	0,170	0,052	-	0,055	0,055	0,059	0,435	0,027
Spec. Surface [Blaine]	300	830	-	-	-	-	-	-
Spec. Weight [g/cm³]	4,95	5,09	-	-	-	-	-	-

SGA-sample no.: 7451/3-1/1ff

Appendix 5.2-3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner LIMS - Pilot scale test

Chemical analysis of

Product pile - Cleaner LIMS concentrate - 'Material 5'

Fe_{tot}	**[%]**	**70,45**		
FeO	[%]	29,18		
SiO_2	[%]	1,31		
Al_2O_3	[%]	0,24	Cr [%]	0,003
CaO	[%]	0,21	Co [%]	0,0018
MgO	[%]	0,21	Ni [%]	0,004
P	[%]	0,039	Cu [%]	0,0006
S	[%]	0,002	Zn [%]	0,006
Na_2O	[%]	0,016	Pb [%]	<0,0005
K_2O	[%]	0,02	As [%]	<0,0005
Mn	[%]	0,058	Cd [%]	<0,0005
TiO_2	[%]	0,083	Tl [%]	<0,001
V	[%]	0,054	SrO [%]	0,003
L.O.I.	[%]	- 3,08	BaO [%]	0,015

Magnetite by Satmagan	**[%]**	**93,6**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	96,1

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

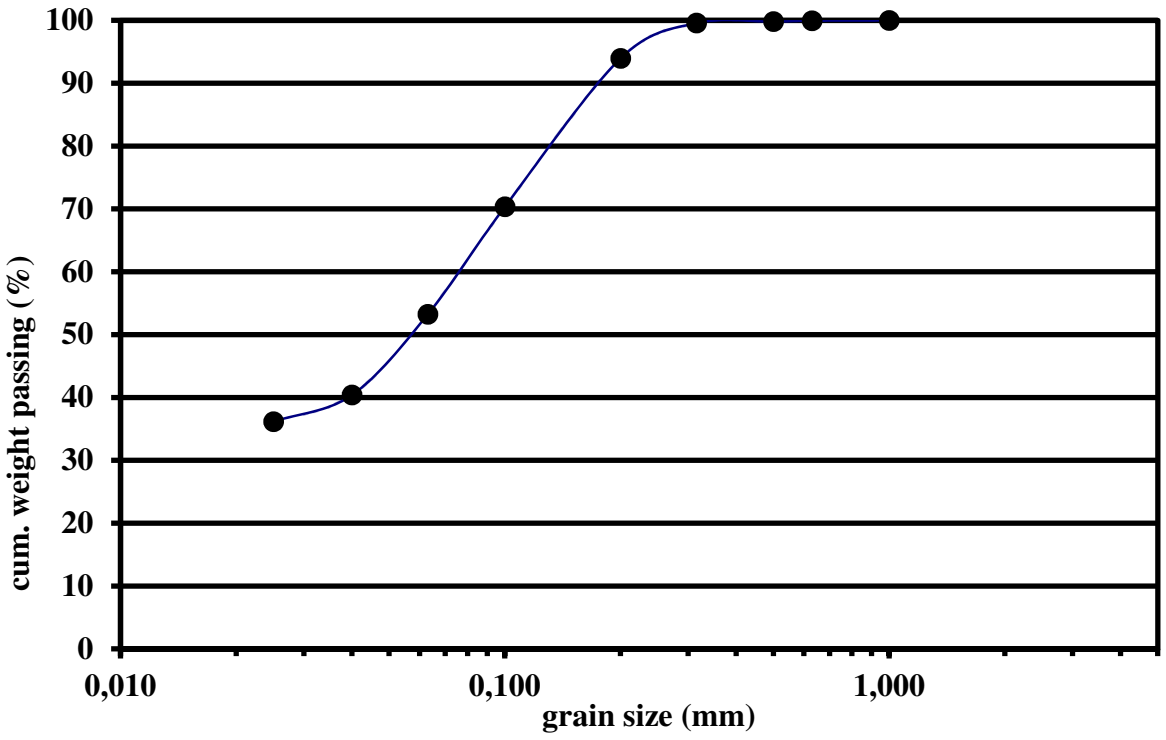
Cleaner LIMS - Pilot scale test

Screen analysis of

Product pile - Cleaner LIMS concentrate - 'Material 5'

Size mm			Weight %	/	Passing cum. %
	+	1,0	0,0	/	100,0
1,0	-	0,63	0,0	/	100,0
0,63	-	0,5	0,1	/	99,8
0,5	-	0,315	0,2	/	99,6
0,315	-	0,2	5,6	/	94,0
0,2	-	0,1	23,6	/	70,3
0,1	-	0,063	17,1	/	53,2
0,063	-	0,04	12,8	/	40,4
0,04	-	0,025	4,2	/	36,2
0,025	-	0	36,2	/	0,0
Calculated total			100,0		

d_{80}	[mm]	0,141	Blaine	[cm²/g]	965
d_{50}	[mm]	0,057	Specific density	[g/cm³]	5,10



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

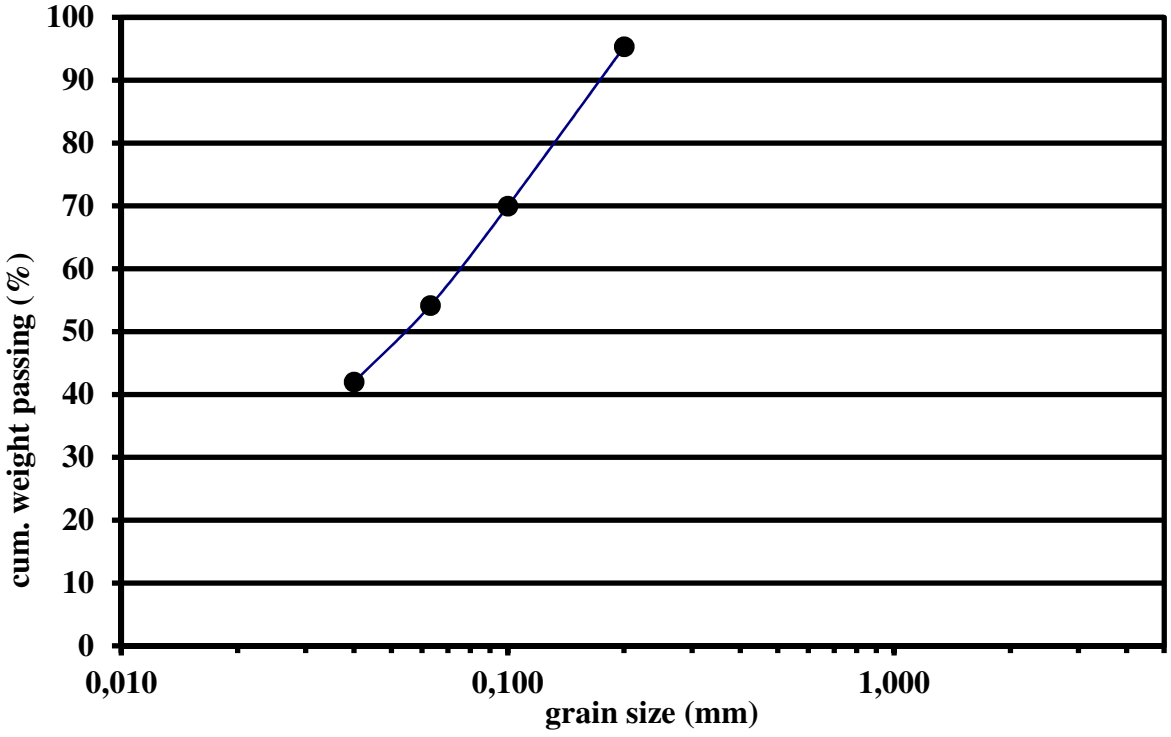
Cleaner LIMS - Pilot scale test

Screen metal analysis of

Product pile - Cleaner LIMS concentrate - 'Material 5'

Size mm			Weight %	/	Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	0,2	4,7	/	95,3					
0,2	-	0,1	25,3	/	70,0	69,4	2,2	0,067	0,124	0,067
0,1	-	0,063	15,8	/	54,2					
0,063	-	0,04	12,2	/	42,0	71,1	0,7	0,019	0,081	0,051
0,04	-	0	42,0	/	0,0	71,3	0,5	0,009	0,050	0,039
Calculated total			100,0			70,4	1,3	0,037	0,088	0,053

d_{80} [mm]	0,140	Blaine [cm²/g]	-
d_{50} [mm]	0,055	Specific density [g/cm³]	-



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Regrinding of rougher stage spiral concentrates

Process overview

Rougher Hematite concentrate 'Material 3'					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	(66,2)	(1,2)	(3,0)	(0,15 % P)
recovery	100,0	-	-	-	(0,30 % TiO2)
recovery v/o	20,1	(35,4)	(0,8)	(1,7)	(0,010 % V)

Ball mill discharge					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	-	-	-	-
recovery	68,4	-	-	-	-
recovery v/o	13,8	-	-	-	-

Rougher Hematite concentrate 'Material 3'
200 kg/h

Screen
DF74 / 0.15 mm

Ball mill
10.0 kWh/t

Screen underflow <0.150 mm

Screen underflow <0.150 mm					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	(66,2)	(1,2)	(3,0)	(0,15 % P)
recovery	100,0	-	-	-	(0,30 % TiO2)
recovery v/o	20,1	(35,4)	(0,8)	(1,7)	(0,010 % V)

Screen overflow >0.150 mm					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	-	-	-	-
recovery	68,4	-	-	-	-
recovery v/o	13,8	-	-	-	-

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Regrinding of rougher stage spiral concentrates

Size distribution of samples taken during test

		Feed	Product	Intermediate products	
		Feed	**Screen underflow <0.150 mm**	**Screen overflow >0.150 mm**	**Ball mill discharge**
Weight	**[%]**	**100,0**	**100,0**	68,4	68,4
Weight	**[%$_{v/o}$]**	**20,1**	**20,1**	13,8	13,8
Size mm		Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]
+	1,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
1,0 -	0,63	2,0 / 98,0	0,0 / 100,0	3,9 / 96,1	0,0 / 100,0
0,63 -	0,5	3,9 / 94,1	0,0 / 100,0	6,7 / 89,4	0,1 / 99,9
0,5 -	0,315	21,7 / 72,4	0,0 / 100,0	22,0 / 67,3	0,2 / 99,8
0,315 -	0,2	23,2 / 49,2	4,2 / 95,8	36,7 / 30,7	0,9 / 98,9
0,2 -	0,1	32,7 / 16,5	32,0 / 63,8	10,8 / 19,8	9,0 / 89,9
0,1 -	0,063	12,7 / 3,9	17,6 / 46,2	2,5 / 17,3	16,9 / 72,9
0,063 -	0,04	2,8 / 1,1	13,5 / 32,7	1,1 / 16,3	19,8 / 53,1
0,04 -	0,025	0,6 / 0,5	8,4 / 24,3	0,7 / 15,5	13,8 / 39,4
0,025 -	0	0,5 / 0,0	24,3 / 0,0	15,5 / 0,0	39,4 / 0,0
		100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80}	[mm]	0,380	0,151	0,421	0,078
d_{50}	[mm]	0,204	0,071	0,261	0,037
Spec. Surface	[Blaine]	120	715	-	-
Spec. Weight	[g/cm³]	5,09	5,09	-	-

SGA-sample no.: 7451/3-1/1ff

Appendix 6-2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Regrinding of rougher stage spiral concentrates

Bond Ball Mill Grindability Test with Rougher LIMS Conentrate - 'Material 2'

Cut size 100 µm - 250 % circulation load

Size mm			Feed % / % passing	Mill discharge % / % passing	Product <100 µm % / % passing
	+	3,15	0,0 / 100,0	0,0 / 100,0	
3,15	-	1,0	0,0 / 100,0	0,0 / 100,0	
1,0	-	0,63	2,3 / 97,6	0,1 / 99,9	
0,63	-	0,315	23,6 / 74,0	1,2 / 98,8	
0,315	-	0,16	43,4 / 30,6	17,0 / 81,8	
0,16	-	0,1	16,4 / 14,2	44,7 / 37,1	1,6 / 98,4
0,1	-	0,08	4,1 / 10,2	8,7 / 28,4	18,4 / 80,0
0,08	-	0,063	5,4 / 4,8	7,7 / 20,7	25,7 / 54,3
0,063	-	0,04	3,3 / 1,5	6,6 / 14,2	22,0 / 32,3
0,04	-	0,025	0,3 / 1,2	3,2 / 11,0	9,3 / 23,1
0,025	-	0	1,2 / 0,0	11,0 / 0,0	23,1 / 0,0

Weight of the mill feed (700 cm³): **1511,1 g** P_i - Grinding fineness of the test: **100 µm**

Cycle	Material <100 µm charged (g)	Material <100 µm discharged (g)	Net product <100 µm (g)	Mill revolutions (rev)	Production rate (g/rev)
3	70	570	500	460	1,09
4	81	606	525	478	1,10
5	86	631	544	469	1,16
6	90	573	484	441	1,10
7	81	613	532	473	1,12
8	87	597	510	458	1,12
9	85	599	515	463	1,11

P - d_{80} of Product = 80 µm

F - d_{80} of Feed = 395 µm

G - Production rate = 1,12 g/rev

$$W_{iB} = \frac{4.9}{P_i^{0.23} \cdot G^{0.82} \cdot (P_i^{-0.5} - F^{-0.5})} = \textbf{25,24 kWh/t}$$

(metric system)

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with rougher stage spiral tailings

Lab scale tests - Wet high intensity magnetic separation (WHIMS)

with Rougher Spiral Tailings A <0.1 mm

		Feed	Products			Calc. balance
		Tailings A <0.1 mm	Concentrate	Middlings	Tailings	
Weight	**[%]**	100,0	**10,3**	**5,0**	**84,7**	**100,0**
Weight	**[%$_{v/o}$]**	17,5	**1,8**	**0,9**	**14,8**	**17,5**
Fe_{tot}	[%]	10,10	**51,70**	**18,30**	**4,50**	**10,05**
Fe_{rec}	[%]	100,5	**52,9**	**9,2**	**37,9**	**100,0**
Fe_{rec}	[%]	100,0	**52,6**	**9,1**	**37,7**	**99,5**
Fe_{rec}	[%$_{v/o}$]	4,7	**2,5**	**0,4**	**1,8**	**4,7**
Magn. by Satm.	[%]	1,2	**-**	**-**	**-**	**-**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	8,6	**-**	**-**	**-**	**-**
$Magn._{rec}$	[%]	-	**-**	**-**	**-**	**-**
$Magn._{rec}$	[%]	-	**-**	**-**	**-**	**-**
$Magn._{rec}$	[%$_{v/o}$]	0,7	**-**	**-**	**-**	**-**
SiO_2	[%]	66,00	**15,30**	**55,00**	**72,10**	**65,40**
$SiO_{2\ rec}$	[%]	100,9	**2,4**	**4,2**	**93,4**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**2,4**	**4,2**	**92,5**	**99,1**
$SiO_{2\ rec}$	[%$_{v/o}$]	32,6	**0,8**	**1,4**	**30,1**	**32,3**
P	[%]	0,53	**0,84**	**0,57**	**0,47**	**0,51**
P_{rec}	[%]	103,3	**16,8**	**5,6**	**77,6**	**100,0**
P_{rec}	[%]	100,0	**16,3**	**5,4**	**75,1**	**96,8**
P_{rec}	[%$_{v/o}$]	39,2	**6,4**	**2,1**	**29,4**	**37,9**
TiO_2	[%]	0,180	**0,500**	**0,270**	**0,140**	**0,184**
V	[%]	0,004	**0,012**	**0,006**	**0,003**	**0,004**
d_{80}	[mm]	0,106	-	-	-	-
d_{50}	[mm]	0,066	-	-	-	-
Spec. Surface	[Blaine]	-	-	-	-	-
Spec. Weight	[g/cm³]	-	-	-	-	-

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with rougher stage spiral tailings

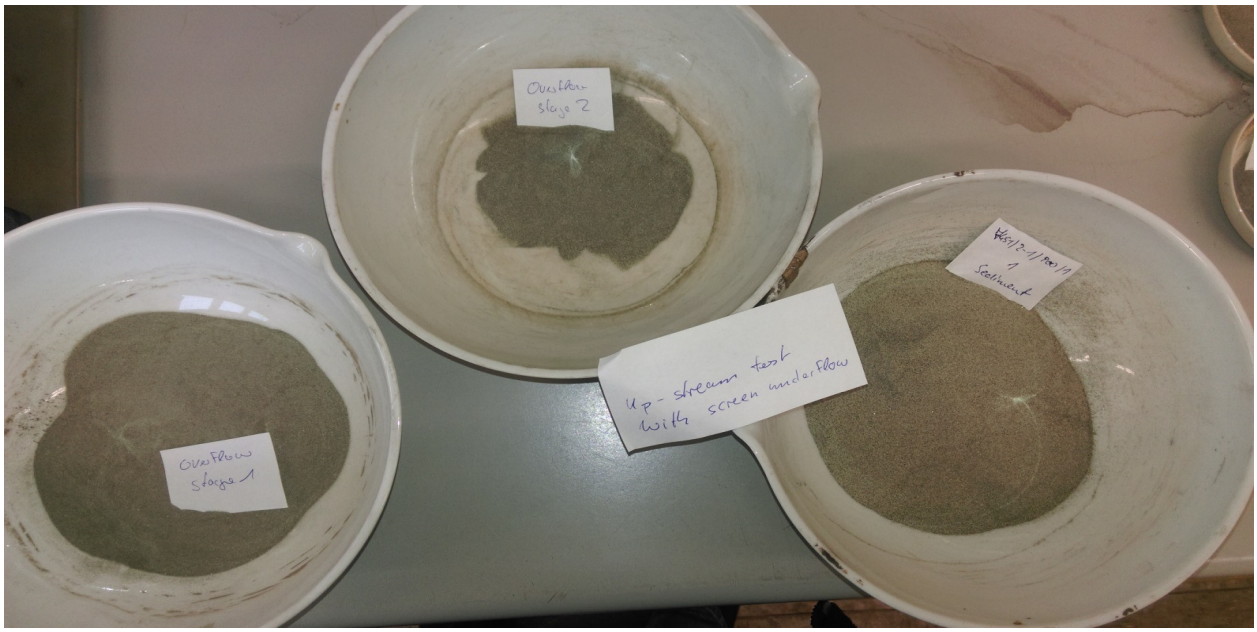
Lab scale tests - Upstream separation (Hindered settling)

with Rougher Spiral Tailings A <0.1 mm

The Test was aported because of obvious failure.

Weight recovery until abortion:

		Feed	Products			Calc. balance
		Tailings A <0.1 mm	Overflow Stage 1	Overflow Stage 2	Sediment	
Weight	[%]	100,0	**32,8**	**7,2**	**60,0**	**100,0**
Weight	[$\%_{v/o}$]	17,5	**5,7**	**1,2**	**10,5**	**17,5**



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with rougher stage spiral tailings

Shaking table test

with Rougher Spiral Tailings A <0.1 mm

		Feed	Products			Calc. balance
		Rougher LIMS Tailings 'Material 1'	Concentrate	Middlings	Tailings	
Weight	**[%]**	100,0	**6,3**	**78,2**	**15,5**	**100,0**
Weight	**[$\%_{v/o}$]**	17,5	**1,1**	**13,7**	**2,7**	**17,5**
Fe_{tot}	[%]	10,10	**62,20**	**6,05**	**8,00**	**9,86**
Fe_{rec}	[%]	102,4	**39,4**	**48,0**	**12,6**	**100,0**
Fe_{rec}	[%]	100,0	**38,5**	**46,9**	**12,3**	**97,7**
Fe_{rec}	[$\%_{v/o}$]	4,7	**1,8**	**2,2**	**0,6**	**4,6**
Magn. by Satm.	[%]	1,2	**3,0**	**0,9**	**1,3**	**1,1**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	8,6	**3,5**	**10,8**	**11,7**	**8,0**
$Magn._{rec}$	[%]	109,8	**17,2**	**64,4**	**18,4**	**100,0**
$Magn._{rec}$	[%]	100,0	**15,6**	**58,7**	**16,8**	**91,1**
$Magn._{rec}$	[$\%_{v/o}$]	0,7	**0,1**	**0,4**	**0,1**	**0,6**
SiO_2	[%]	66,00	**5,27**	**71,30**	**63,00**	**65,88**
$SiO_{2\ rec}$	[%]	100,2	**0,5**	**84,7**	**14,8**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**0,5**	**84,5**	**14,8**	**99,8**
$SiO_{2\ rec}$	[$\%_{v/o}$]	32,6	**0,2**	**27,5**	**4,8**	**32,5**
P	[%]	0,530	**0,580**	**0,560**	**0,350**	**0,529**
P_{rec}	[%]	100,2	**6,9**	**82,9**	**10,3**	**100,0**
P_{rec}	[%]	100,0	**6,8**	**82,7**	**10,2**	**99,8**
P_{rec}	[$\%_{v/o}$]	39,2	**2,7**	**32,4**	**4,0**	**39,1**
TiO_2	[%]	0,180	**0,510**	**0,145**	**0,240**	**0,183**
V	[%]	0,004	**0,012**	**0,003**	**0,005**	**0,004**
d_{80}	[mm]	0,106	**0,074**	**0,099**	**0,069**	-
d_{50}	[mm]	0,066	**0,050**	**0,073**	**0,038**	-
Spec. Surface	[Blaine]	-	-	-	-	-
Spec. Weight	[g/cm^3]	-	-	-	-	-

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with rougher stage spiral tailings

Size distribution of products from shaking table test with Rougher Spiral Tailings A <0.1 mm

Size mm	Feed Weight / Passing [%] / [cum. %]	Concentrate Weight / Passing [%] / [cum. %]	Middlings Weight / Passing [%] / [cum. %]	Tailings Weight / Passing [%] / [cum. %]
+ 1,0	0,0 / 100,0	0,1 / 99,9	0,0 / 100,0	0,0 / 100,0
1,0 - 0,63	0,0 / 100,0	0,2 / 99,7	0,0 / 100,0	0,0 / 100,0
0,63 - 0,5	0,0 / 100,0	0,2 / 99,5	0,0 / 99,9	0,0 / 100,0
0,5 - 0,315	0,0 / 100,0	0,8 / 98,8	0,0 / 99,9	0,0 / 100,0
0,315 - 0,2	0,1 / 99,9	0,9 / 97,9	0,2 / 99,7	0,1 / 99,9
0,2 - 0,1	21,1 / 78,8	5,8 / 92,1	18,2 / 81,4	3,2 / 96,8
0,1 - 0,063	31,4 / 47,4	17,2 / 74,8	43,6 / 37,8	20,1 / 76,7
0,063 - 0,04	23,4 / 24,0	43,5 / 31,4	3,2 / 34,5	25,2 / 51,4
0,04 - 0,025	5,5 / 18,5	14,7 / 16,7	12,7 / 21,8	11,0 / 40,5
0,025 - 0	18,5 / 0,0	16,7 / 0,0	21,8 / 0,0	40,5 / 0,0
	100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,106	0,074	0,099	0,069
d_{50} [mm]	0,066	0,050	0,073	0,038
Spec. Surface [Blaine]	-	-	-	-
Spec. Weight [g/cm³]	-	-	-	-

SGA-sample no.: 7451/1-1/1ff

Appendix 7.1-3.2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Composition and chemical analysis of Scavenger stage feed

%		Tailings A <0.1 mm	Cleaner LIMS tailings	Scavenger stage spirals feed	
				Calculated	Analysed
Weight	[$\%_{v/o}$]	17,5	2,8	20,3	
	[%]	86,2	13,8	100,0	
Fe_{tot}	[%]	10,1	31,90	13,11	12,90
FeO	[%]	-	-	-	-
SiO_2	[%]	66,0	40,10	62,43	62,50
Al_2O_3	[%]	-	-	-	-
CaO	[%]	-	-	-	-
MgO	[%]	-	-	-	-
P	[%]	0,530	0,550	0,533	0,540
S	[%]	-	-	-	-
Na_2O	[%]	-	-	-	-
K_2O	[%]	-	-	-	-
Mn	[%]	-	-	-	-
TiO_2	[%]	0,18	0,500	0,224	0,230
V	[%]	0,0035	0,019	0,006	0,002
L.O.I.	[%]	-	-	-	-
Magnetite by Satmagan	[%]	1,2	14,4	3,0	3,1
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	8,6	32,6	16,7	17,4

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

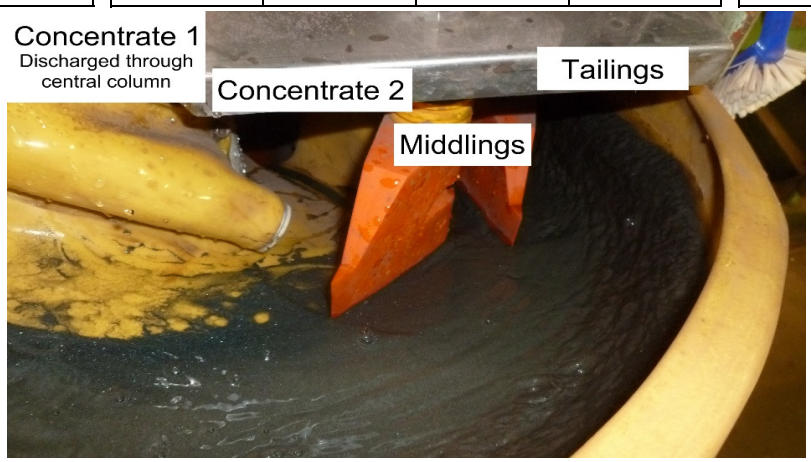
Iron recovery in Scavenger stage

Batch scale single stage spiral separation

with Scavenger stage feed

(Single spiral due to low available feed sample, feed rate @ 1000 kg/h)

		Feed	Products				Calc. balance
		Scavenger stage feed	Concentrate 1	Concentrate 2	Middlings	Tailings	
Weight	**[%]**	100,0	**8,7**	**0,5**	**5,9**	**84,8**	**100,0**
Weight	**[$\%_{v/o}$]**	20,3	**1,8**	**0,1**	**1,2**	**17,2**	**20,3**
Fe_{tot}	[%]	12,90	**41,00**	**31,95**	**13,95**	**9,60**	**12,72**
Fe_{rec}	[%]	101,4	**28,2**	**1,4**	**6,5**	**64,0**	**100,0**
Fe_{rec}	[%]	100,0	**27,8**	**1,4**	**6,4**	**63,1**	**98,6**
Fe_{rec}	[$\%_{v/o}$]	7,0	**1,9**	**0,1**	**0,4**	**4,4**	**6,9**
Magn. by Satm.	[%]	3,1	**6,0**	**4,8**	**2,6**	**2,6**	**2,9**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	17,4	**10,6**	**10,8**	**13,6**	**19,6**	**16,6**
$Magn._{rec}$	[%]	106,4	**18,1**	**0,9**	**5,3**	**75,7**	**100,0**
$Magn._{rec}$	[%]	100,0	**17,0**	**0,9**	**5,0**	**71,1**	**94,0**
$Magn._{rec}$	[$\%_{v/o}$]	2,1	**0,4**	**0,0**	**0,1**	**1,5**	**2,0**
SiO_2	[%]	62,50	**28,10**	**36,70**	**60,50**	**66,50**	**62,62**
$SiO_{2\ rec}$	[%]	99,8	**3,9**	**0,3**	**5,7**	**90,0**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**3,9**	**0,3**	**5,7**	**90,2**	**100,2**
$SiO_{2\ rec}$	[$\%_{v/o}$]	35,9	**1,4**	**0,1**	**2,1**	**32,4**	**36,0**
P	[%]	0,540	**0,940**	**1,350**	**0,805**	**0,470**	**0,536**
P_{rec}	[%]	100,8	**15,3**	**1,4**	**8,9**	**74,4**	**100,0**
P_{rec}	[%]	100,0	**15,2**	**1,4**	**8,8**	**73,8**	**99,2**
P_{rec}	[$\%_{v/o}$]	46,4	**7,1**	**0,6**	**4,1**	**34,3**	**46,1**
TiO_2	[%]	0,230	**0,430**	**0,400**	**0,230**	**0,200**	**0,223**
V	[%]	0,002	**0,013**	**0,010**	**0,006**	**0,006**	**0,006**
d_{80}	[mm]	0,108	0,100	0,099	0,147	0,107	0,109
d_{50}	[mm]	0,068	0,067	0,067	0,082	0,069	0,069
Spec. Surface	[Blaine]	-	-	-	-	-	-
Spec. Weight	[g/cm^3]	-	-	-	-	-	-



SGA-sample no.: 7451/650/1..4

Appendix 7.2-2.1

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Size distribution of products from Scavenger stage spiral separation test

Size mm	Feed Weight / Passing [%] / [cum. %]	Concentrate 1 Weight / Passing [%] / [cum. %]	Concentrate 2 Weight / Passing [%] / [cum. %]	Middlings Weight / Passing [%] / [cum. %]	Tailings Weight / Passing [%] / [cum. %]
+ 1,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
1,0 - 0,63	0,2 / 99,8	0,4 / 99,6	0,3 / 99,7	0,6 / 99,4	0,0 / 100,0
0,63 - 0,5	0,2 / 99,7	0,5 / 99,1	0,2 / 99,5	0,5 / 98,9	0,1 / 99,9
0,5 - 0,315	0,2 / 99,5	1,5 / 97,6	0,4 / 99,1	1,0 / 97,9	0,1 / 99,9
0,315 - 0,2	0,6 / 98,9	2,7 / 94,9	0,8 / 98,3	1,6 / 96,2	0,3 / 99,6
0,2 - 0,1	20,5 / 78,4	14,5 / 80,4	17,7 / 80,6	30,5 / 65,8	21,1 / 78,6
0,1 - 0,063	32,7 / 45,7	33,8 / 46,6	34,2 / 46,5	31,7 / 34,1	33,7 / 44,9
0,063 - 0,04	23,1 / 22,5	3,1 / 43,5	29,8 / 16,7	19,9 / 14,2	23,8 / 21,1
0,04 - 0,025	9,2 / 13,4	24,2 / 19,4	5,4 / 11,3	9,4 / 4,8	12,2 / 8,9
0,025 - 0	13,4 / 0,0	19,4 / 0,0	11,3 / 0,0	4,8 / 0,0	8,9 / 0,0
	100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,108	0,100	0,099	0,147	0,107
d_{50} [mm]	0,068	0,067	0,067	0,082	0,069
Spec. Surface [Blaine]	-	-	-	-	-
Spec. Weight [g/cm³]	-	-	-	-	-

SGA-sample no.: 7451/650/1..4

Appendix 7.2-2.2

Nordic Iron Ore AB

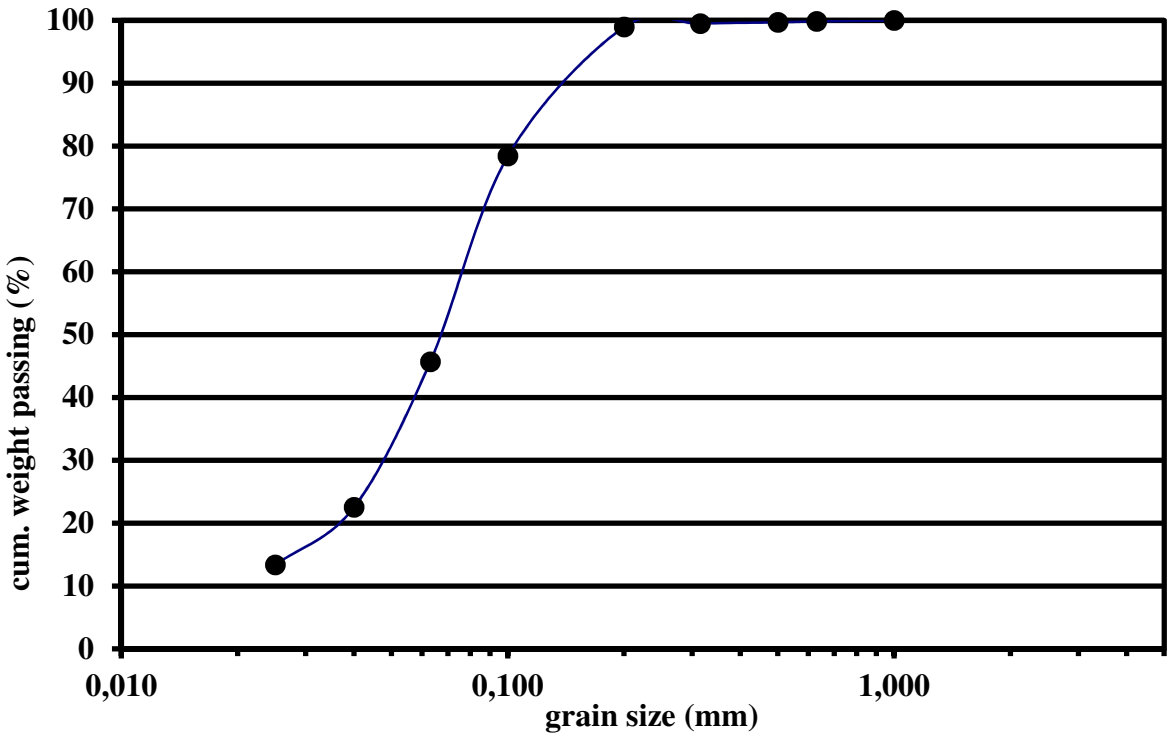
Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Screen metal analysis of Scavenger stage feed

Size mm			Weight %		Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0	0,0	/	100,0					
1,0	-	0,63	0,2	/	99,8					
0,63	-	0,5	0,2	/	99,7					
0,5	-	0,315	0,2	/	99,5	5,3	71,5	0,305	0,130	0,0030
0,315	-	0,2	0,6	/	98,9					
0,2	-	0,1	20,5	/	78,4					
0,1	-	0,063	32,7	/	45,7	6,9	69,3	0,540	0,155	0,0035
0,063	-	0,04	23,1	/	22,5	14,0	60,0	0,700	0,250	0,0055
0,04	-	0,025	9,2	/	13,4	24,1	47,9	0,760	0,340	0,0078
0,025	-	0	13,4	/	0,0	34,9	35,7	0,610	0,495	0,0160
Calculated total			100,0			13,5	61,2	0,556	0,234	0,0059

d_{80} [mm]	0,108	Blaine [cm²/g]	-
d_{50} [mm]	0,068	Specific density [g/cm³]	-



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Sink float analysis

with Scavenger stage feed

Screen metal Analysis

mm			Weight [%]	/	Passing [cum. %]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec./feed}$ [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0	0,0	/	100,0							
1,0	-	0,1	21,6	/	78,4	5,3		8,5	71,5	0,305	0,130	0,0030
0,1	-	0,063	32,7	/	45,7	6,9		16,7	69,3	0,540	0,155	0,0035
0,063	-	0,04	23,1	/	22,5	14,0		24,0	60,0	0,700	0,250	0,0055
0,04	-	0,0	22,5	/	0,0	30,5		50,9	40,7	0,671	0,432	0,0127
			100,0			13,5		100,0	61,2	0,556	0,234	0,0059
d_{80} [µm] =		108	Analysis of basis			12,9			62,5	0,540	0,230	0,0020

Sink float analysis

Fraction > 0,1 mm

kg/l			weight [%]	rec. [%]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec./feed}$ [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	>	3,3	3,4	0,7	67,7	42,1	3,6	1,7	0,088	0,450	0,0190
3,3	-	2,7	17,7	3,8	15,8	50,8	4,3	40,4	1,510	0,430	0,0120
	<	2,7	78,9	17,0	0,5	7,2	0,6	81,3	0,007	0,035	<0.005
			100,0	21,6	5,5	100,0	8,5	71,3	0,276	0,119	

Fraction 0,1 - 0,063 mm

kg/l			weight [%]	rec. [%]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec./feed}$ [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	>	3,3	5,0	1,6	67,5	49,1	8,2	1,8	0,096	0,680	0,0170
3,3	-	2,7	10,6	3,5	22,1	34,2	5,7	27,4	4,210	0,460	0,0120
	<	2,7	84,4	27,6	1,4	16,7	2,8	79,0	0,072	0,082	<0.005
			100,0	32,7	6,8	100,0	16,7	69,7	0,512	0,152	

Fraction 0,063 - 0,04 mm

kg/l			weight [%]	rec. [%]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec./feed}$ [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	>	3,3	14,1	3,3	68,1	68,5	16,4	0,9	0,145	0,720	0,0170
3,3	-	2,7	6,9	1,6	39,2	19,4	4,6	15,4	3,330	0,720	0,0130
	<	2,7	78,9	18,3	2,2	12,1	2,9	75,0	0,540	0,115	<0.005
			100,0	23,1	14,0	100,0	24,0	60,4	0,678	0,242	

Summary of Fractions 1,0 - 0,1 mm

kg/l			weight	rec. [%]	Fe [%]	$Fe_{rec./feed}$ [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	>	3,3		5,6	67,9	28,2	1,3	0,123	0,673	0,0173
3,3	-	2,7		8,9	22,5	14,7	30,8	2,892	0,494	0,0122
	<	2,7		62,9	1,4	6,3	78,5	0,190	0,079	<0.005
				77,5	8,6	49,1	67,4	0,496	0,170	

SGA-sample no.: 7451/650/50x/601…609

Appendix 7.2-4

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Lab scale flotation test #S1

Silica flotation with Scavenger stage feed

Flotation procedure

	Reagent	Dosage [g/t]	Conditioning time [min]	Flotation time [min]	Cumulated flot. time [min]	pH
Stage 1	Flotigam EDA	80	2,0	2,0	2,0	8,4
Stage 2	Flotigam EDA	50	2,0	1,5	3,5	8,4
Stage 3	Flotigam EDA	50	2,0	1,0	4,5	8,4
Stage 4	Flotigam EDA	50	2,0	1,0	5,5	8,3

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	SiO_2 [%]	$SiO_{2\,rec}$ [%]	$SiO_{2\,rec}$ [$\%_{v/o}$]	P [%]	TiO_2 [%]	V [%]
Test sample: Scavenger stage feed											
Feed	100,0	20,3	12,9	100,0	7,0	62,50	100,0	35,9	0,54	0,23	0,002
Weight recovery and composition of products											
Froth 1	32,0	6,5	13,3	33,3	2,3	61,00	31,5	11,2	0,47	0,26	0,006
Froth 2	33,9	6,9	11,4	30,2	2,1	65,40	35,8	12,7	0,52	0,18	0,004
Froth 3	20,5	4,2	10,8	17,4	1,2	64,50	21,3	7,6	0,62	0,17	0,004
Froth 4	8,2	1,7	12,9	8,3	0,6	58,20	7,7	2,8	0,68	0,24	0,006
Concentrate	**5,3**	**1,1**	**25,8**	**10,8**	**0,7**	**42,90**	**3,7**	**1,3**	**0,54**	**0,46**	**0,018**
Calc. balance	100,0	20,3	12,7	100,0	6,9	62,02	100,0	35,6	0,54	0,22	0,006

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	SiO_2 [%]	$SiO_{2\,rec}$ [%]	$SiO_{2\,rec}$ [$\%_{v/o}$]	P [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	20,3	12,7	100,0	6,9	62,02	100,0	35,6	0,54	0,22	0,006
after Stage 1	68,0	13,8	12,49	66,7	4,6	62,50	68,5	24,4	0,57	0,21	0,005
after Stage 2	34,1	6,9	13,63	36,5	2,5	59,61	32,7	11,7	0,62	0,23	0,007
after Stage 3	13,6	2,8	17,92	19,1	1,3	52,21	11,4	4,1	0,63	0,32	0,011
after Stage 4	5,3	1,1	25,80	10,8	0,7	42,90	3,7	1,3	0,54	0,46	0,018
Feed	100,0	20,3	12,9	100,0	7,0	62,50	100,0	35,9	0,54	0,23	0,002
after Stage 1	68,0	13,8	12,7	67,1	4,7	63,21	68,8	24,7	0,57	0,22	0,000
after Stage 2	34,1	6,9	13,4	35,4	2,5	62,11	33,8	12,1	0,60	0,23	-0,002
after Stage 3	13,6	2,8	15,0	15,8	1,1	60,67	13,2	4,7	0,59	0,27	-0,005
after Stage 4	5,3	1,1	16,3	6,7	0,5	62,18	5,3	1,9	0,53	0,29	-0,012

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Lab scale test on screening followed by upstream separation with scavenger stage feed

1. Screening at 0,040 mm

Feed: Scavenger stage feed (see screen metal analysis in Appendix 7.2-3)

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
100	20,3	12,9	62,5	0,540	0,230	0,0020
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	7,0	35,9	46,4		

Size mm			Weight % / Passing cum. %	Fe_{tot} %	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0	~~0,0~~ / ~~100,0~~					
1,0	-	0,63	~~0,2~~ / ~~99,8~~					
0,63	-	0,5	~~0,2~~ / ~~99,7~~					
0,5	-	0,315	~~0,2~~ / ~~99,5~~					
0,315	-	0,2	~~0,6~~ / ~~98,9~~					
0,2	-	0,1	~~20,5~~ / ~~78,4~~					
0,1	-	0,063	~~32,7~~ / ~~45,7~~					
0,063	-	0,04	~~23,1~~ / 22,5					
0,04	-	0,025	9,2 / 13,4	24,1	47,9	0,760	0,340	0,0078
0,025	-	0	13,4 / 0,0	34,9	35,7	0,610	0,495	0,0160
Calculated total			100,0	30,5	40,7	0,671	0,432	0,0127

Properties of scavenger stage feed <0,040 mm:

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
22,5	4,6	30,5	40,7	0,671	0,432	0,0127
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	3,7	5,3	13,0		

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery in Scavenger stage

Lab scale test on screening followed by upstream separation with scavenger stage feed

2. Upstream separation with Scavenger stage feed <0,040 mm

Test sample: Scavenger stage feed <0,040 mm

	weight [%]	v/o [%$_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [%$_{v/o}$]	SiO_2 [%]	$SiO_{2\,rec}$ [%]	$SiO_{2\,rec}$ [%$_{v/o}$]	P [%]	TiO_2 [%]	V [%]
Feed	100,0	4,6	30,5	100,0	3,7	40,67	100,0	5,3	0,67	0,43	0,013

Upstream separation procedure

	Upstream velocity [mm/s]	Duration of stage [min]	Cumulated time [min]
Stage 1	1,53	5,0	5,0
Stage 2	2,32	5,0	10,0
Stage 3	4,71	5,0	15,0

Weight recovery and composition of products

	weight [%]	v/o [%$_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [%$_{v/o}$]	SiO_2 [%]	$SiO_{2\,rec}$ [%]	$SiO_{2\,rec}$ [%$_{v/o}$]	P [%]	TiO_2 [%]	V [%]
Overflow 1	5,5	0,3	8,9	1,6	0,1	63,90	8,7	0,5	0,61	0,29	0,005
Overflow 2	20,1	0,9	9,5	6,2	0,2	64,70	31,9	1,7	0,70	0,24	0,004
Overflow 3	39,0	1,8	22,7	28,9	1,1	48,90	46,7	2,5	0,87	0,35	0,007
Concentrate	**35,4**	**1,6**	**54,8**	**63,3**	**2,4**	**14,70**	**12,7**	**0,7**	**0,40**	**0,67**	**0,028**
Calc. balance	100,0	4,6	30,6	100,0	3,7	40,82	100,0	5,3	0,65	0,44	0,014

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [%$_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [%$_{v/o}$]	SiO_2 [%]	$SiO_{2\,rec}$ [%]	$SiO_{2\,rec}$ [%$_{v/o}$]	P [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	4,6	30,6	100,0	3,7	40,82	100,0	5,3	0,65	0,44	0,014
after Stage 1	94,5	4,3	31,89	98,4	3,7	39,46	91,3	4,8	0,66	0,45	0,014
after Stage 2	74,3	3,4	37,98	92,2	3,4	32,62	59,4	3,1	0,64	0,50	0,017
after Stage 3	35,4	1,6	54,80	63,3	2,4	14,70	12,7	0,7	0,40	0,67	0,028
Feed	100,0	4,6	30,5	100,0	3,7	40,67	100,0	5,3	0,67	0,43	0,013
after Stage 1	94,5	4,3	31,8	98,4	3,7	39,31	91,3	4,8	0,67	0,44	0,013
after Stage 2	74,3	3,4	36,5	89,0	3,3	33,90	61,9	3,3	0,67	0,48	0,015
after Stage 3	35,4	1,6	43,8	50,8	1,9	26,04	22,6	1,2	0,57	0,55	0,019

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Cleaner stage spiral feed - 'Material 6'

Chemical analysis of

Reground rougher spiral concentrate - 'Material 6'

Fe_{tot}	**[%]**	**66,15**		
FeO	[%]	0,96		
SiO_2	[%]	3,04	Cr [%]	0,012
Al_2O_3	[%]	0,61	Co [%]	0,0005
CaO	[%]	0,55	Ni [%]	0,0012
MgO	[%]	0,20	Cu [%]	0,0005
P	[%]	0,149	Zn [%]	0,0013
S	[%]	0,005	Pb [%]	<0,0005
Na_2O	[%]	0,097	As [%]	0,0008
K_2O	[%]	0,03	Cd [%]	<0,0005
Mn	[%]	0,0155	Tl [%]	<0,001
TiO_2	[%]	0,30	SrO [%]	0,0006
V	[%]	0,01	BaO [%]	0,0009
L.O.I.	[%]	0,05		

Magnetite by Satmagan	**[%]**	**1,6**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,7

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

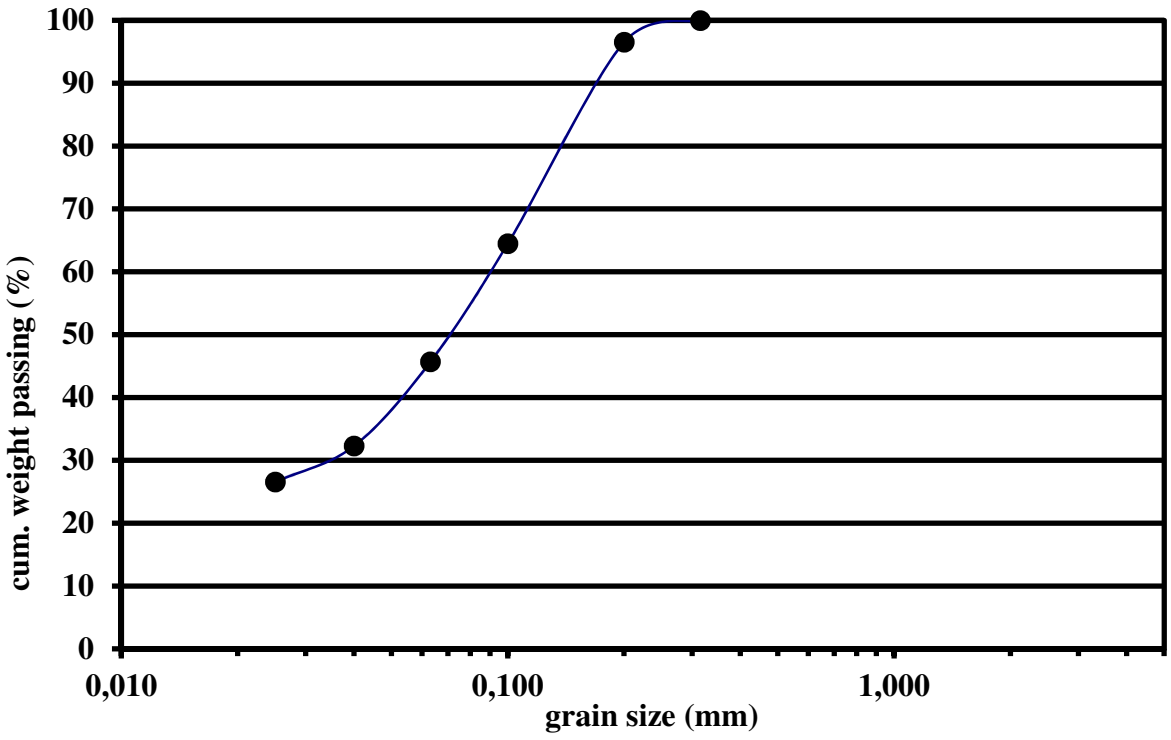
Lab scale tests with Cleaner stage spiral feed - 'Material 6'

Screen metal analysis of

Reground rougher spiral concentrate - 'Material 6'

Size mm	Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
+ 1,0						
1,0 - 0,63						
0,63 - 0,5						
0,5 - 0,315	0,0 / 100,0	67,3	2,05	0,102	0,280	0,0110
0,315 - 0,2	3,4 / 96,5					
0,2 - 0,1	32,1 / 64,5	64,4	5,00	0,205	0,295	0,0105
0,1 - 0,063	18,8 / 45,7	65,2	3,90	0,230	0,350	0,0109
0,063 - 0,04	13,4 / 32,3	67,7	1,67	0,088	0,310	0,0108
0,04 - 0,025	5,7 / 26,6	68,3	1,18	0,047	0,265	0,0109
0,025 - 0	26,6 / 0,0	67,9	1,47	0,053	0,250	0,0105
Calculated total	100,0	66,2	3,09	0,141	0,293	0,0107

d_{80} [mm]	0,148	Blaine [cm²/g]	780
d_{50} [mm]	0,072	Specific density [g/cm³]	5,07



SGA-sample no.: 7451/4-1/100

Appendix 8.1-2

Studiengesellschaft für Eisenerzaufbereitung SGA

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Cleaner stage spiral feed - 'Material 6'

Shaking table test

with Reground rougher spiral concentrate - 'Material 6'

		Feed	Products				Calc. balance
		Reground rougher spiral concentrate - 'Material 6'	Concentrate 1	Concentrate 2	Middlings	Tailings	
Weight	**[%]**	100,0	**53,4**	**9,9**	**16,7**	**20,0**	**100,0**
Weight	**[%$_{v/o}$]**	20,1	**10,7**	**2,0**	**3,3**	**4,0**	**20,1**
Fe_{tot}	[%]	66,15	**69,20**	**66,15**	**55,10**	**66,35**	**65,98**
Fe_{rec}	[%]	100,3	**56,0**	**9,9**	**13,9**	**20,1**	**100,0**
Fe_{rec}	[%]	100,0	**55,9**	**9,9**	**13,9**	**20,1**	**99,7**
Fe_{rec}	[%$_{v/o}$]	35,4	**19,8**	**3,5**	**4,9**	**7,1**	**35,3**
Magn. by Satm.	[%]	1,6	**1,2**	**1,3**	**1,4**	**2,9**	**1,6**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,7	**1,2**	**1,4**	**1,8**	**3,1**	**1,7**
$Magn._{rec}$	[%]	102,4	**40,0**	**8,4**	**14,7**	**36,9**	**100,0**
$Magn._{rec}$	[%]	100,0	**39,0**	**8,2**	**14,3**	**36,1**	**97,6**
$Magn._{rec}$	[%$_{v/o}$]	1,1	**0,4**	**0,1**	**0,2**	**0,4**	**1,0**
SiO_2	[%]	3,04	**0,16**	**2,46**	**14,15**	**3,13**	**3,31**
$SiO_{2\ rec}$	[%]	91,8	**2,6**	**7,4**	**71,1**	**18,9**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**2,8**	**8,0**	**77,5**	**20,6**	**109,0**
$SiO_{2\ rec}$	[%$_{v/o}$]	1,7	**0,0**	**0,1**	**1,3**	**0,4**	**1,9**
P	[%]	0,149	**0,020**	**0,260**	**0,580**	**0,080**	**0,149**
P_{rec}	[%]	100,0	**7,2**	**17,3**	**64,8**	**10,8**	**100,0**
P_{rec}	[%]	100,0	**7,2**	**17,3**	**64,8**	**10,8**	**100,0**
P_{rec}	[%$_{v/o}$]	12,7	**0,9**	**2,2**	**8,2**	**1,4**	**12,7**
TiO_2	[%]	0,300	**0,315**	**0,350**	**0,250**	**0,245**	**0,294**
V	[%]	0,010	**0,011**	**0,011**	**0,009**	**0,011**	**0,011**
d_{80}	[mm]	0,148	-	-	0,088	-	-
d_{50}	[mm]	0,072	-	-	0,039	-	-
Spec. Surface	[Blaine]	-	-	-	-	-	-
Spec. Weight	[g/cm³]	-	-	-	-	-	-

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Cleaner stage spiral feed - 'Material 6'

Size distribution of products from shaking table test with 'Material 6'

Size mm	Feed Weight / Passing [%] / [cum. %]	Concentrate 1 Weight / Passing [%] / [cum. %]	Concentrate 2 Weight / Passing [%] / [cum. %]	Middlings Weight / Passing [%] / [cum. %]	Tailings Weight / Passing [%] / [cum. %]
+ 1,0	0,0 / 100,0	-	-	0,0 / 100,0	-
1,0 - 0,63	0,0 / 100,0	-	-	0,0 / 100,0	-
0,63 - 0,5	0,0 / 100,0	-	-	0,0 / 100,0	-
0,5 - 0,315	0,0 / 100,0	-	-	0,1 / 99,9	-
0,315 - 0,2	3,4 / 96,5	-	-	0,7 / 99,1	-
0,2 - 0,1	32,1 / 64,5	-	-	15,2 / 83,9	-
0,1 - 0,063	18,8 / 45,7	-	-	12,1 / 71,8	-
0,063 - 0,04	13,4 / 32,3	-	-	19,6 / 52,2	-
0,04 - 0,025	5,7 / 26,6	-	-	23,2 / 29,0	-
0,025 - 0	26,6 / 0,0	-	-	29,0 / 0,0	-
	100,0 / -	-	-	100,0 / -	-
d_{80} [mm]	0,148	-	-	0,088	-
d_{50} [mm]	0,072	-	-	0,039	-
Spec. Surface [Blaine]	-	-	-	-	-
Spec. Weight [g/cm³]	-	-	-	-	-

SGA-sample no.: 7451/4-1/100/1..4

Appendix 8.1-3.2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale tests with Cleaner stage spiral feed - 'Material 6'

Sink float analysis

with Reground rougher spiral concentrate - 'Material 6'

Screen metal Analysis

mm			Weight	/	Passing	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]		[cum. %]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	+	0,1	35,5	/	64,5	64,6		34,7	4,7	0,195	0,294	0,0105
0,1	-	0,063	18,8	/	45,7	65,2		18,5	3,9	0,230	0,350	0,0109
0,063	-	0,04	13,4	/	32,3	67,7		13,7	1,7	0,088	0,310	0,0108
0,04	-	0,0	32,3	/	0,0	68,0		33,1	1,4	0,052	0,253	0,0106
			100,0			66,2		100,0	3,1	0,141	0,293	0,0107
d_{80} [µm]	=	148	Analysis of basis			66,2			3,0	0,149	0,300	0,0100

Sink float analysis

Fraction 0,1 - 0,063 mm

kg/l			weight	v/o	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	74,6	14,0	69,1	79,3	12,8	0,3	0,023	0,335	0,0110
3,3	-	2,7	21,5	4,0	62,3	20,6	11,5	3,8	0,870	0,290	0,0110
	<	2,7	4,0	0,7	1,2	0,1	0,2	80,5	0,370	0,040	0,0040
			100,0	18,8	65,0	100,0	18,5	4,2	0,219	0,314	0,0107

Fraction 0,063 - 0,04 mm

kg/l			weight	v/o	Fe	$Fe_{rec.}$	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	86,7	11,6	69,1	89,0	9,4	0,3	0,036	0,320	0,0120
3,3	-	2,7	13,3	1,8	55,4	11,0	7,6	13,3	0,570	0,275	0,0110
	<	2,7	0,0	0,0	-	-	-	-	-	-	-
			100,0	13,4	67,2	100,0	13,7	2,0	0,107	0,314	0,0119

Summary of Fractions 0,1 - 0,04 mm

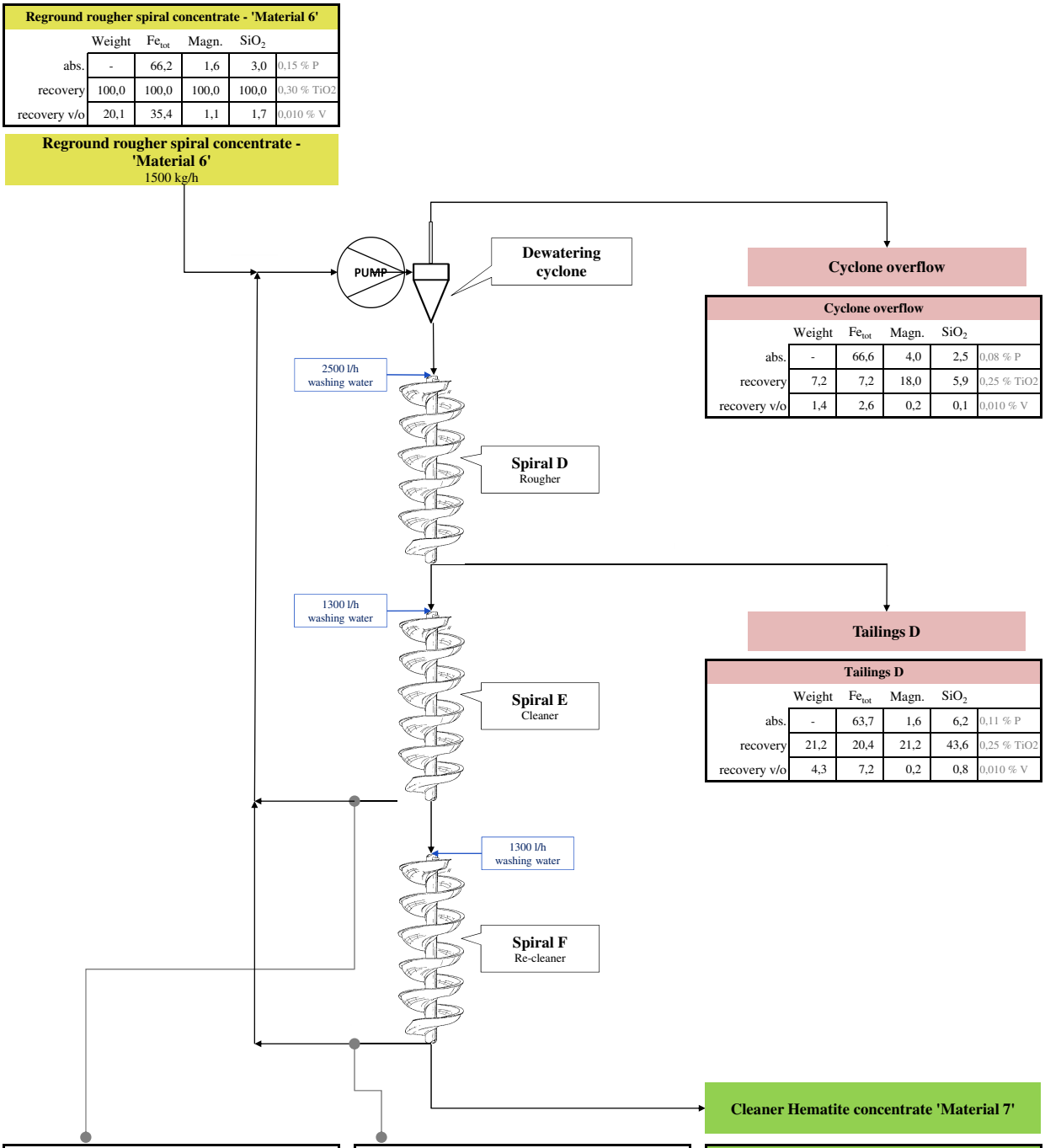
kg/l			v/o	Fe	$Fe_{rec./feed}$	SiO_2	P	TiO_2	V
			[%]	[%]	[%]	[%]	[%]	[%]	[%]
	>	3,3	25,6	69,1	22,2	0,3	0,029	0,328	0,0115
3,3	-	2,7	5,8	60,2	19,1	6,7	0,778	0,285	0,0110
	<	2,7	0,7	1,2	0,2	80,5	0,370	0,040	0,0040
			32,2	65,9	41,6	3,3	0,172	0,314	0,0112

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Process overview



Reground rougher spiral concentrate - 'Material 6'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	66,2	1,6	3,0	0,15 % P
recovery	100,0	100,0	100,0	100,0	0,30 % TiO2
recovery v/o	20,1	35,4	1,1	1,7	0,010 % V

Cyclone overflow

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	66,6	4,0	2,5	0,08 % P
recovery	7,2	7,2	18,0	5,9	0,25 % TiO2
recovery v/o	1,4	2,6	0,2	0,1	0,010 % V

Tailings D

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	63,7	1,6	6,2	0,11 % P
recovery	21,2	20,4	21,2	43,6	0,25 % TiO2
recovery v/o	4,3	7,2	0,2	0,8	0,010 % V

Tailings E

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	38,1	1,2	34,5	0,47 % P
recovery	7,7	4,4	5,7	86,8	0,19 % TiO2
recovery v/o	1,5	1,6	0,1	1,5	0,007 % V

Tailings F

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	44,1	1,2	28,0	0,54 % P
recovery	2,7	1,8	2,0	25,0	0,22 % TiO2
recovery v/o	0,5	0,6	0,0	0,4	0,008 % V

Cleaner Hematite concentrate 'Material 7'

	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	66,9	1,2	2,1	0,19 % P
recovery	71,6	72,3	53,7	50,4	0,33 % TiO2
recovery v/o	14,4	25,6	0,6	0,9	0,011 % V

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Chemical analysis of samples taken during test

(Feed rate @ 1500 kg/h)

		Feed	Products			Calc. balance	Intermediate products	
		Reground rougher spiral concentrate - 'Material 6'	Cleaner Hematite concentrate 'Material 7'	Tailings D	Cyclone overflow		Tailings E	Tailings F
Weight	[%]	100,0	**71,6**	**21,2**	**7,2**	**100,0**	7,7	2,7
Weight	[$\%_{v/o}$]	20,1	**14,4**	**4,3**	**1,4**	**20,1**	1,5	0,5
Fe_{tot}	[%]	66,15	**66,85**	**63,67**	**66,62**	**66,16**	38,10	44,10
Fe_{rec}	[%]	100,0	**72,3**	**20,4**	**7,2**	**100,0**	4,4	1,8
Fe_{rec}	[%]	100,0	**72,3**	**20,4**	**7,2**	**100,0**	4,4	1,8
Fe_{rec}	[$\%_{v/o}$]	35,4	**25,6**	**7,2**	**2,6**	**35,4**	1,6	0,6
Magn. by Satm.	[%]	1,6	**1,2**	**1,6**	**4,0**	**1,5**	1,2	1,2
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,7	**1,3**	**1,8**	**4,3**	**1,6**	2,3	2,0
$Magn._{rec}$	[%]	107,7	**57,8**	**22,8**	**19,4**	**100,0**	6,2	2,2
$Magn._{rec}$	[%]	100,0	**53,7**	**21,2**	**18,0**	**92,9**	5,7	2,0
$Magn._{rec}$	[$\%_{v/o}$]	1,1	**0,6**	**0,2**	**0,2**	**1,0**	0,1	0,0
SiO_2	[%]	3,04	**2,14**	**6,24**	**2,48**	**3,03**	34,50	28,00
$SiO_{2\ rec}$	[%]	100,2	**50,5**	**43,6**	**5,9**	**100,0**	87,0	25,0
$SiO_{2\ rec}$	[%]	100,0	**50,4**	**43,6**	**5,9**	**99,8**	86,8	25,0
$SiO_{2\ rec}$	[$\%_{v/o}$]	1,7	**0,9**	**0,8**	**0,1**	**1,7**	1,5	0,4
P	[%]	0,149	**0,190**	**0,110**	**0,077**	**0,165**	0,47	0,54
P_{rec}	[%]	90,4	**82,5**	**14,2**	**3,4**	**100,0**	21,6	8,9
P_{rec}	[%]	100,0	**91,3**	**15,7**	**3,7**	**110,7**	23,9	9,8
P_{rec}	[$\%_{v/o}$]	12,7	**11,6**	**2,0**	**0,5**	**14,1**	3,0	1,2
TiO_2	[%]	0,30	**0,33**	**0,25**	**0,25**	**0,31**	0,19	0,22
V	[%]	0,010	**0,011**	**0,010**	**0,010**	**0,011**	0,007	0,008
d_{80}	[mm]	0,148	**0,170**	**0,036**	**0,021**	**0,131**	0,131	0,000
d_{50}	[mm]	0,072	**0,108**	**0,022**	**0,013**	**0,083**	0,037	0,000
Spec. Surface	[Blaine]	780	**690**	**1110**	**5095**	**-**	-	0
Spec. Weight	[g/cm³]	780,00	**5,09**	**4,87**	**5,01**	**-**	-	0,00

SGA-sample no.: 7451/5-1/1ff

Appendix 8.2-2

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Size distribution of samples taken during test

Size mm	Feed Weight / Passing [%] / [cum. %]	Cleaner Hematite concentrate 'Material 7' Weight / Passing [%] / [cum. %]	Tailings D Weight / Passing [%] / [cum. %]	Cyclone overflow Weight / Passing [%] / [cum. %]	Tailings E Weight / Passing [%] / [cum. %]	Tailings F Weight / Passing [%] / [cum. %]
+ 1,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
1,0 - 0,63	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
0,63 - 0,5	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
0,5 - 0,315	0,0 / 100,0	0,1 / 99,9	0,1 / 99,9	0,0 / 100,0	0,8 / 99,2	0,1 / 99,9
0,315 - 0,2	3,4 / 96,5	5,1 / 94,8	0,1 / 99,9	0,0 / 100,0	2,6 / 96,6	1,2 / 98,7
0,2 - 0,1	32,1 / 64,5	48,8 / 46,0	1,4 / 98,5	0,4 / 99,6	37,1 / 59,5	26,9 / 71,8
0,1 - 0,063	18,8 / 45,7	25,6 / 20,4	4,6 / 93,9	1,1 / 98,5	8,1 / 51,4	11,5 / 60,2
0,063 - 0,04	13,4 / 32,3	15,5 / 4,9	4,7 / 89,2	0,7 / 97,8	13,7 / 37,7	2,6 / 57,6
0,04 - 0,025	5,7 / 26,6	3,8 / 1,2	32,5 / 56,7	2,4 / 95,4	18,3 / 19,4	42,3 / 15,3
0,025 - 0	26,6 / 0,0	1,2 / 0,0	56,7 / 0,0	95,4 / 0,0	19,4 / 0,0	15,3 / 0,0
	100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,148	0,170	0,036	0,021	0,155	0,131
d_{50} [mm]	0,072	0,108	0,022	0,013	0,061	0,037
Spec. Surface [Blaine]	780	690	1110	5095	-	-
Spec. Weight [g/cm³]	780,00	5,09	4,87	5,01	-	-

SGA-sample no.: 7451/5-1/1ff

Appendix 8.2-3

Nordic Iron Ore AB

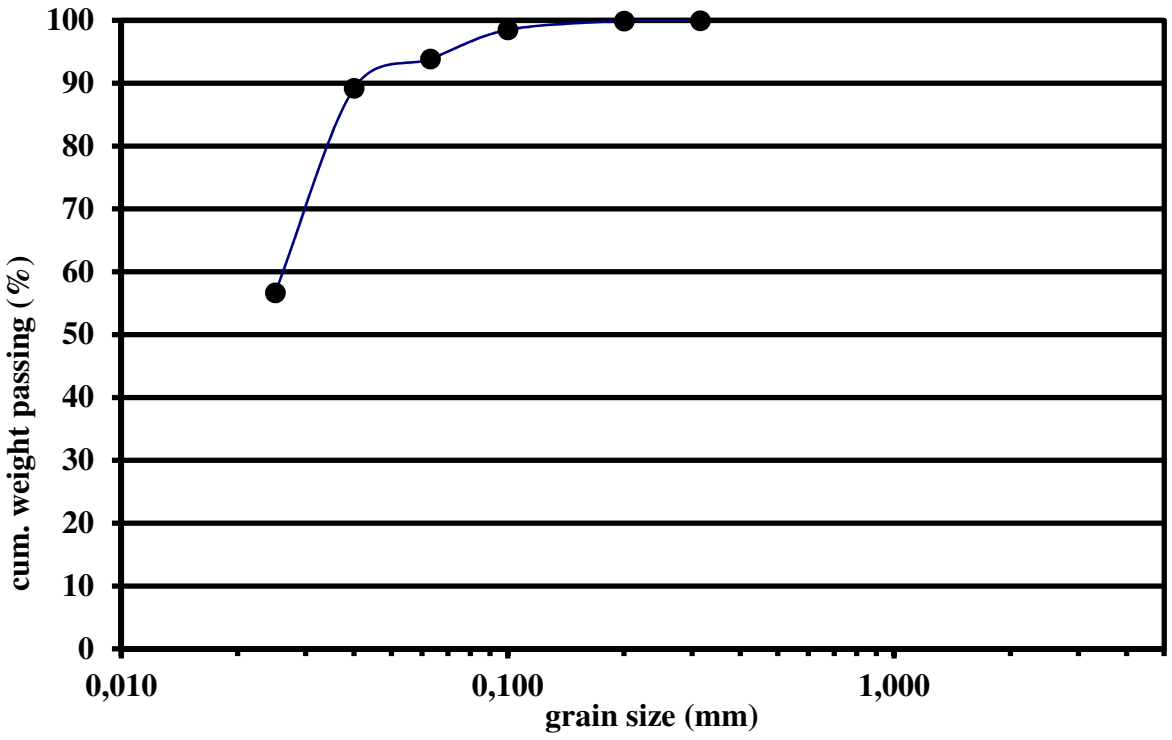
Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Screen metal analysis of Tailings from Spiral D

Size mm			Weight %	Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0							
1,0	-	0,63							
0,63	-	0,5							
0,5	-	0,315	0,1	99,9					
0,315	-	0,2	0,1	99,9	5,8	71,40	0,107	0,106	0,0020
0,2	-	0,1	1,4	98,5					
0,1	-	0,063	4,6	93,9	17,3	60,40	0,550	0,137	0,0040
0,063	-	0,04	4,7	89,2	60,8	9,50	0,256	0,270	0,0100
0,04	-	0,025	32,5	56,7	65,3	4,15	0,123	0,260	0,0106
0,025	-	0	56,7	0,0	67,8	1,27	0,048	0,250	0,0105
Calculated total			100,0		63,4	6,38	0,106	0,247	0,0101

d_{80} [mm]	0,036	Blaine [cm²/g]	1110
d_{50} [mm]	0,022	Specific density [g/cm³]	4,87



SGA-sample no.: 7451/5-1/2

Appendix 8.2-4

Nordic Iron Ore AB

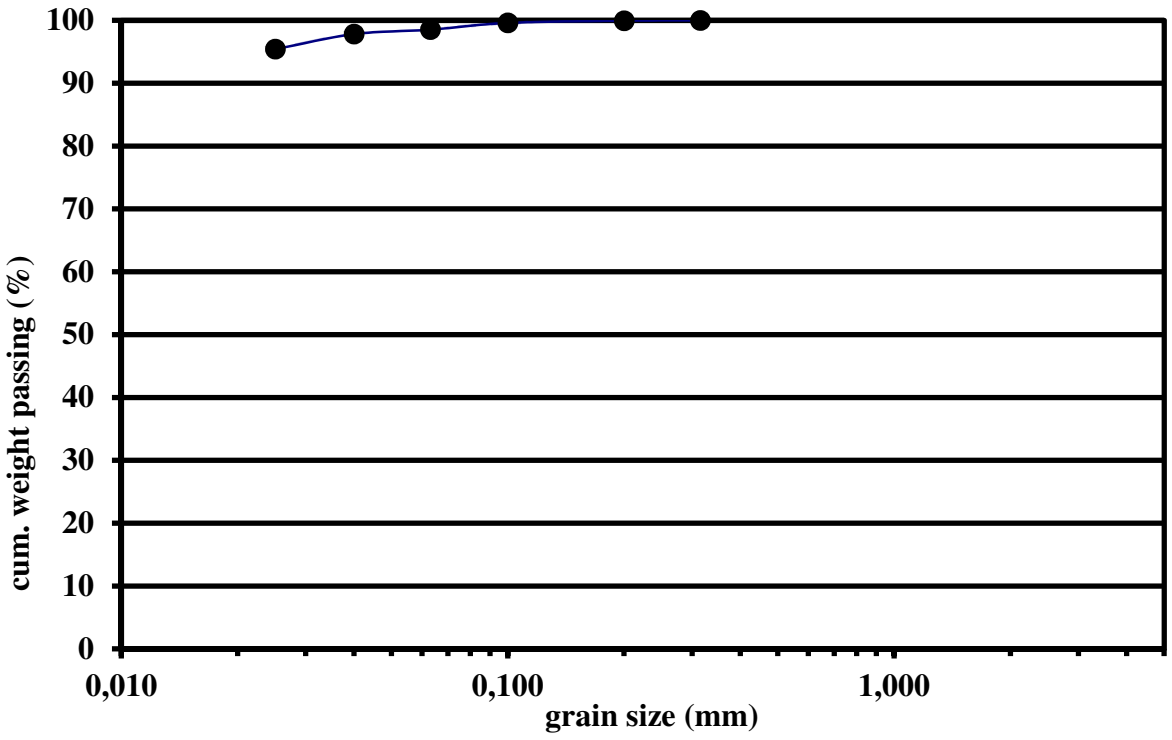
Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Screen metal analysis of Cyclone overflow

Size mm			Weight %	Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0							
1,0	-	0,63							
0,63	-	0,5							
0,5	-	0,315	0,0	100,0					
0,315	-	0,2	0,0	100,0					
0,2	-	0,1	0,4	99,6					
0,1	-	0,063	1,1	98,5	54,8	15,55	0,220	0,245	0,0090
0,063	-	0,04	0,7	97,8					
0,04	-	0,025	2,4	95,4					
0,025	-	0	95,4	0,0	66,7	2,17	0,072	0,245	0,0110
Calculated total			100,0		66,2	2,78	0,079	0,245	0,0109

d_{80} [mm]	<0,020	Blaine [cm²/g]	5095
d_{50} [mm]	<0,020	Specific density [g/cm³]	5,01



SGA-sample no.: 7451/5-1/2

Appendix 8.2-5

Nordic Iron Ore AB

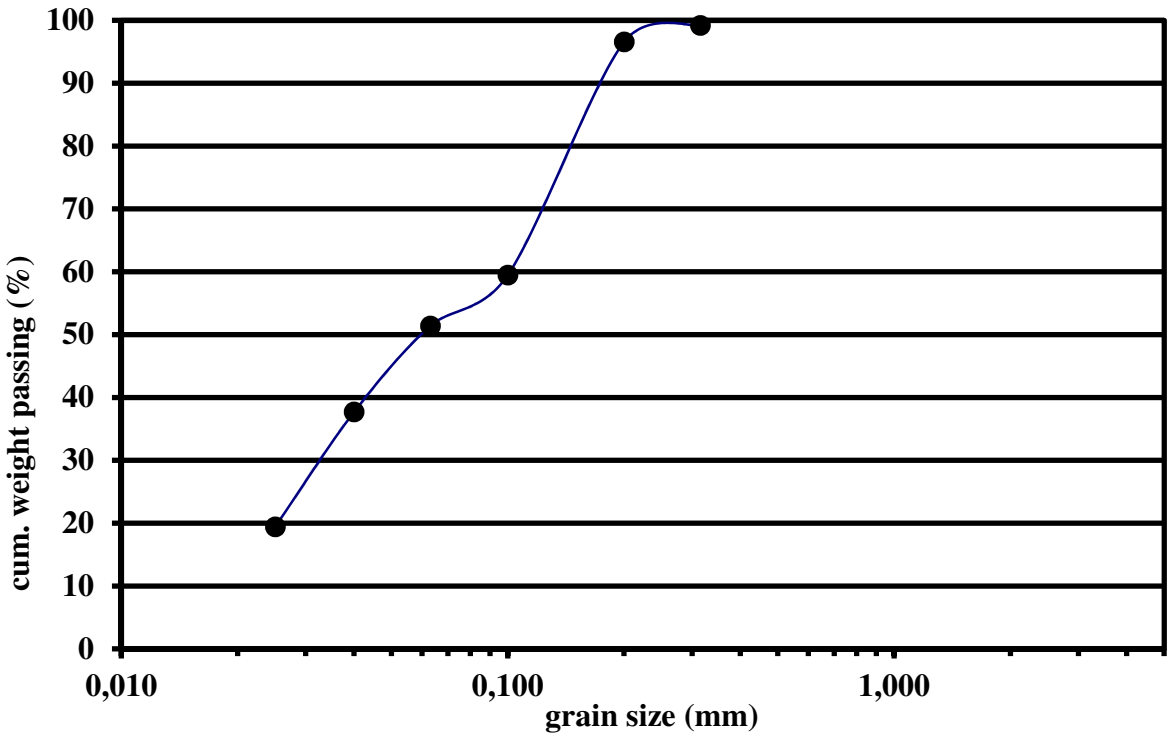
Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Screen metal analysis of Tailings from Spiral E

Size mm	Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
+ 1,0						
1,0 - 0,63						
0,63 - 0,5						
0,5 - 0,315	0,8 / 99,2					
0,315 - 0,2	2,6 / 96,6	6,8	66,80	0,820	0,110	0,0030
0,2 - 0,1	37,1 / 59,5					
0,1 - 0,063	8,1 / 51,4					
0,063 - 0,04	13,7 / 37,7	62,9	6,10	0,252	0,280	0,0100
0,04 - 0,025	18,3 / 19,4	68,3	1,12	0,049	0,265	0,0107
0,025 - 0	19,4 / 0,0	68,2	0,93	0,039	0,250	0,0105
Calculated total	100,0	37,6	33,70	0,450	0,189	0,0068

d_{80} [mm]	0,155	Blaine	[cm²/g]	-	
d_{50} [mm]	0,061	Specific density	[g/cm³]	-	



SGA-sample no.: 7451/5-1/4

Appendix 8.2-6

Nordic Iron Ore AB

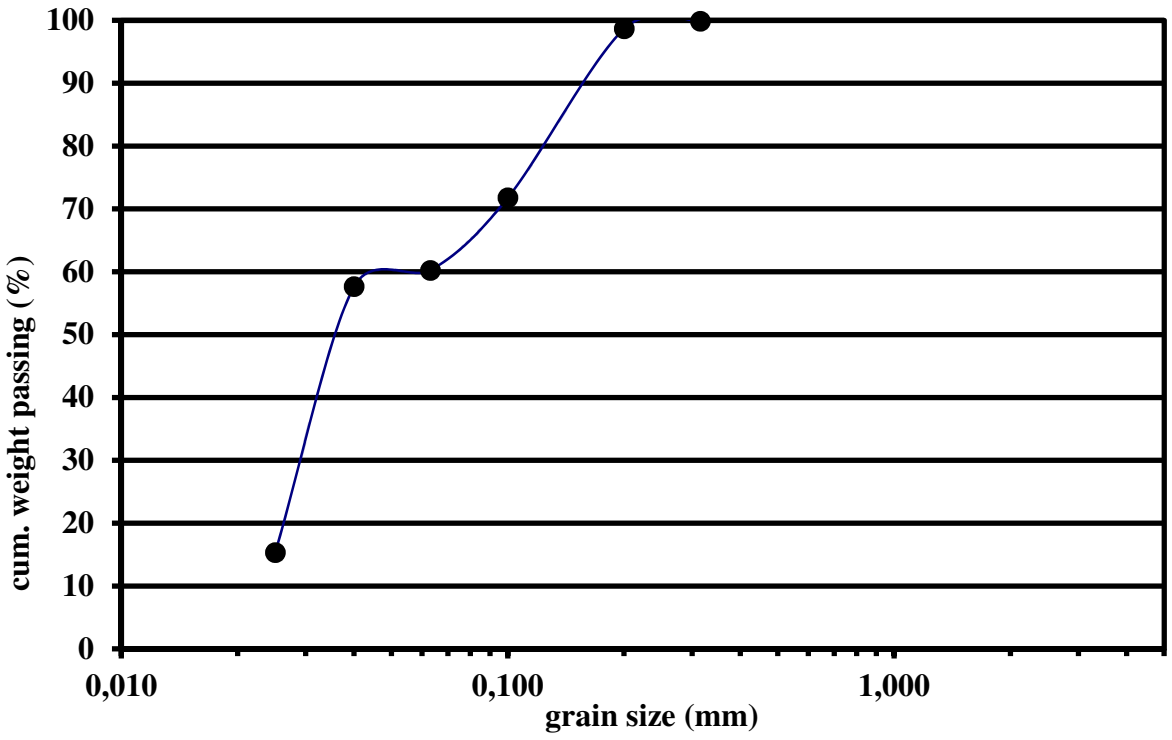
Blötberget - 8 t Pilot sample (2015/16)

Cleaner stage spiral separation - Pilot scale test

Screen metal analysis of Tailings from Spiral F

Size mm			Weight %	Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0							
1,0	-	0,63							
0,63	-	0,5							
0,5	-	0,315	0,1	99,9					
0,315	-	0,2	1,2	98,7	4,4	72,20	1,060	0,110	0,0030
0,2	-	0,1	26,9	71,8					
0,1	-	0,063	11,5	60,2	18,2	55,10	1,260	0,155	0,0045
0,063	-	0,04	2,6	57,6	65,2	4,19	0,230	0,290	0,0102
0,04	-	0,025	42,3	15,3	67,4	1,86	0,110	0,280	0,0107
0,025	-	0	15,3	0,0	68,5	0,55	0,026	0,255	0,0110
Calculated total			100,0		44,1	27,72	0,501	0,214	0,0078

d_{80} [mm]	0,131	Blaine [cm²/g]	-
d_{50} [mm]	0,037	Specific density [g/cm³]	-



SGA-sample no.: 7451/5-1/5

Appendix 8.2-7

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery from Cleaner spirals tailings

Scenario of screening

Reground rougher spiral concentrate - 'Material 6'

at 0.063 mm

Feed: Reground rougher spiral concentrate - 'Material 6'

(see screen metal analysis in Appendix 8.1-2)

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
100	20,1	66,2	3,0	0,149	0,300	0,0100
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	35,4	1,7	12,7		

Size mm			Weight %	/	Passing cum. %	Fe_{tot} %	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0								
1,0	-	0,63								
0,63	-	0,5								
0,5	-	0,315	~~0,0~~	/	~~100,0~~					
0,315	-	0,2	~~3,4~~	/	~~96,5~~					
0,2	-	0,1	~~32,1~~	/	~~64,5~~					
0,1	-	0,063	~~18,8~~	/	45,7					
0,063	-	0,04	13,4	/	32,3	67,7	1,67	0,088	0,310	0,0108
0,04	-	0,025	5,7	/	26,6	68,3	1,18	0,047	0,265	0,0109
0,025	-	0	26,6	/	0,0	67,9	1,47	0,053	0,250	0,0105
Calculated total			100,0			67,9	1,49	0,063	0,269	0,0106

Properties of 'Material 6' <0,063 mm:

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
45,7	9,2	67,9	1,5	0,063	0,269	0,0106
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	16,6	0,4	2,4		

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery from Cleaner spirals tailings

Scenario of screening
Tailings from Spiral D
at 0.063 mm

Feed: Tailings from Spiral D

(see screen metal analysis in Appendix 8.2-4)

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
100	4,3	63,7	6,2	0,110	0,250	0,0100
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	7,2	0,8	2,0		

Size mm			Weight %	/	Passing cum. %	Fe_{tot} %	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0								
1,0	-	0,63								
0,63	-	0,5								
0,5	-	0,315	~~0,1~~	/	~~99,9~~					
0,315	-	0,2	~~0,1~~	/	~~99,9~~					
0,2	-	0,1	~~1,4~~	/	~~98,5~~					
0,1	-	0,063	~~4,6~~	/	93,9					
0,063	-	0,04	4,7	/	89,2	60,8	9,50	0,256	0,270	0,0100
0,04	-	0,025	32,5	/	56,7	65,3	4,15	0,123	0,260	0,0106
0,025	-	0	56,7	/	0,0	67,8	1,27	0,048	0,250	0,0105
Calculated total			100,0			66,6	2,68	0,084	0,254	0,0105

Properties of 'Material 6' <0,063 mm:

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
93,9	4,0	66,6	2,7	0,084	0,254	0,0105
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	7,1	0,3	1,4		

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery from Cleaner spirals tailings

Lab scale test on screening followed by upstream separation with Tailings from Spiral D

1. Screening at 0,040 mm

Feed: Tailings from Spiral D (see screen metal analysis in Appendix 8.2-4)

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
100	4,3	63,7	6,0	0,105	0,250	0,0100
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	7,2	0,7	1,9		

Size mm			Weight % / Passing cum. %	Fe_{tot} %	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0						
1,0	-	0,63						
0,63	-	0,5						
0,5	-	0,315	~~0,1~~ / ~~99,9~~					
0,315	-	0,2	~~0,1~~ / ~~99,9~~					
0,2	-	0,1	~~1,4~~ / ~~98,5~~					
0,1	-	0,063	~~4,6~~ / ~~93,9~~					
0,063	-	0,04	~~4,7~~ / 89,2					
0,04	-	0,025	32,5 / 56,7	65,3	4,2	0,123	0,260	0,0106
0,025	-	0	56,7 / 0,0	67,8	1,3	0,048	0,250	0,0105
Calculated total			100,0	66,9	2,3	0,075	0,254	0,0105

Properties of scavenger stage feed <0,040 mm:

weight [%]	v/o [$\%_{v/o}$]	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
89,2	3,8	66,9	2,3	0,075	0,254	0,0105
$Fe/SiO_2/P_{rec}$	[$\%_{v/o}$]	6,8	0,2	1,2		

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery from Cleaner spirals tailings

Lab scale test on screening followed by upstream separation with Tailings from Spiral D

2. Upstream separation with Tailings from Spiral D <0,040 mm

Test sample: Tailings from Spiral D <0,040 mm

	weight [%]	v/o [%v/o]	Fe [%]	Fe rec. [%]	Fe rec. [%v/o]	SiO_2 [%]	SiO_2 rec [%]	SiO_2 rec [%v/o]	P [%]	TiO_2 [%]	V [%]
Feed	100,0	3,8	66,9	100,0	6,8	2,32	100,0	0,2	0,075	0,25	0,011

Upstream separation procedure

	Upstream velocity [mm/s]	Duration of stage [min]	Cumulated time [min]
Stage 1	0,40	5,0	5,0
Stage 2	0,62	5,0	10,0
Stage 3	2,64	5,0	15,0

Weight recovery and composition of products

	weight [%]	v/o [%v/o]	Fe [%]	Fe rec. [%]	Fe rec. [%v/o]	SiO_2 [%]	SiO_2 rec [%]	SiO_2 rec [%v/o]	P [%]	TiO_2 [%]	V [%]
Overflow 1	2,9	0,1	52,6	2,3	0,2	15,80	18,4	0,0	0,35	0,22	0,009
Overflow 2	5,3	0,2	61,4	4,9	0,3	8,42	18,2	0,0	0,21	0,24	0,010
Overflow 3	50,7	1,9	67,4	51,0	3,5	2,24	46,1	0,1	0,073	0,26	0,011
Concentrate	**41,1**	**1,6**	**68,4**	**41,9**	**2,8**	**1,04**	**17,3**	**0,0**	**0,046**	**0,27**	**0,011**
Calc. balance	100,0	3,8	67,1	100,0	6,8	2,47	100,0	0,3	0,077	0,26	0,011

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [%v/o]	Fe [%]	Fe rec. [%]	Fe rec. [%v/o]	SiO_2 [%]	SiO_2 rec [%]	SiO_2 rec [%v/o]	P [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	3,8	67,1	100,0	6,8	2,47	100,0	0,3	0,077	0,26	0,011
after Stage 1	97,1	3,7	67,49	97,7	6,6	2,07	81,6	0,2	0,069	0,26	0,011
after Stage 2	91,8	3,5	67,85	92,9	6,3	1,70	63,4	0,2	0,061	0,26	0,011
after Stage 3	41,1	1,6	68,40	41,9	2,8	1,04	17,3	0,0	0,046	0,27	0,011
Feed	100,0	3,8	66,9	100,0	6,8	2,32	100,0	0,2	0,075	0,25	0,011
after Stage 1	97,1	3,7	67,3	97,7	6,6	1,92	80,4	0,2	0,067	0,25	0,011
after Stage 2	91,8	3,5	67,6	92,8	6,3	1,56	61,9	0,2	0,059	0,26	0,011
after Stage 3	41,1	1,6	67,8	41,6	2,8	1,19	21,1	0,1	0,052	0,26	0,011

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery from Cleaner spirals tailings

Pilot scale test

Screening of tailings from Spiral D at 0.053 mm

(Derrick screen DF200, feed rate @ 150 kg/h,)

		Feed	Products		Calc. balance
		Tailings from Spiral D	Screen underflow <0.053 mm	Screen overflow >0.053 mm	
Weight	[%]	100,0	**90,8**	**9,2**	**100,0**
Weight	[$\%_{v/o}$]	4,3	**3,9**	**0,4**	**4,3**
Fe_{tot}	[%]	63,70	**66,10**	**40,70**	**63,77**
Fe_{rec}	[%]	99,9	**94,2**	**5,8**	**100,0**
Fe_{rec}	[%]	100,0	**94,3**	**5,8**	**100,1**
Fe_{rec}	[$\%_{v/o}$]	7,2	**6,8**	**0,4**	**7,2**
Magn. by Satm.	[%]	1,7	**1,8**	**1,7**	**1,8**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,9	**2,0**	**3,0**	**2,1**
$Magn._{rec}$	[%]	92,9	**91,6**	**8,4**	**100,0**
$Magn._{rec}$	[%]	100,0	**98,5**	**9,1**	**107,6**
$Magn._{rec}$	[$\%_{v/o}$]	0,2	**0,2**	**0,0**	**0,3**
SiO_2	[%]	6,00	**3,49**	**32,50**	**6,15**
$SiO_{2\ rec}$	[%]	97,6	**51,6**	**48,4**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**52,8**	**49,6**	**102,4**
$SiO_{2\ rec}$	[$\%_{v/o}$]	0,7	**0,4**	**0,4**	**0,7**
P	[%]	0,105	**0,099**	**0,185**	**0,107**
P_{rec}	[%]	98,2	**84,2**	**15,8**	**100,0**
P_{rec}	[%]	100,0	**85,7**	**16,1**	**101,8**
P_{rec}	[$\%_{v/o}$]	1,9	**1,6**	**0,3**	**1,9**
TiO_2	[%]	0,250	**0,260**	**0,195**	**0,254**
V	[%]	0,010	**0,010**	**0,007**	**0,010**
d_{80}	[mm]	0,039	**0,036**	**0,120**	**0,044**
d_{50}	[mm]	0,023	**0,021**	**0,055**	**0,024**
Spec. Surface	[Blaine]	1135	**1160**	**700**	**1118**
Spec. Weight	[g/cm^3]	4,89	**5,03**	**3,76**	**4,91**

SGA-sample no.: 7451/6-1/100 & 200

Appendix 8.3-4.1

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Iron recovery from Cleaner spirals tailings

Size distribution of products from screening of Tailings from Spiral D at 0.053 mm

Size mm	Feed Weight / Passing [%] / [cum. %]	Screen underflow <0.053 mm Weight / Passing [%] / [cum. %]	Screen overflow >0.053 mm Weight / Passing [%] / [cum. %]
+ 1,0	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
1,0 - 0,63	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
0,63 - 0,5	0,0 / 100,0	0,0 / 100,0	0,0 / 100,0
0,5 - 0,315	0,1 / 99,9	0,0 / 100,0	0,0 / 100,0
0,315 - 0,2	0,0 / 99,9	0,0 / 100,0	1,3 / 98,7
0,2 - 0,1	2,2 / 97,7	0,0 / 100,0	23,3 / 75,3
0,1 - 0,063	4,7 / 93,0	1,8 / 98,2	20,7 / 54,6
0,063 - 0,04	11,9 / 81,0	11,5 / 86,7	13,8 / 40,8
0,04 - 0,025	26,4 / 54,6	27,9 / 58,9	12,6 / 28,2
0,025 - 0	54,6 / 0,0	58,9 / 0,0	28,2 / 0,0
	100,0 / -	100,0 / -	100,0 / -
d_{80} [mm]	0,039	0,036	0,120
d_{50} [mm]	0,023	0,021	0,055
Spec. Surface [Blaine]	1135	1160	700
Spec. Weight [g/cm³]	4,89	5,03	3,76

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Chemical analysis of

Cleaner spiral concentrate (bulk sample) - 'Material 7'

Fe_{tot}	**[%]**	**66,7**		
FeO	[%]	0,62		
SiO_2	[%]	2,45	Cr [%]	0,0056
Al_2O_3	[%]	0,54	Co [%]	0,0005
CaO	[%]	0,6	Ni [%]	<0,0005
MgO	[%]	0,19	Cu [%]	<0,0005
P	[%]	0,175	Zn [%]	0,001
S	[%]	0,004	Pb [%]	0,0011
Na_2O	[%]	0,076	As [%]	0,0005
K_2O	[%]	0,02	Cd [%]	<0,0005
Mn	[%]	0,007	Tl [%]	<0,001
TiO_2	[%]	0,33	SrO [%]	0,0005
V	[%]	0,011	BaO [%]	0,0006
L.O.I.	[%]	0,01		

Magnetite by Satmagan	**[%]**	**1,2**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,3

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

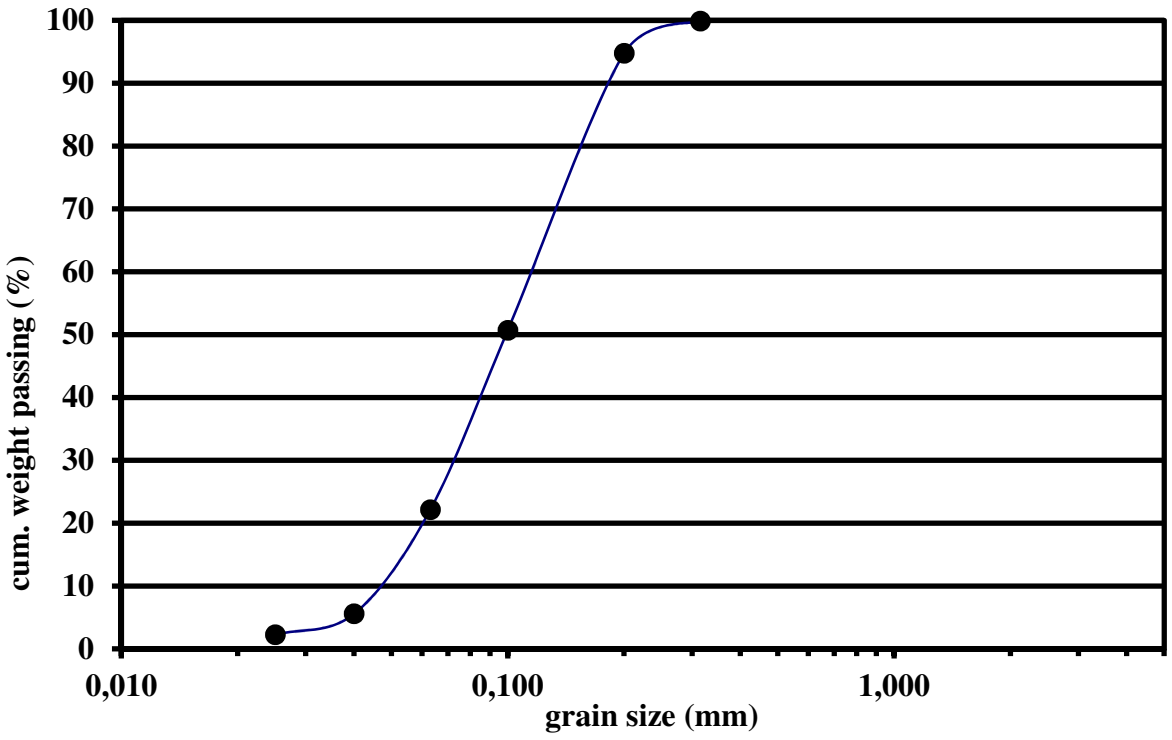
Lab scale flotation tests for apatite removal

Screen metal analysis of

Cleaner spiral concentrate (bulk sample) - 'Material 7'

Size mm	Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
+ 1,0						
1,0 - 0,63						
0,63 - 0,5						
0,5 - 0,315	0,1 / 99,9	68,0	1,25	0,102	0,280	0,0110
0,315 - 0,2	5,1 / 94,8					
0,2 - 0,1	44,1 / 50,7	65,8	3,31	0,235	0,310	0,0110
0,1 - 0,063	28,5 / 22,2	66,6	2,65	0,225	0,360	0,0110
0,063 - 0,04	16,6 / 5,6	68,4	0,90	0,062	0,325	0,0110
0,04 - 0,025	3,3 / 2,3	68,7	0,69	0,030	0,275	0,0110
0,025 - 0	2,3 / 0,0	65,3	2,26	0,065	0,260	0,0108
Calculated total	100,0	66,6	2,50	0,186	0,323	0,0110

d_{80} [mm]	0,166	Blaine [cm²/g]	780
d_{50} [mm]	0,099	Specific density [g/cm³]	5,07



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A1

With Reground rougher spiral concentrate - 'Material 6'

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH
Conditioning	Sodium silicate	500	10,0	0,0	0,0	9,3
Conditioning	Atrac 1563	30	5,0	0,0	0,0	8,5
Stage 1	Frother (MIBC)	30	0,5	1,5	1,5	8,4
Stage 2	Atrac 1563	30	2,0	1,0	2,5	8,2
Conditioning	Atrac 1563	30	0,0	0,0	2,5	8,1
Stage 3	Frother (MIBC)	30	2,0	1,0	3,5	8,1
Stage 4	·/·	0	4,0	1,0	4,5	8,1
Stage 5	Atrac 1563	60	2,0	1,0	5,5	8,2

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Reground rougher spiral concentrate - 'Material 6'											
Feed	100,0	14,4	66,2	100,0	25,3	0,149	100,0	9,1	3,04	0,30	0,010
Weight recovery and composition of products											
Froth 1	0,6	0,1	8,0	0,1	0,0	16,0	55,3	5,5	0,97	0,05	0,003
Froth 2	0,3	0,0	42,3	0,2	0,1	6,13	12,9	1,3	1,78	0,18	0,007
Froth 3	0,6	0,1	57,2	0,6	0,1	2,33	9,2	0,9	1,75	0,25	0,010
Froth 4	1,1	0,2	60,6	1,0	0,3	1,14	7,9	0,8	3,28	0,28	0,011
Froth 5	1,1	0,2	67,6	1,1	0,3	0,086	0,6	0,1	1,45	0,27	0,011
Concentrate	**96,2**	**13,9**	**66,5**	**97,0**	**24,5**	**0,024**	**14,2**	**1,4**	**3,35**	**0,30**	**0,011**
Calc. balance	100,0	14,4	65,9	100,0	25,2	0,162	100,0	9,9	3,30	0,30	0,010

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	14,4	65,9	100,0	25,2	0,162	100,0	9,9	3,30	0,30	0,010
after Stage 1	99,4	14,3	66,25	99,9	25,2	0,073	44,7	4,4	3,31	0,30	0,010
after Stage 2	99,1	14,3	66,34	99,7	25,2	0,052	31,9	3,2	3,32	0,30	0,010
after Stage 3	98,5	14,2	66,40	99,2	25,0	0,037	22,7	2,2	3,33	0,30	0,011
after Stage 4	97,3	14,0	66,46	98,1	24,8	0,025	14,8	1,5	3,33	0,30	0,011
after Stage 5	96,2	13,9	66,45	97,0	-	0,024	14,2	-	3,35	0,30	0,011
Feed	100,0	14,4	66,2	100,0	25,3	0,149	100,0	9,1	3,04	0,30	0,010
after Stage 1	99,4	14,3	66,5	99,9	25,3	0,060	39,8	3,6	3,05	0,30	0,010
after Stage 2	99,1	14,3	66,6	99,7	25,3	0,039	25,9	2,4	3,06	0,30	0,010
after Stage 3	98,5	14,2	66,6	99,2	25,1	0,024	15,9	1,4	3,06	0,30	0,010
after Stage 4	97,3	14,0	66,7	98,1	24,9	0,011	7,5	0,7	3,06	0,30	0,010
after Stage 5	96,2	13,9	66,7	97,0	24,6	0,011	6,8	0,6	3,08	0,30	0,010

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A2

With Cleaner spiral concentrate - 'Material 7'

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	9,6	Conditioning at 35,7 % solids
Conditioning	Atrac 1563	90	5,0	0,0	0,0	9,0	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	30	1,0	1,5	1,5	9,0	
Stage 2	Atrac 1563	75	2,0	1,0	2,5	8,8	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Cleaner spiral concentrate - 'Material 7'											
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
Weight recovery and composition of products											
Froth 1	1,4	0,2	38,6	0,8	0,2	7,8	63,2	6,7	0,46	0,19	0,007
Froth 2	3,3	0,5	63,6	3,2	0,8	1,43	27,5	2,9	0,55	0,32	0,011
Concentrate	**95,3**	**13,7**	**67,5**	**96,0**	**24,6**	**0,017**	**9,3**	**1,0**	**2,30**	**0,32**	**0,011**
Calc. balance	100,0	14,4	67,0	100,0	25,6	0,174	100,0	10,6	2,22	0,32	0,011

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	14,4	67,0	100,0	25,6	0,174	100,0	10,6	2,22	0,32	0,011
after Stage 1	98,6	14,2	67,37	99,2	25,4	0,065	36,8	3,9	2,24	0,32	0,011
after Stage 2	95,3	13,7	67,50	96,0	24,6	0,017	9,3	1,0	2,30	0,32	0,011
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
after Stage 1	98,6	14,2	67,3	99,2	25,4	0,081	42,2	4,9	2,16	0,33	0,011
after Stage 2	95,3	13,7	67,4	96,0	24,6	0,036	17,9	2,1	2,22	0,33	0,011

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A3

With Cleaner spiral concentrate - 'Material 7'

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	9,1	Conditioning at 58,8 % solids
Conditioning	Atrac 1563	60	2,0	0,0	0,0	8,9	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	20	0,0	1,5	1,5	8,9	
Stage 2	Atrac 1563	20	1,0	1,0	2,5	8,9	
Conditioning	Atrac 1563	20	1,0	0,0	2,5	8,9	
Stage 3	Frother (MIBC)	20	0,0	1,0	3,5	8,9	
Stage 4	Atrac 1563	20	1,0	1,0	4,5	8,8	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Cleaner spiral concentrate - 'Material 7'											
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
Weight recovery and composition of products											
Froth 1	0,4	0,1	36,2	0,2	0,1	8,5	20,1	2,2	0,52	0,18	0,006
Froth 2	0,4	0,1	25,4	0,2	0,0	11,45	28,3	3,1	0,63	0,15	0,005
Froth 3	0,4	0,1	28,9	0,2	0,0	10,35	23,3	2,5	0,84	0,17	0,006
Froth 4	0,2	0,0	40,2	0,1	0,0	6,93	7,8	0,8	1,44	0,23	0,007
Concentrate	**98,5**	**14,2**	**67,0**	**99,3**	**25,3**	**0,037**	**20,5**	**2,2**	**2,38**	**0,33**	**0,011**
Calc. balance	100,0	14,4	66,4	100,0	25,4	0,178	100,0	10,8	2,36	0,33	0,011

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	14,4	66,4	100,0	25,4	0,178	100,0	10,8	2,36	0,33	0,011
after Stage 1	99,6	14,3	66,56	99,8	25,4	0,143	79,9	8,7	2,36	0,33	0,011
after Stage 2	99,1	14,3	66,74	99,6	25,3	0,092	51,6	5,6	2,37	0,33	0,011
after Stage 3	98,7	14,2	66,90	99,4	25,3	0,051	28,3	3,1	2,38	0,33	0,011
after Stage 4	98,5	14,2	66,95	99,3	25,3	0,037	20,5	2,2	2,38	0,33	0,011
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
after Stage 1	99,6	14,3	67,0	99,8	25,5	0,155	81,3	9,4	2,15	0,33	0,011
after Stage 2	99,1	14,3	67,2	99,6	25,5	0,105	54,9	6,4	2,15	0,33	0,011
after Stage 3	98,7	14,2	67,3	99,4	25,5	0,064	33,2	3,9	2,16	0,33	0,011
after Stage 4	98,5	14,2	67,4	99,3	25,4	0,050	25,9	3,0	2,16	0,33	0,011

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A4

With Cleaner spiral concentrate - 'Material 7'

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	9,5	Conditioning at 35,7 % solids
Conditioning	Atrac 1563	50	3,0	0,0	0,0	8,9	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	40	0,0	1,5	1,5	8,8	
Conditioning	Atrac 1563	50	2,0	0,0	1,5	8,7	
Stage 2	Frother (MIBC)	20	0,0	1,5	3,0	8,7	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Cleaner spiral concentrate - 'Material 7'											
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
Weight recovery and composition of products											
Froth 1	0,2	0,0	26,0	0,1	0,0	10,8	10,3	1,2	0,99	0,14	0,003
Froth 2	0,9	0,1	29,3	0,4	0,1	10,25	47,5	5,5	0,83	0,16	0,004
Concentrate	**98,9**	**14,2**	**66,8**	**99,5**	**25,3**	**0,081**	**42,2**	**4,9**	**2,31**	**0,33**	**0,010**
Calc. balance	100,0	14,4	66,3	100,0	25,4	0,190	100,0	11,6	2,29	0,32	0,010

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	14,4	66,3	100,0	25,4	0,190	100,0	11,6	2,29	0,32	0,010
after Stage 1	99,8	14,4	66,42	99,9	25,4	0,171	89,7	10,4	2,30	0,32	0,010
after Stage 2	98,9	14,2	66,75	99,5	25,3	0,081	42,2	4,9	2,31	0,33	0,010
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
after Stage 1	99,8	14,4	66,9	99,9	25,6	0,171	89,7	10,4	2,14	0,33	0,011
after Stage 2	98,9	14,2	67,3	99,5	25,5	0,082	42,6	4,9	2,15	0,33	0,011

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A5

With Cleaner spiral concentrate - 'Material 7'

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	9,3	Conditioning at 55,6 % solids
Conditioning	Atrac 1563	100	2,5	0,0	0,0	8,9	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	30	0,0	2,0	2,0	8,8	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Cleaner spiral concentrate - 'Material 7'											
Feed	100,0	14,4	66,9	100,0	25,6	0,190	100,0	11,6	2,14	0,33	0,011
Weight recovery and composition of products											
Froth 1	1,1	0,2	26,0	0,4	0,1	10,8	60,7	7,3	0,99	0,14	0,003
Concentrate	**98,9**	**14,2**	**67,0**	**99,6**	**25,4**	**0,078**	**39,3**	**4,7**	**2,34**	**0,14**	**0,010**
Calc. balance	100,0	14,4	66,5	100,0	25,5	0,196	100,0	12,0	2,33	0,14	0,010

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

First pilot scale flotation test for apatite removal

Composition and chemical analysis of Flotation feed

		Cleaner spiral concentrate 'Material 7'	Cyclone overflow from cleaner spirals	Tailings D <0.053 mm	Flotation feed Calculated	Flotation feed Analysed
Theoretical proprotion	Weight [%v/o]	14,4	1,4	3,9	**19,7**	
	[%]	73,0	7,3	19,7	100,0	
Mixture (optimized for maximum weight)	Weight [kg]	540	49	133	722	
	[%]	74,8	6,8	18,4	100,0	
Fe_{tot}	[%]	66,7	66,10	66,10	66,55	66,45
FeO	[%]	-	-	-	-	-
SiO_2	[%]	2,45	3,11	3,49	2,69	2,72
Al_2O_3	[%]	-	-	-	-	-
CaO	[%]	-	-	-	-	-
MgO	[%]	-	-	-	-	-
P	[%]	0,175	0,078	0,099	0,154	0,157
S	[%]	-	-	-	-	-
Na_2O	[%]	-	-	-	-	-
K_2O	[%]	-	-	-	-	-
Mn	[%]	-	-	-	-	-
TiO_2	[%]	0,33	0,245	0,260	0,311	0,310
V	[%]	0,011	0,011	0,010	0,011	0,010
L.O.I.	[%]	-	-	-	-	-
Magnetite by Satmagan	[%]	1,2	4,0	1,8	1,5	1,6
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,3	4,4	2,0	1,6	1,7

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

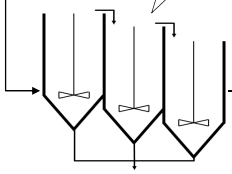
First pilot scale flotation test for apatite removal

Process overview

Flotation feed					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	66,5	1,6	2,7	0,16 % P
recovery	100,0	100,0	100,0	100,0	0,31 % TiO2
recovery v/o	19,7	34,9	1,0	1,5	0,010 % V

Flotation feed
300 kg/h

Flotation
Conditioning stage with 3 min
1st flotation stage with 3 min
2nd flotation stage with 3.6 min



Froth 1

Froth 1					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	53,4	2,3	1,9	2,79 % P
recovery	0,4	0,3	0,6	0,3	0,22 % TiO2
recovery v/o	0,1	0,1	0,0	0,0	0,009 % V

Froth 2

Froth 2					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	55,9	2,8	2,2	1,49 % P
recovery	0,5	0,4	0,9	0,4	0,23 % TiO2
recovery v/o	0,1	0,2	0,0	0,0	0,009 % V

Flotation hematite concentrate

Flotation hematite concentrate					
	Weight	Fe_{tot}	Magn.	SiO_2	
abs.	-	66,4	1,5	2,6	0,14 % P
recovery	99,1	98,9	92,9	95,8	0,31 % TiO2
recovery v/o	19,5	34,5	1,0	1,5	0,010 % V

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

First pilot scale flotation test for apatite removal

Pilot scale test

Flotation details

Flotation procedure

	Reagent	Dosage [g/t]	Conditioning time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	9,6	0,0	0,0	8,6	Conditioning at 24,2 % solids
Conditioning	Atrac 1563	100	6,0	0,0	0,0	8,4	Flotation at 24,2 % solids
Stage 1	Frother (MIBC)	30	0,0	**3,0**	3,0	8,3	
Conditioning	Atrac 1563	50	0,0	0,0	3,0	8,2	
Stage 2	Frother (MIBC)	30	0,0	**3,6**	**6,6**	8,2	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Flotation feed											
Feed	100,0	19,7	66,5	100,0	34,9	0,157	100,0	0,09	2,72	0,31	0,010
Weight recovery and composition of products											
Froth 1	0,4	0,1	53,4	0,3	0,1	2,8	7,2	0,01	1,91	0,22	0,009
Froth 2	0,5	0,1	55,9	0,4	0,2	1,49	5,0	0,00	2,18	0,23	0,009
Concentrate	**99,1**	**19,5**	**66,4**	**99,2**	**34,5**	**0,139**	**87,7**	**0,08**	**2,63**	**0,31**	**0,010**
Calc. balance	100,0	19,7	66,2	100,0	34,7	0,157	100,0	0,09	2,62	0,30	0,010

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	19,7	66,2	100,0	34,7	0,157	100,0	0,09	2,62	0,30	0,010
after Stage 1	99,6	19,6	66,29	99,7	34,6	0,146	92,8	0,08	2,63	0,30	0,010
after Stage 2	99,1	19,5	66,35	99,2	34,5	0,139	87,7	0,08	2,63	0,31	0,010
Feed	100,0	19,7	66,5	100,0	34,9	0,157	100,0	0,09	2,72	0,31	0,010
after Stage 1	99,6	19,6	66,5	99,7	34,7	0,146	92,8	0,08	2,72	0,31	0,010
after Stage 2	99,1	19,5	66,6	99,2	34,6	0,139	87,8	0,08	2,73	0,31	0,010

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

First pilot scale flotation test for apatite removal

Chemical analysis of samples taken during test

(Feed rate @ 300 kg/h)

		Feed	Products			Calc. balance
		Flotation feed	Flotation hematite concentrate	Froth 1	Froth 2	
Weight	**[%]**	100,0	**99,1**	**0,4**	**0,5**	**100,0**
Weight	**[$\%_{v/o}$]**	19,7	**19,5**	**0,1**	**0,1**	**19,7**
Fe_{tot}	[%]	66,45	**66,35**	**53,35**	**55,85**	**66,24**
Fe_{rec}	[%]	100,3	**99,2**	**0,3**	**0,4**	**100,0**
Fe_{rec}	[%]	100,0	**98,9**	**0,3**	**0,4**	**99,7**
Fe_{rec}	[$\%_{v/o}$]	34,9	**34,5**	**0,1**	**0,2**	**34,7**
Magn. by Satm.	[%]	1,6	**1,5**	**2,3**	**2,8**	**1,5**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,7	**1,6**	**3,1**	**3,6**	**1,6**
$Magn._{rec}$	[%]	105,9	**98,4**	**0,6**	**1,0**	**100,0**
$Magn._{rec}$	[%]	100,0	**92,9**	**0,6**	**0,9**	**94,4**
$Magn._{rec}$	[$\%_{v/o}$]	1,0	**1,0**	**0,0**	**0,0**	**1,0**
SiO_2	[%]	2,72	**2,63**	**1,91**	**2,18**	**2,62**
$SiO_{2\ rec}$	[%]	103,6	**99,3**	**0,3**	**0,4**	**100,0**
$SiO_{2\ rec}$	[%]	100,0	**95,8**	**0,3**	**0,4**	**96,5**
$SiO_{2\ rec}$	[$\%_{v/o}$]	1,5	**1,5**	**0,0**	**0,0**	**1,5**
P	[%]	0,157	**0,139**	**2,790**	**1,490**	**0,157**
P_{rec}	[%]	100,0	**87,7**	**7,2**	**5,0**	**100,0**
P_{rec}	[%]	100,0	**87,7**	**7,2**	**5,0**	**100,0**
P_{rec}	[$\%_{v/o}$]	13,1	**11,5**	**0,9**	**0,7**	**13,1**
TiO_2	[%]	0,31	**0,31**	**0,22**	**0,23**	**0,30**
V	[%]	0,010	**0,010**	**0,009**	**0,009**	**0,010**
d_{80}	[mm]	0,155	**0,152**	-	-	-
d_{50}	[mm]	0,080	**0,084**	-	-	-
Spec. Surface	[Blaine]	-	-	-	-	-
Spec. Weight	[g/cm³]	-	**5,08**	**4,41**	**4,42**	-

SGA-sample no.: 7451/7-2/1ff

Appendix 9.2-4

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

First pilot scale flotation test for apatite removal

Size distribution of samples taken during test

Size mm	Feed	Flotation hematite concentrate	Froth 1	Froth 2
	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]
+ 1,0			Sample too few for sctreen analysis	Sample too few for sctreen analysis
1,0 - 0,63				
0,63 - 0,5				
0,5 - 0,315				
0,315 - 0,2	4,5 / 95,5	0,0 / 100,0		
0,2 - 0,1	34,7 / 60,8	41,5 / 58,5		
0,1 - 0,063	20,2 / 40,5	20,0 / 38,5		
0,063 - 0,04	14,6 / 25,9	14,2 / 24,3		
0,04 - 0,025	8,5 / 17,4	7,8 / 16,5		
0,025 - 0	17,4 / 0,0	16,5 / 0,0		
	100,0 / -	100,0 / -	-	-
d_{80} [mm]	0,155	0,152	-	-
d_{50} [mm]	0,080	0,084	-	-
Spec. Surface [Blaine]	-	-	-	-
Spec. Weight [g/cm³]	-	5,08	4,41	4,42

Nordic Iron Ore AB

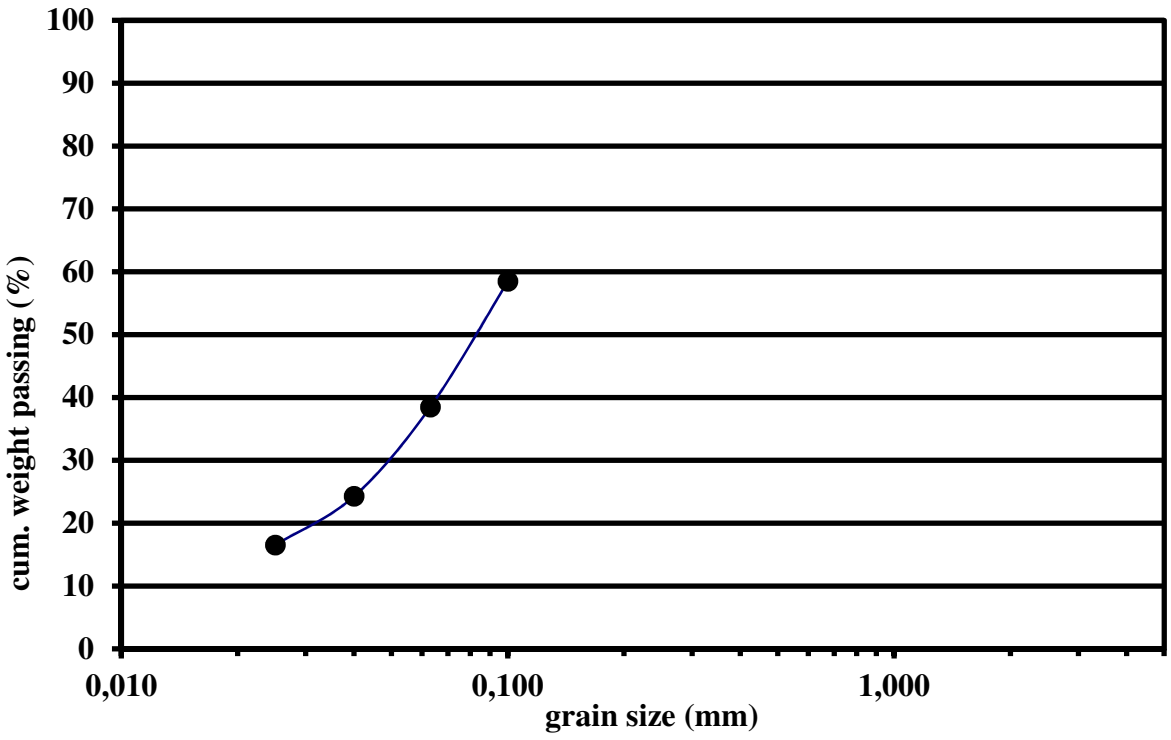
Blötberget - 8 t Pilot sample (2015/16)

First pilot scale flotation test for apatite removal

Screen metal analysis of Flotation concentrate (1st pilot test)

Size mm	Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
+ 1,0						
1,0 - 0,63						
0,63 - 0,5						
0,5 - 0,315						
0,315 - 0,2						
0,2 - 0,1	41,5 / 58,5	66,1	2,98	0,187	0,310	0,0110
0,1 - 0,063	20,0 / 38,5	66,7	2,33	0,203	0,370	0,0112
0,063 - 0,04	14,2 / 24,3	67,8	1,68	0,043	0,325	0,0111
0,04 - 0,025	7,8 / 16,5	67,9	1,64	0,027	0,275	0,0110
0,025 - 0	16,5 / 0,0	67,4	1,83	0,034	0,260	0,0110
Calculated total	100,0	66,8	2,37	0,132	0,313	0,0111

d_{80} [mm]	0,152	Blaine	[cm²/g]	-	
d_{50} [mm]	0,084	Specific density	[g/cm³]	5,08	



SGA-sample no.: 7451/5-1/100

Appendix 9.2-6

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A6

With Flotation concentrate (1st pilot test)

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	8,9	Conditioning at 35,7 % solids
Conditioning	Atrac 1563	100	3,0	0,0	0,0	8,5	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	30	0,0	1,5	1,5	8,4	
Conditioning	Atrac 1563	50	2,0	0,0	1,5	8,4	
Stage 2	Frother (MIBC)	30	0,0	1,5	3,0	8,4	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Flotation concentrate (1st pilot test)											
Feed	100,0	19,5	66,6	100,0	34,6	0,130	100,0	10,8	2,63	0,31	0,012
Weight recovery and composition of products											
Froth 1	0,8	0,2	32,9	0,4	0,1	8,9	56,9	6,2	1,25	0,15	0,006
Froth 2	0,7	0,1	51,5	0,5	0,2	3,63	18,4	2,0	1,82	0,23	0,009
Concentrate	**98,5**	**19,2**	**67,0**	**99,1**	**34,3**	**0,033**	**24,7**	**2,7**	**2,66**	**0,31**	**0,011**
Calc. balance	100,0	19,5	66,6	100,0	34,6	0,131	100,0	10,9	2,64	0,31	0,011

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	19,5	66,6	100,0	34,6	0,131	100,0	10,9	2,64	0,31	0,011
after Stage 1	99,2	19,4	66,90	99,6	34,5	0,057	43,1	4,7	2,65	0,31	0,011
after Stage 2	98,5	19,2	67,00	99,1	34,3	0,033	24,7	2,7	2,66	0,31	0,011
Feed	100,0	19,5	66,6	100,0	34,6	0,130	100,0	10,8	2,63	0,31	0,012
after Stage 1	99,2	19,4	66,9	99,6	34,5	0,056	42,5	4,6	2,64	0,31	0,012
after Stage 2	98,5	19,2	67,0	99,1	34,3	0,032	24,0	2,6	2,65	0,31	0,012

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A7

With Flotation concentrate (1st pilot test)

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	8,9	Conditioning at 35,7 % solids
Conditioning	Atrac 1563	100	3,0	0,0	0,0	8,6	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	30	0,0	1,5	1,5	8,6	
Conditioning	Atrac 1563	50	2,0	0,0	1,5	8,5	
Stage 2	Frother (MIBC)	30	0,0	1,5	3,0	8,5	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Flotation concentrate (1st pilot test) after 10 min grinding in lab rod mill											**(d80 at 0,12 mm)**
Feed	100,0	19,5	66,6	100,0	34,6	0,130	100,0	10,8	2,63	0,31	0,012
Weight recovery and composition of products											
Froth 1	1,2	0,2	42,8	0,7	0,3	5,9	50,6	5,7	2,30	0,19	0,007
Froth 2	0,5	0,1	31,3	0,2	0,1	8,40	30,5	3,4	3,58	0,17	0,006
Concentrate	**98,3**	**19,2**	**67,1**	**99,0**	**34,3**	**0,026**	**18,9**	**2,1**	**2,65**	**0,31**	**0,011**
Calc. balance	100,0	19,5	66,6	100,0	34,6	0,135	100,0	11,2	2,65	0,31	0,011

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	19,5	66,6	100,0	34,6	0,135	100,0	11,2	2,65	0,31	0,011
after Stage 1	98,8	19,3	66,92	99,3	34,4	0,068	49,4	5,5	2,65	0,31	0,011
after Stage 2	98,3	19,2	67,10	99,0	34,3	0,026	18,9	2,1	2,65	0,31	0,011
Feed	100,0	19,5	66,6	100,0	34,6	0,130	100,0	10,8	2,63	0,31	0,012
after Stage 1	98,8	19,3	66,9	99,3	34,4	0,062	47,3	5,1	2,63	0,31	0,012
after Stage 2	98,3	19,2	67,1	99,0	34,3	0,021	15,8	1,7	2,63	0,31	0,012

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Lab scale flotation tests for apatite removal

Lab scale flotation test #A8

With Flotation concentrate (1st pilot test)

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	8,6	Conditioning at 35,7 % solids
Conditioning	Atrac 1563	100	3,0	0,0	0,0	8,2	Flotation at 35,7 % solids
Stage 1	Frother (MIBC)	30	0,0	1,5	1,5	8,1	
Conditioning	Atrac 1563	50	2,0	0,0	1,5	8,1	
Stage 2	Frother (MIBC)	30	0,0	1,5	3,0	8,1	

Test sample: Flotation concentrate (1st pilot test) after 25 min grinding in lab rod mill

(d80 at 0,083 mm)

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Feed	100,0	19,5	66,6	100,0	34,6	0,130	100,0	10,8	2,63	0,31	0,012

Weight recovery and composition of products

Froth 1	1,8	0,3	40,9	1,1	0,4	6,5	88,9	9,5	1,99	0,19	0,007
Froth 2	1,0	0,2	63,2	1,0	0,3	0,35	2,8	0,3	3,61	0,28	0,011
Concentrate	**97,2**	**19,0**	**66,9**	**97,9**	**33,8**	**0,011**	**8,3**	**0,9**	**2,68**	**0,31**	**0,011**
Calc. balance	100,0	19,5	66,4	100,0	34,5	0,129	100,0	10,7	2,68	0,31	0,011

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	19,5	66,4	100,0	34,5	0,129	100,0	10,7	2,68	0,31	0,011
after Stage 1	98,2	19,2	66,86	98,9	34,1	0,015	11,1	1,2	2,69	0,31	0,011
after Stage 2	97,2	19,0	66,90	97,9	33,8	0,011	8,3	0,9	2,68	0,31	0,011
Feed	100,0	19,5	66,6	100,0	34,6	0,130	100,0	10,8	2,63	0,31	0,012
after Stage 1	98,2	19,2	67,1	98,9	34,2	0,015	11,6	1,3	2,64	0,31	0,012
after Stage 2	97,2	19,0	67,1	97,9	33,9	0,012	8,8	1,0	2,63	0,31	0,012

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Composition and chemical analysis of Flotation feed

		Residuals from Cells (1st test)	Froth (1st test)	Flotation concentrate (1st test)	Recombined Flotation feed Calculated	analysed	1st feed
Theoretical proprotion	Weight [kg]	40,0	60,0	353,0		**453,0**	
	[%]	8,8	13,2	77,9		100,0	
Mixture (optimized for similar chem. composition)	Weight [kg]	40,6	**40**	363		443,6	
	[%]	9,2	9,0	81,8		100,0	
	Fe_{tot} [%]	65,6	64,50	66,63	66,34	**66,40**	66,45
	FeO [%]	-	-	-	-	**-**	-
	SiO_2 [%]	4,26	3,12	2,63	2,82	**2,77**	2,72
	Al_2O_3 [%]	-	-	-	-	**-**	-
	CaO [%]	-	-	-	-	**-**	-
	MgO [%]	-	-	-	-	**-**	-
	P [%]	0,035	0,540	0,130	0,158	**0,157**	0,157
	S [%]	-	-	-	-	**-**	-
	Na_2O [%]	-	-	-	-	**-**	-
	K_2O [%]	-	-	-	-	**-**	-
	Mn [%]	-	-	-	-	**-**	-
	TiO_2 [%]	0,29	0,280	0,310	0,305	**0,310**	0,310
	V [%]	0,0108	0,010	0,012	0,011	**0,012**	0,010
	L.O.I. [%]	-	-	-	-	**-**	-
Magnetite by Satmagan	[%]	1,2	4,0	1,8	2,0	**1,6**	1,6
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,3	4,5	2,0	2,2	**1,7**	1,7

SGA-sample no.: 7451/710

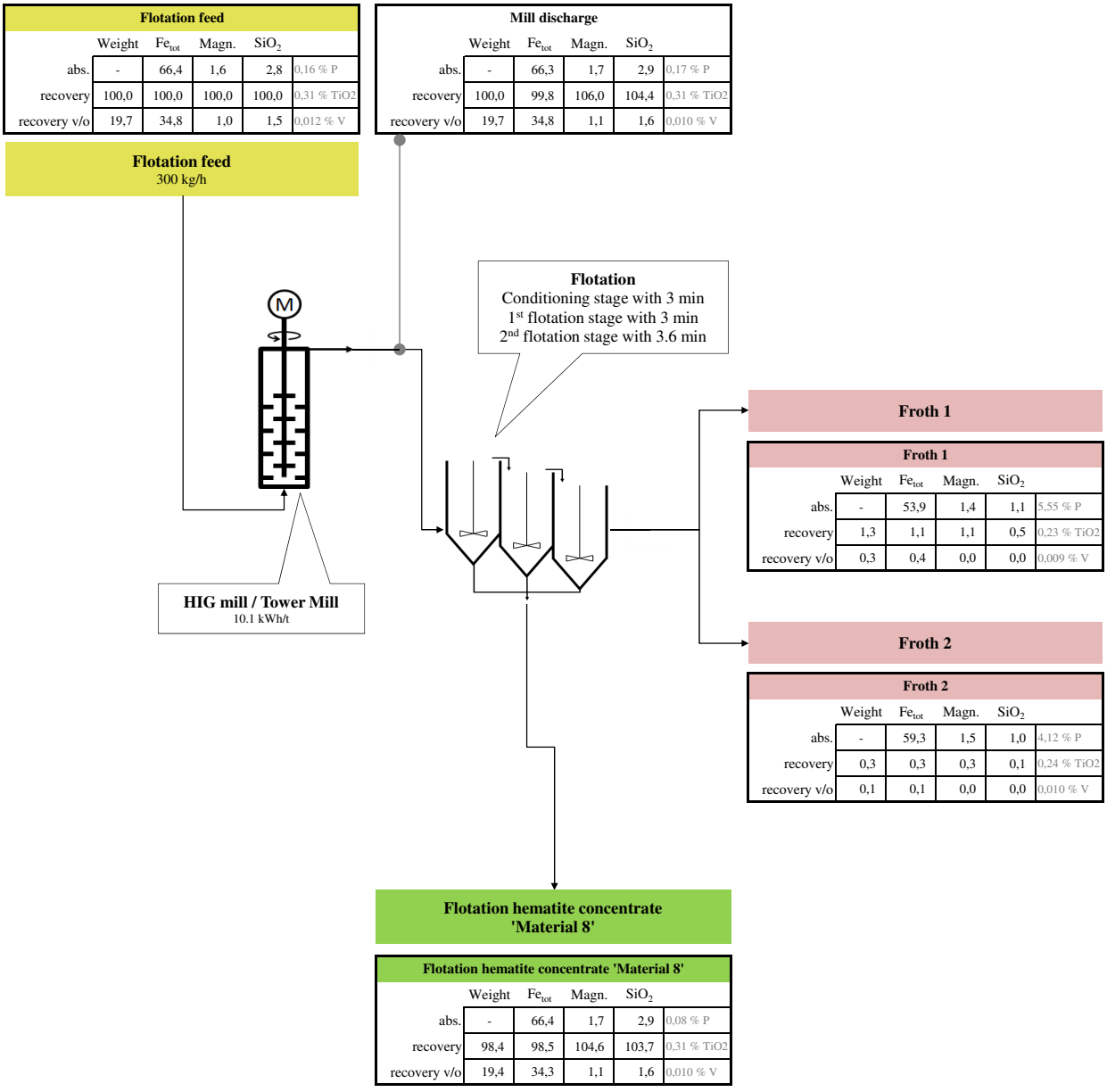
Appendix 9.4-1

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Process overview



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Pilot scale test

Flotation details

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	9,6	0,0	0,0		Conditioning at 27,2 % solids
Conditioning	Atrac 1563	100	6,0	0,0	0,0		Flotation at 27,2 % solids
Stage 1	Frother (MIBC)	30	0,0	**3,0**	3,0		
Conditioning	Atrac 1563	50	0,0	0,0	3,0		
Stage 2	Frother (MIBC)	30	0,0	**3,6**	**6,6**		

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Flotation feed											
Feed	100,0	19,7	66,4	100,0	34,8	0,157	100,0	0,09	2,77	0,31	0,012
Weight recovery and composition of products											
Froth 1	1,3	0,3	53,9	1,1	0,4	5,6	43,3	0,04	1,13	0,23	0,009
Froth 2	0,3	0,1	59,3	0,3	0,1	4,12	7,6	0,01	0,99	0,24	0,010
Concentrate	**98,4**	**19,4**	**66,4**	**98,7**	**34,3**	**0,083**	**49,1**	**0,05**	**2,92**	**0,31**	**0,010**
Calc. balance	100,0	19,7	66,3	100,0	34,8	0,166	100,0	0,09	2,89	0,31	0,010

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	19,7	66,3	100,0	34,8	0,166	100,0	0,09	2,89	0,31	0,010
after Stage 1	98,7	19,5	66,42	98,9	34,4	0,096	56,7	0,05	2,91	0,31	0,010
after Stage 2	98,4	19,4	66,44	98,7	34,3	0,083	49,1	0,05	2,92	0,31	0,010
Feed	100,0	19,7	66,4	100,0	34,8	0,157	100,0	0,09	2,77	0,31	0,012
after Stage 1	98,7	19,5	66,6	98,9	34,5	0,086	54,1	0,05	2,79	0,31	0,012
after Stage 2	98,4	19,4	66,6	98,7	34,4	0,073	46,0	0,04	2,80	0,31	0,012

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Chemical analysis of samples taken during test

(Feed rate @ 300 kg/h)

		Feed	Products			Calc. balance	
		Flotation feed (recombined)	Flotation hematite concentrate	Froth 1	Froth 2		Mill discahrge
Weight	**[%]**	100,0	**98,4**	**1,3**	**0,3**	**100,0**	100,0
Weight	**[$\%_{v/o}$]**	19,7	**19,4**	**0,3**	**0,1**	**19,7**	19,7
Fe_{tot}	[%]	66,40	**66,44**	**53,90**	**59,30**	**66,26**	66,50
Fe_{rec}	[%]	100,2	**98,7**	**1,1**	**0,3**	**100,0**	100,4
Fe_{rec}	[%]	100,0	**98,5**	**1,1**	**0,3**	**99,8**	100,2
Fe_{rec}	[$\%_{v/o}$]	34,8	**34,3**	**0,4**	**0,1**	**34,8**	34,9
Magn. by Satm.	[%]	1,6	**1,7**	**1,4**	**1,5**	**1,7**	1,7
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,7	**1,8**	**1,9**	**1,8**	**1,9**	1,8
$Magn._{rec}$	[%]	94,4	**98,7**	**1,1**	**0,3**	**100,0**	100,3
$Magn._{rec}$	[%]	100,0	**104,6**	**1,1**	**0,3**	**106,0**	106,3
$Magn._{rec}$	[$\%_{v/o}$]	1,0	**1,1**	**0,0**	**0,0**	**1,1**	1,1
SiO_2	[%]	2,77	**2,92**	**1,13**	**0,99**	**2,89**	2,87
$SiO_{2\ rec}$	[%]	95,8	**99,4**	**0,5**	**0,1**	**100,0**	99,3
$SiO_{2\ rec}$	[%]	100,0	**103,7**	**0,5**	**0,1**	**104,4**	103,6
$SiO_{2\ rec}$	[$\%_{v/o}$]	1,5	**1,6**	**0,0**	**0,0**	**1,6**	1,6
P	[%]	0,157	**0,083**	**5,550**	**4,120**	**0,166**	0,165
P_{rec}	[%]	94,3	**49,1**	**43,3**	**7,6**	**100,0**	99,1
P_{rec}	[%]	100,0	**52,0**	**45,9**	**8,1**	**106,0**	105,1
P_{rec}	[$\%_{v/o}$]	13,1	**6,8**	**6,0**	**1,1**	**13,9**	13,8
TiO_2	[%]	0,31	**0,31**	**0,23**	**0,24**	**0,31**	0,31
V	[%]	0,012	**0,010**	**0,009**	**0,010**	**0,010**	0,011
d_{80}	[mm]	0,137	**0,110**	**0,089**		-	0,106
d_{50}	[mm]	0,066	**0,058**	**0,045**		-	0,057
Spec. Surface	[Blaine]	720	**845**	-	-	-	845
Spec. Weight	[g/cm³]	5,08	**5,05**	**4,55**	**4,76**	-	5,04

SGA-sample no.: 7451/8-1/1ff

Appendix 9.4-4

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Size distribution of samples taken during test

Size mm	Feed	Flotation hematite concentrate	Froth 1	Froth 2	Mill discahrge
	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]	Weight / Passing [%] / [cum. %]		Weight / Passing [%] / [cum. %]
+ 1,0			Screen analysis from combined product pile		
1,0 - 0,63					
0,63 - 0,5					
0,5 - 0,315					
0,315 - 0,16	11,9 / 88,1	2,8 / 97,2	0,8 / 99,2		4,4 / 95,6
0,16 - 0,1	20,7 / 67,4	20,8 / 76,4	12,2 / 87,0		17,4 / 78,1
0,1 - 0,063	19,0 / 48,4	22,4 / 54,0	23,7 / 63,3		24,9 / 53,2
0,063 - 0,04	14,7 / 33,7	17,5 / 36,4	17,5 / 45,8		13,1 / 40,2
0,04 - 0,025	10,0 / 23,7	9,9 / 26,6	11,7 / 34,1		14,6 / 25,5
0,025 - 0	23,7 / 0,0	26,6 / 0,0	34,1 / 0,0		25,5 / 0,0
	100,0 / -	100,0 / -	100,0 / -		100,0 / -
d_{80} [mm]	0,137	0,110	0,089		0,106
d_{50} [mm]	0,066	0,058	0,045		0,057
Spec. Surface [Blaine]	720	845	-	-	845
Spec. Weight [g/cm³]	5,08	5,05	4,55	4,76	5,04

Nordic Iron Ore AB

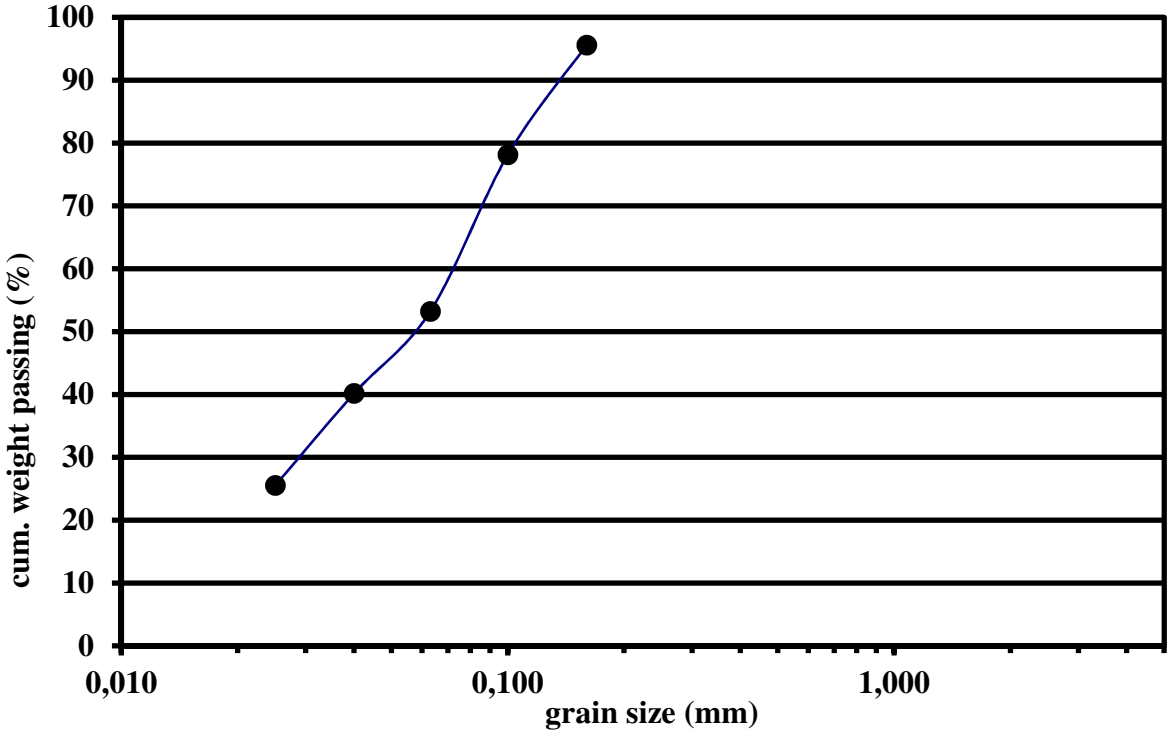
Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Screen metal analysis of Mill discharge (2nd pilot test)

Size mm			Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
	+	1,0						
1,0	-	0,63						
0,63	-	0,5						
0,5	-	0,315						
0,315	-	0,16	4,4 / 95,6	65,2	4,15	0,175	0,280	0,0120
0,16	-	0,1	17,4 / 78,1	64,7	4,60	0,220	0,300	0,0110
0,1	-	0,063	24,9 / 53,2	65,6	3,35	0,260	0,355	0,0110
0,063	-	0,04	13,1 / 40,2	67,5	1,77	0,112	0,325	0,0120
0,04	-	0,025	14,6 / 25,5	67,3	2,15	0,090	0,290	0,0120
0,025	-	0	25,5 / 0,0	67,3	1,93	0,076	0,260	0,0110
Calculated total			100,0	66,4	2,86	0,158	0,304	0,0113

d_{80} [mm]	0,106	Blaine [cm²/g]	845
d_{50} [mm]	0,057	Specific density [g/cm³]	5,04



SGA-sample no.: 7451/5-1/100

Appendix 9.4-6

Nordic Iron Ore AB

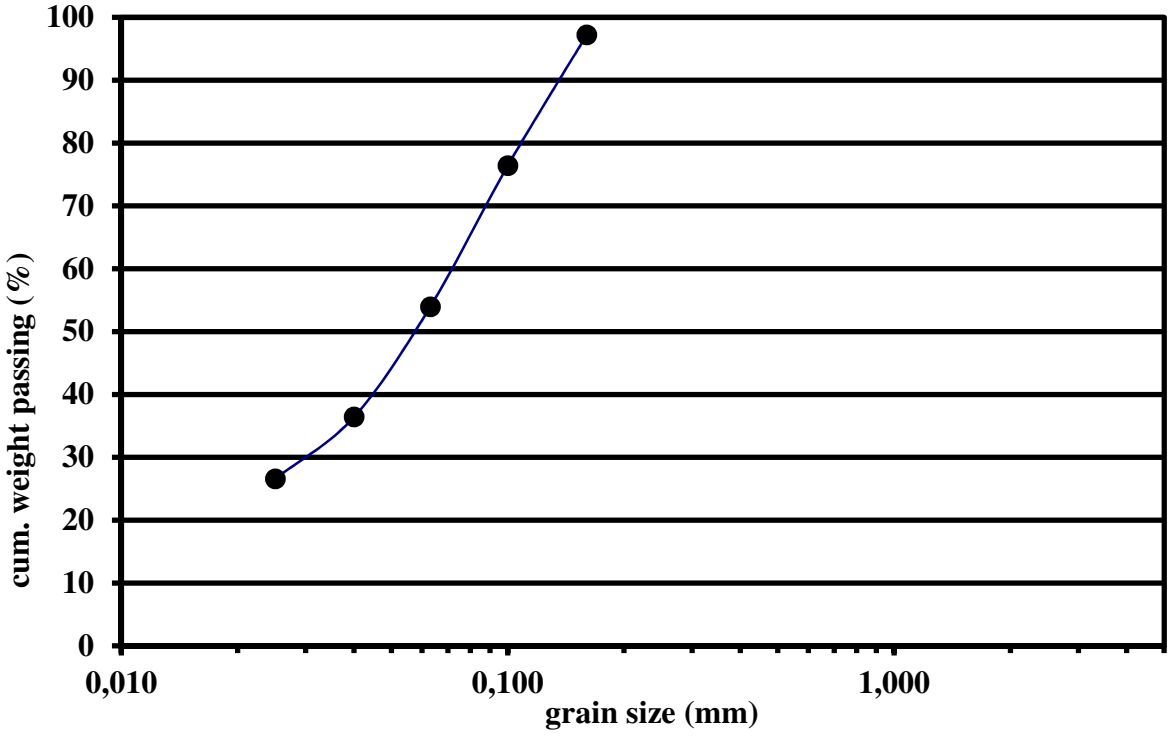
Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Screen metal analysis of Flotation concentrate (2nd pilot test)

Size mm	Weight % / Passing cum. %	Fe_{tot} [%]	SiO_2 [%]	P [%]	TiO_2 [%]	V [%]
+ 1,0						
1,0 - 0,63						
0,63 - 0,5						
0,5 - 0,315						
0,315 - 0,16	2,8 / 97,2	62,3	4,25	0,226	0,285	0,0130
0,16 - 0,1	20,8 / 76,4	64,6	4,89	0,184	0,310	0,0110
0,1 - 0,063	22,4 / 54,0	66,2	2,99	0,162	0,355	0,0120
0,063 - 0,04	17,5 / 36,4	67,6	2,03	0,037	0,325	0,0120
0,04 - 0,025	9,9 / 26,6	67,9	1,82	0,019	0,285	0,0120
0,025 - 0	26,6 / 0,0	67,4	2,03	0,029	0,265	0,0120
Calculated total	100,0	66,5	2,88	0,097	0,308	0,0118

d_{80} [mm]	0,110	Blaine [cm²/g]	845
d_{50} [mm]	0,058	Specific density [g/cm³]	5,05



SGA-sample no.: 7451/5-1/100

Appendix 9.4-7

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Lab scale flotation test #A9

With Mill discharge (2nd pilot test)

Flotation procedure

	Reagent	Dosage [g/t]	Conditio time [min]	Flotation time [min]	Cumulated flot. time [min]	pH	
Conditioning	Sodium silicate	500	10,0	0,0	0,0	9,3	Conditioning at 27,1 % solids
Conditioning	Atrac 1563	100	3,0	0,0	0,0	9,0	Flotation at 27,1 % solids
Stage 1	Frother (MIBC)	30	0,0	1,5	1,5	9,0	
Conditioning	Atrac 1563	50	**0,0**	0,0	1,5	8,9	
Stage 2	Frother (MIBC)	30	0,0	1,5	3,0	8,9	

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Test sample: Mill discharge (2nd pilot test)											
											(d80 at 0,106 mm)
Feed	100,0	19,7	66,5	100,0	34,9	0,165	100,0	13,8	2,87	0,31	0,011
Weight recovery and composition of products											
Froth 1	8,7	1,7	62,2	8,2	2,9	1,7	85,0	12,1	0,72	0,26	0,011
Froth 2	4,7	0,9	67,7	4,9	1,7	0,14	3,9	0,6	1,13	0,29	0,012
Concentrate	**86,5**	**17,1**	**66,6**	**86,9**	**30,2**	**0,022**	**11,1**	**1,6**	**3,25**	**0,32**	**0,012**
Calc. balance	100,0	19,7	66,2	100,0	34,7	0,171	100,0	14,3	2,93	0,31	0,012

Calculation of remaining concentrate after respective flotation stage

	weight [%]	v/o [$\%_{v/o}$]	Fe [%]	$Fe_{rec.}$ [%]	$Fe_{rec.}$ [$\%_{v/o}$]	P [%]	P_{rec} [%]	P_{rec} [$\%_{v/o}$]	SiO_2 [%]	TiO_2 [%]	V [%]
Calc. balance	100,0	19,7	66,2	100,0	34,7	0,171	100,0	14,3	2,93	0,31	0,012
after Stage 1	91,3	18,0	66,61	91,8	31,9	0,028	15,0	2,1	3,14	0,32	0,012
after Stage 2	86,5	17,1	66,55	86,9	30,2	0,022	11,1	1,6	3,25	0,32	0,012
Feed	100,0	19,7	66,5	100,0	34,9	0,165	100,0	13,8	2,87	0,31	0,011
after Stage 1	91,3	18,0	66,9	91,8	32,0	0,022	12,1	1,7	3,08	0,31	0,011
after Stage 2	86,5	17,1	66,9	87,0	30,3	0,016	8,2	1,1	3,18	0,32	0,011

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Chemical analysis of

Flotation Hematite Concentrate (product pile) - 'Material 8'

Fe_{tot}	**[%]**	**66,45**		
FeO	[%]	1,11		
SiO_2	[%]	3,0	Cr [%]	0,0137
Al_2O_3	[%]	0,6	Co [%]	<0,0005
CaO	[%]	0,395	Ni [%]	0,0024
MgO	[%]	0,2	Cu [%]	0,0008
P	[%]	0,096	Zn [%]	0,0019
S	[%]	0,008	Pb [%]	0,0018
Na_2O	[%]	0,091	As [%]	0,0017
K_2O	[%]	0,02	Cd [%]	<0,0005
Mn	[%]	0,015	Tl [%]	<0,001
TiO_2	[%]	0,31	SrO [%]	0,0007
V	[%]	0,0105	BaO [%]	0,0008
L.O.I.	[%]	0,05		

Magnetite by Satmagan	**[%]**	**1,7**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	1,8

Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

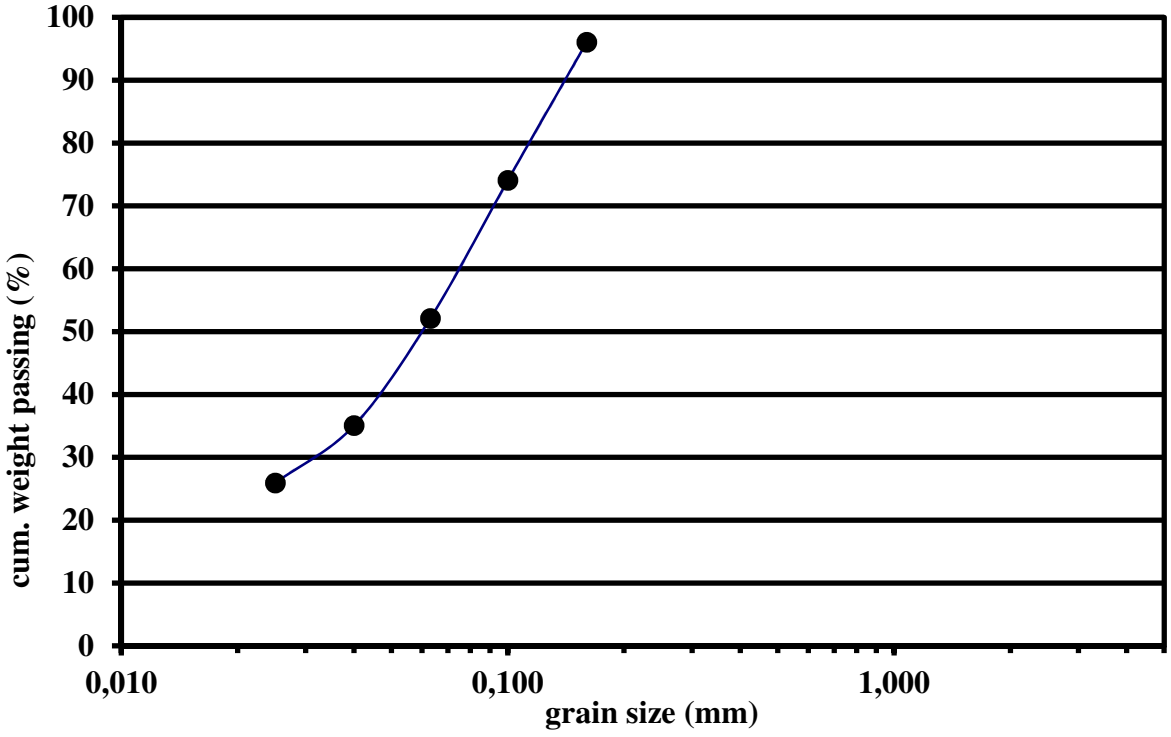
Second pilot scale flotation test for apatite removal

Screen analysis of

Flotation Hematite Concentrate (product pile) - 'Material 8'

Size mm			Weight %	/	Passing cum. %
	+	1,0			
1,0	-	0,63			
0,63	-	0,5			
0,5	-	0,315			
0,315	-	0,16	3,9	/	96,1
0,16	-	0,1	22,0	/	74,1
0,1	-	0,063	22,0	/	52,1
0,063	-	0,04	17,0	/	35,1
0,04	-	0,025	9,1	/	25,9
0,025	-	0	25,9	/	0,0
Calculated total			100,0		

d_{80}	[mm]	0,116	Blaine	[cm²/g]	760
d_{50}	[mm]	0,060	Specific density	[g/cm³]	5,06



Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Second pilot scale flotation test for apatite removal

Combined final concentrates

		Feed	Products		Calc. balance
		ROM sample	Cleaner LIMS Concentrate 'Material 5'	Flotation Hematite Concentrate 'Material 8'	
Weight	**[%]**	-	**61,2**	**38,8**	**100,0**
Weight	**[$\%_{v/o}$]**	100,0	**30,6**	**19,4**	**50,0**
Fe_{tot}	[%]	37,60	**70,55**	**66,44**	**68,96**
Fe_{rec}	[%]	-	**62,6**	**37,4**	**100,0**
Fe_{rec}	[%]	-	**-**	**-**	**-**
Fe_{rec}	[$\%_{v/o}$]	100,0	**57,4**	**34,3**	**91,7**
Magn. by Satm.	[%]	30,3	**93,9**	**1,7**	**58,1**
$Fe_{bound\ to.\ Magn.}$ / Fe_{tot}	[%]	-	**96,2**	**1,8**	**60,9**
$Magn._{rec}$	[%]	-	**98,9**	**1,1**	**100,0**
$Magn._{rec}$	[%]	-	**-**	**-**	**-**
$Magn._{rec}$	[$\%_{v/o}$]	100,0	**94,8**	**1,1**	**95,9**
SiO_2	[%]	35,35	**1,15**	**2,92**	**1,84**
$SiO_{2\ rec}$	[%]	-	**38,3**	**61,7**	**100,0**
$SiO_{2\ rec}$	[%]	-	**-**	**-**	**-**
$SiO_{2\ rec}$	[$\%_{v/o}$]	100,0	**1,0**	**1,6**	**2,6**
P	[%]	0,236	**0,033**	**0,083**	**0,052**
P_{rec}	[%]	-	**38,5**	**61,5**	**100,0**
P_{rec}	[%]	-	**-**	**-**	**-**
P_{rec}	[$\%_{v/o}$]	100,0	**4,3**	**6,8**	**11,1**
TiO_2	[%]	0,185	**0,084**	**0,310**	**0,172**
V	[%]	0,022	**0,057**	**0,010**	**0,039**
d_{80}	[mm]	-	**0,131**	**0,110**	**0,123**
d_{50}	[mm]	-	**0,052**	**0,058**	**0,054**
Spec. Surface	[Blaine]	-	**830**	**845**	**836**
Spec. Weight	[g/cm³]	-	**5,09**	**5,05**	**5,07**

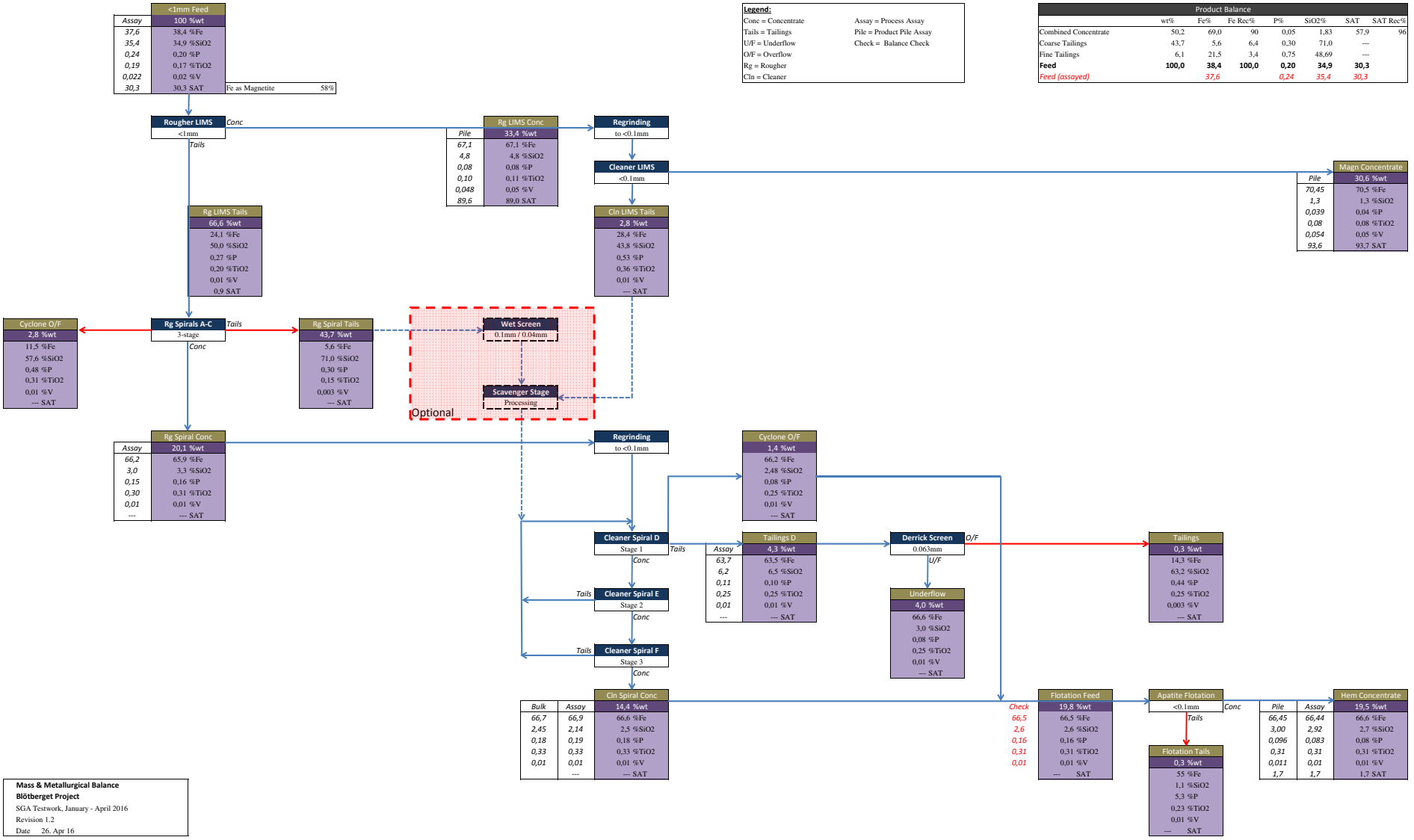
Nordic Iron Ore AB

Blötberget - 8 t Pilot sample (2015/16)

Summary

Processing balance of Blötberget project

based on testwork results from this project, provided by Tata Steel Consulting



Appendix 10-1

Nordic Iron Ore AB
Blötberget - 3 ROM sub-samples (18 t total, 2015)

Jaw Crusher

Ratzinger Type	Inlet port	400 x 250 mm
B 1415/25	Instal. electrical power	15 kW
	Jaw setting	

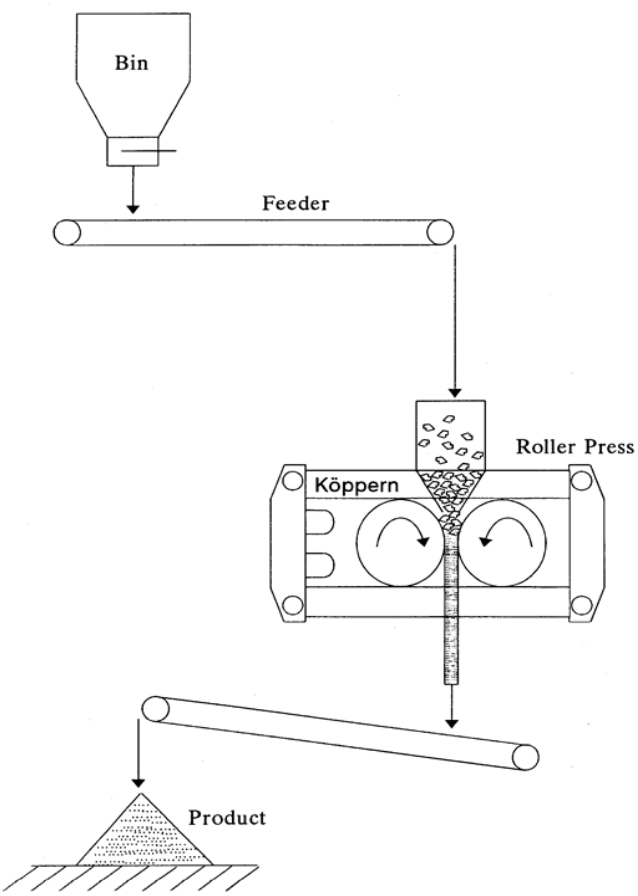
Appendix E-1

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

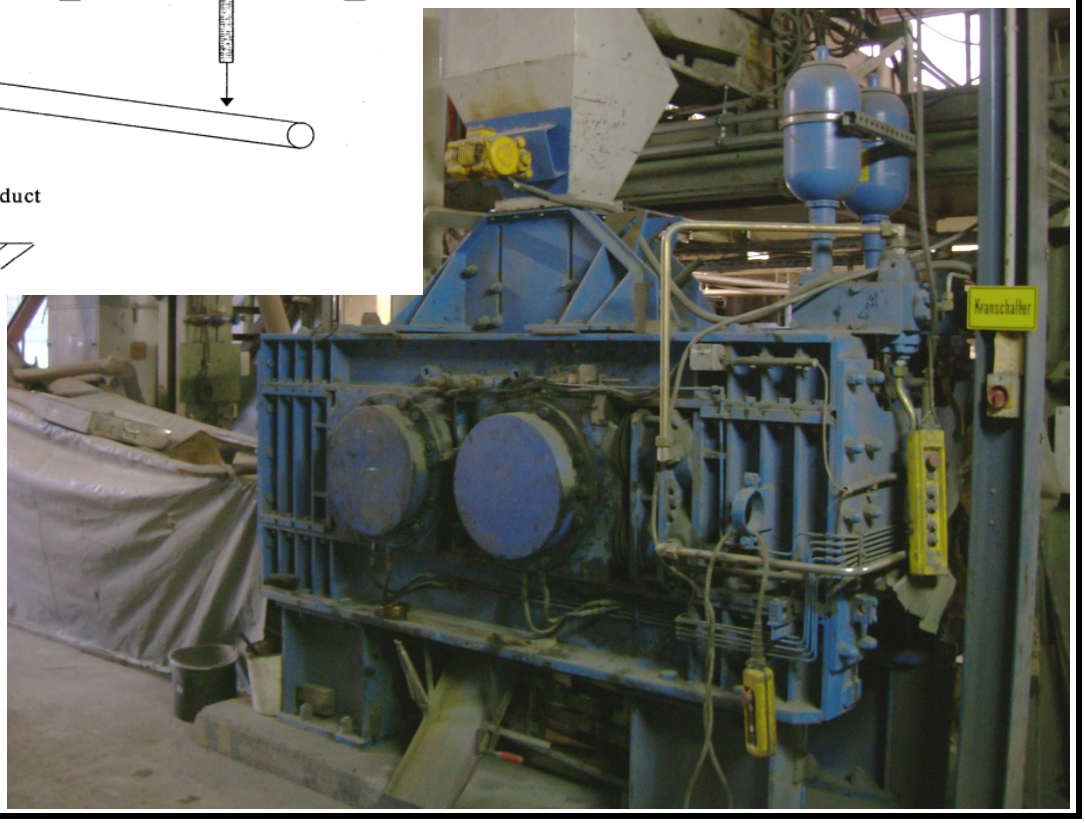
High Pressure Grinding Rolls (HPGR)

Manufactorer **Köppern**

Type 2 / 6,5 - 230



Roller diameter	650 mm
Working width	230 mm
Roller speed	15 - 30 min^{-1}
Circumferential speed	0,5 - 1,0 m/s
Roll surface	Stud lining
Specific pressing force	up to 8000 kN/m²
Total pressing force	up to 1196 kN
Power of main drive	90 kW
Feeding device	Filling funnel
Throughput for Iron Ore	up to 25 t/h



Appendix E-2

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Dry screen

Främbs & Freudenberg
(1954)

Length	1200 mm
Width	600 mm
Screen	single screen
Cut size	between 0,315 and 10 mm
Oscillation	1420 min^{-1}
Feeding by shaking trough	

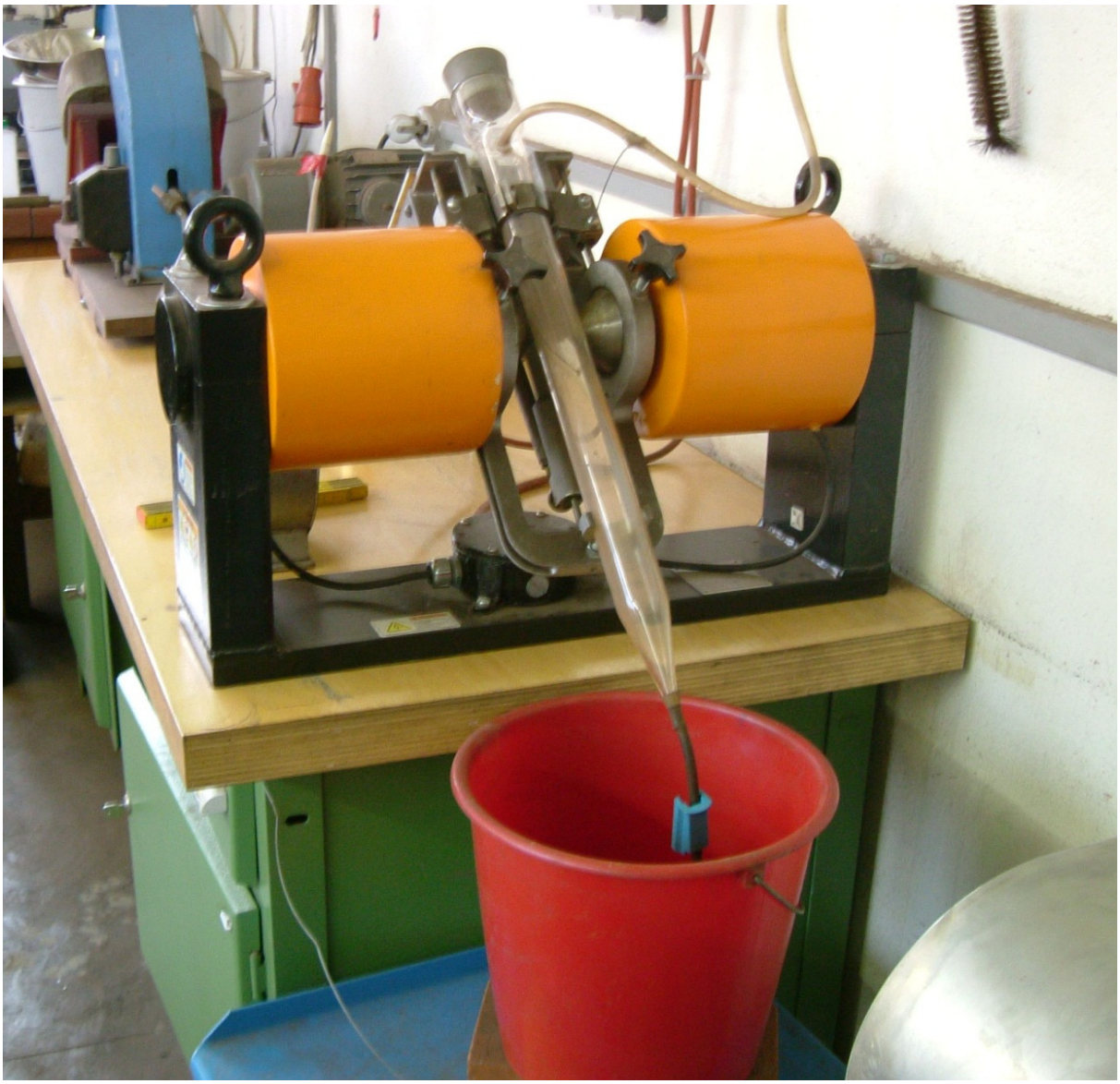
Appendix E-3

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Davis Tube

Eriez Model EDT

Tube diameter	38	mm
Inclination of the tube	50°	
Frequency of strokes	120	/min
Field strenght	3500	Gauss
Feed weight	10	g
Waterflow	1,5	l/min
Test time	10	min



Appendix E-4

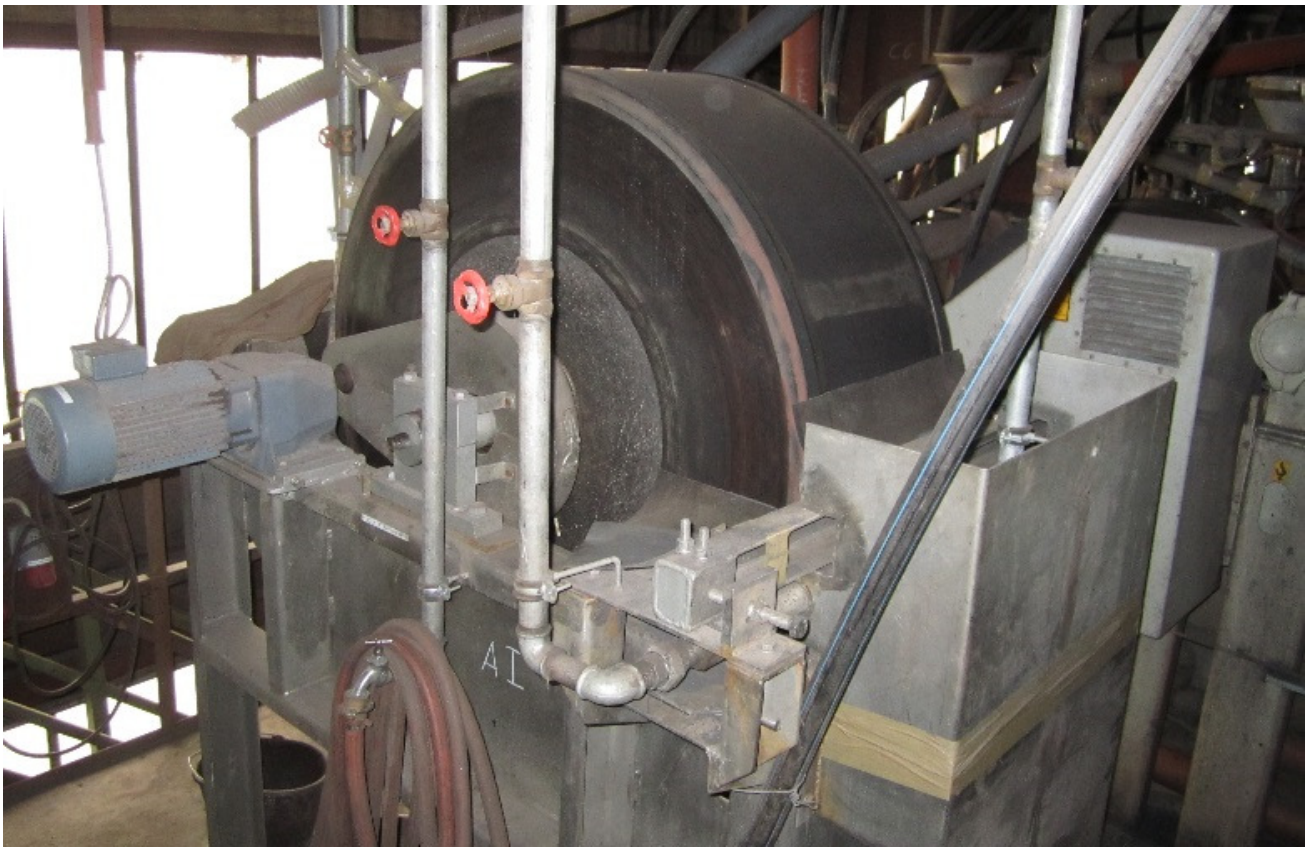
Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Pilot Plant Wet Medium Intensity Magnetic Separator

FST Type FPMWS 1203-Separator (wet)

(1-stage separator, especially for Cobber stage)

Diameter	1200	mm
Width	300	mm
Field strenght	3500	Gauss
Speed of rotation	28	rpm
Tank	Concurrent	



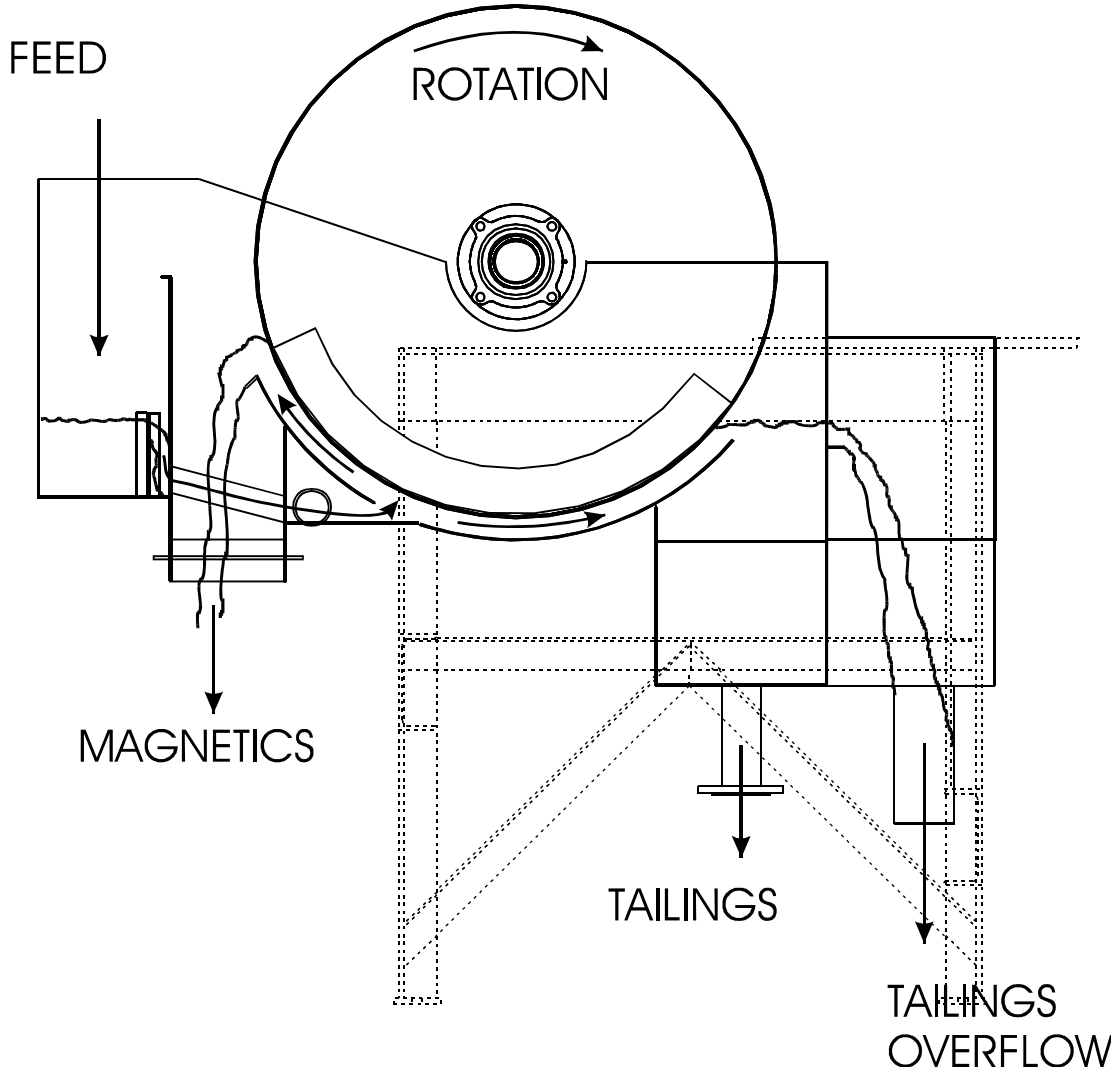
Appendix E-5

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Pilot Plant Low Intensity Magnetic Separator

Eriez Type
(1-stage separator,
especially for Rougher stage)

Diameter	1200	mm
Width	450	mm
Field strenght	1000	Gauss in 30 mm distance
Pulpflow	10 - 15	m³/h for each stage
Tank	Countercurrent	



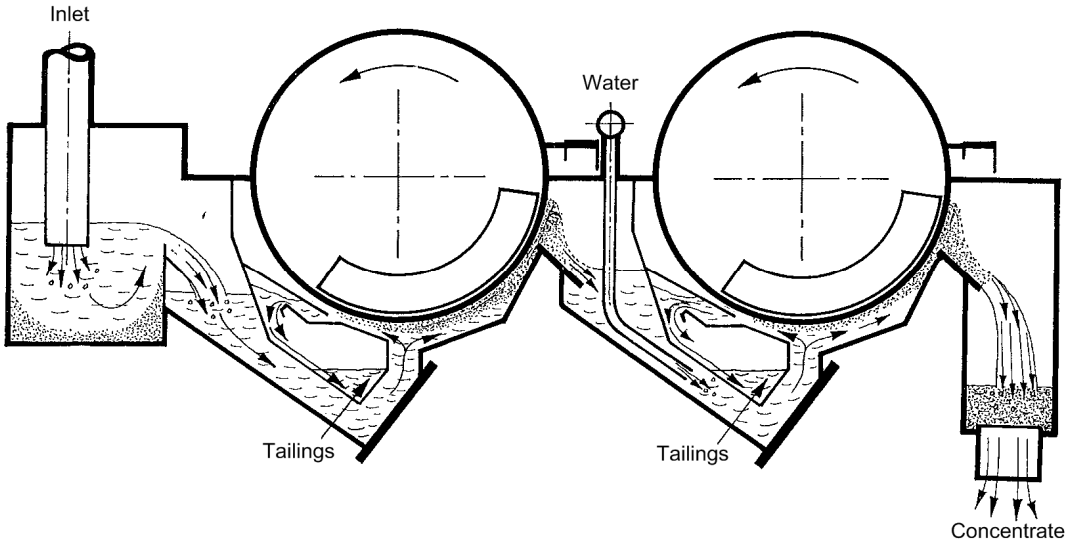
Appendix E-6

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Pilot Plant Low Intensity Magnetic Separator

Sala Type
(2-stage separator,
especially for Cleaner stage)

Diameter	916	mm
Width	300	mm
Field strenght	600	Gauss in 30 mm distance
Pulpflow	10 - 15	m³/h for each stage
Tank	Countercurrent	



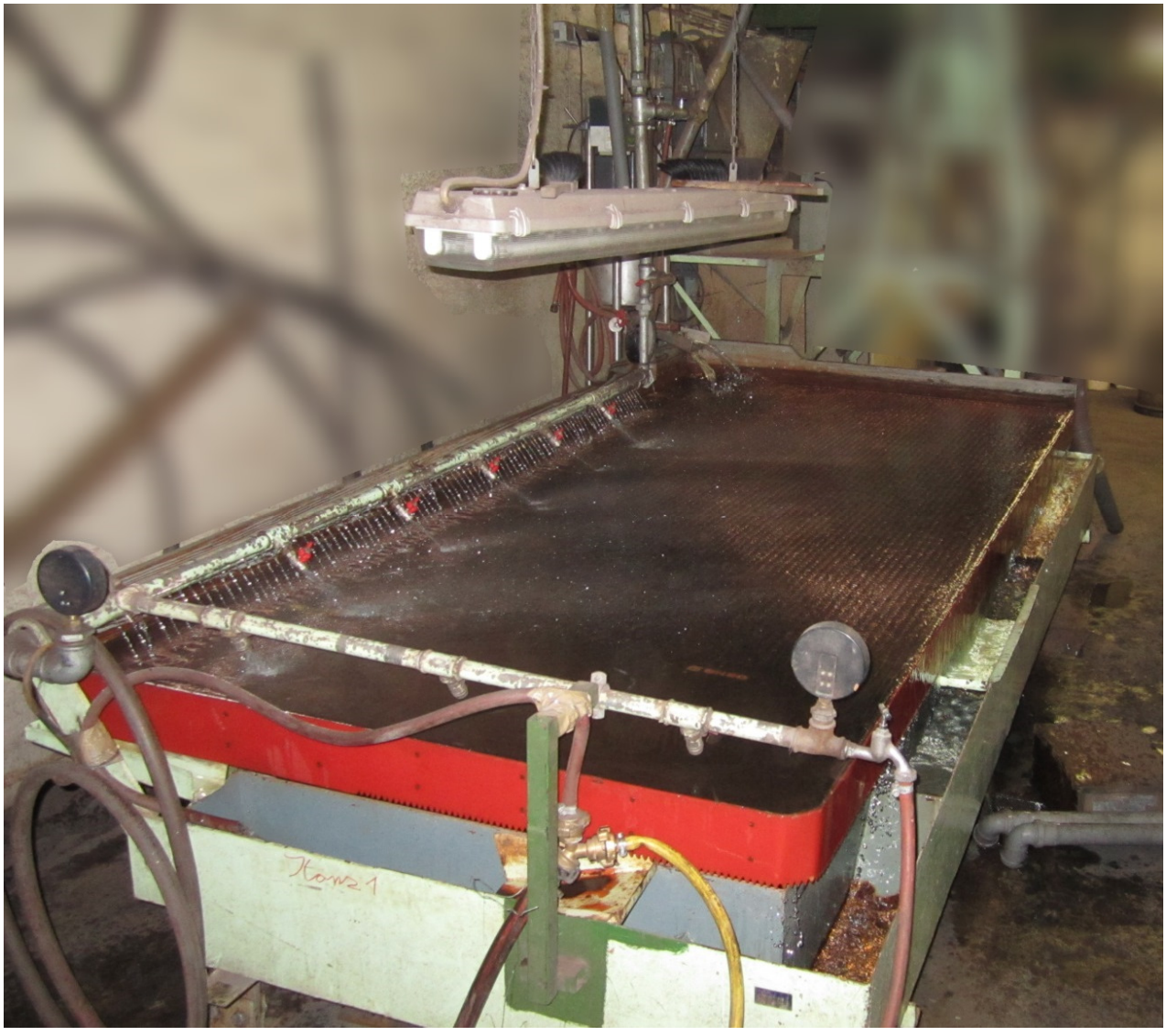
Appendix E-7

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Shaking table

Humboldt Wedag

Length	3.2 m
Width	1.3 m
Capacity	100-200 kg/h
Oscillation	330 min^{-1}



Appendix E-8

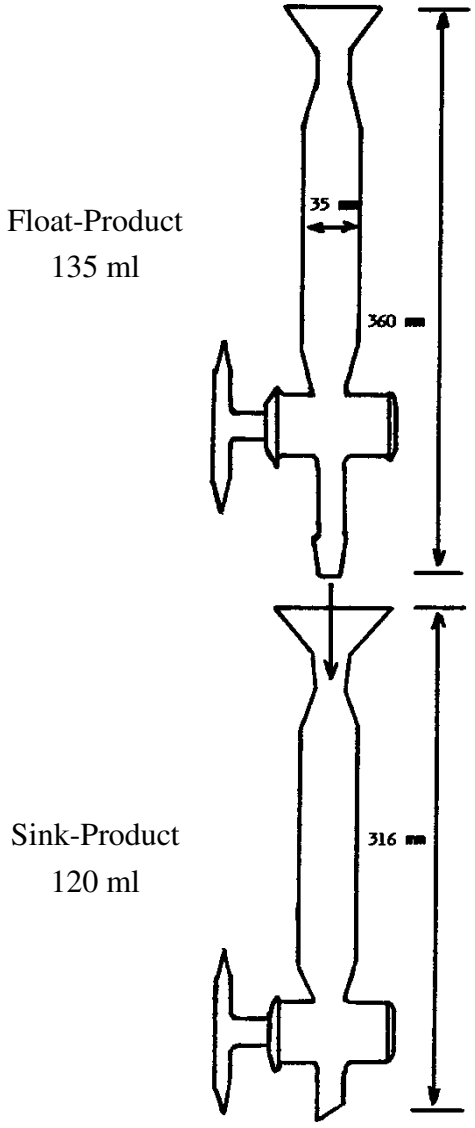
Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Sink-float laboratory equipment

Standard reagents

Bromoform	**Dijodmethan**	**Clericis liquid**
1.0 - 2.89 kg/l	2.9 - 3.3 kg/l	3.4 - 3.9 kg/l
Xylol for dilution	Xylol for dilution	Water for dilution

Glass-cyclinders used for sink-float analysis



Appendix E-9

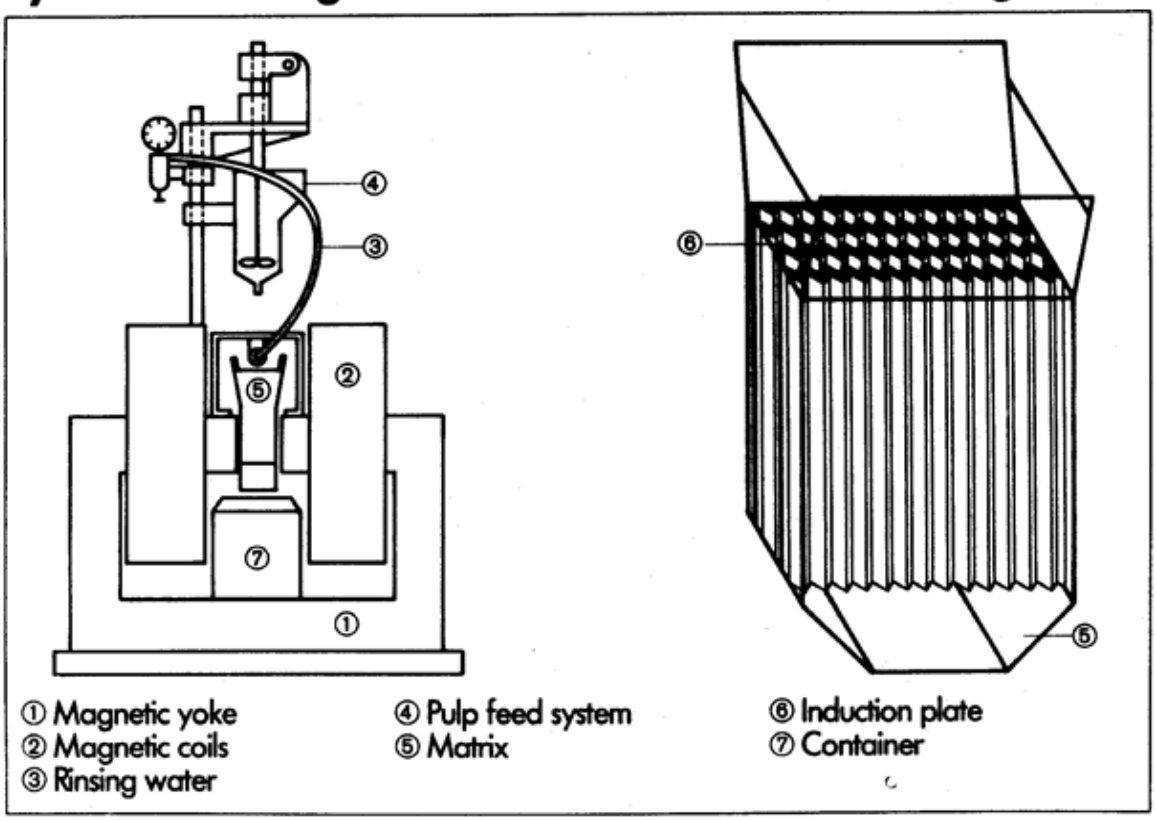
Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Laboratory High Intensity Magnetic Separator

Test method
Laboratory high intensity magnetic separation

Test objective
Simulation of an industrial high intensity magnetic separator

High Intensity Magnetic Separator
System »Studiengesellschaft für Eisenerzaufbereitung«



① Magnetic yoke
② Magnetic coils
③ Rinsing water
④ Pulp feed system
⑤ Matrix
⑥ Induction plate
⑦ Container

Test procedure
The magnetic force on a particle is

$$\vec{F} = \frac{m}{2} \cdot \mu_o \cdot \chi \cdot \text{grad}\ \vec{B}^2$$

To achieve high gradients, the flux is distorted by the induction plates or other kinds of matrix elements.
The pulp flows down through the gaps between the induction plates and the magnetics are attracted to the tips. The nonmagnetics are collected in a container.
The induction plates are rinsed to remove adhering nonmagnetic particles. Thus a middle product arises.
The current is switched off and the matrix is rinsed again to remove the magnetics.

Appendix E-10

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Pilot Plant Spiral Separation

3 stage spiral concentrator

consisting of:

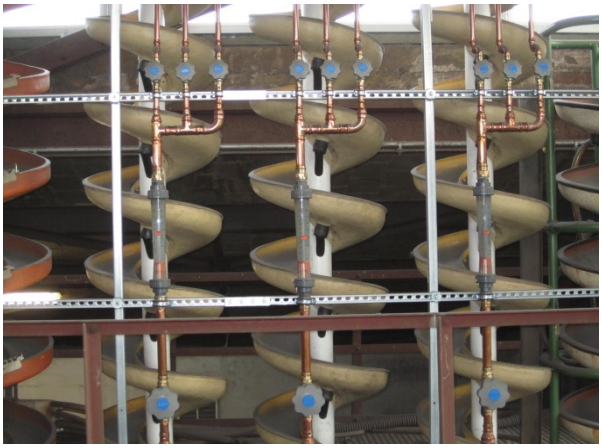
3 rougher units

2 x 3 cleaner units

1 cyclone for dewatering of the cleaner 1

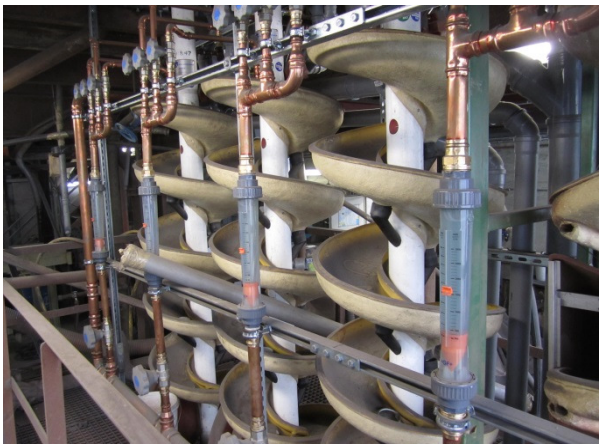
and cleaner 2 tailings

Manufacturer	CPG Resources Mineral Technologies PTY (ltd)	
Brand name	WW6PLUS	
Spiral outer diameter	600	mm
Spiral inner diameter	110	mm
Spiral gradient	ca. 20	degree



Rougher stage, consisting of 3 units spiral conc. type WW6PLUS, 7 turns.

Cleaner stage 1, consisting of 3 units spiral conc. type WW6PLUS, 5 turns.



Cleaner stage 2, consisting of 3 unis spiral conc. type WW6PLUS, 5 turns.

Cyclone, Krebs type D4BB-12-972, diameter 100 mm.

Appendix E-11

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Wet screen

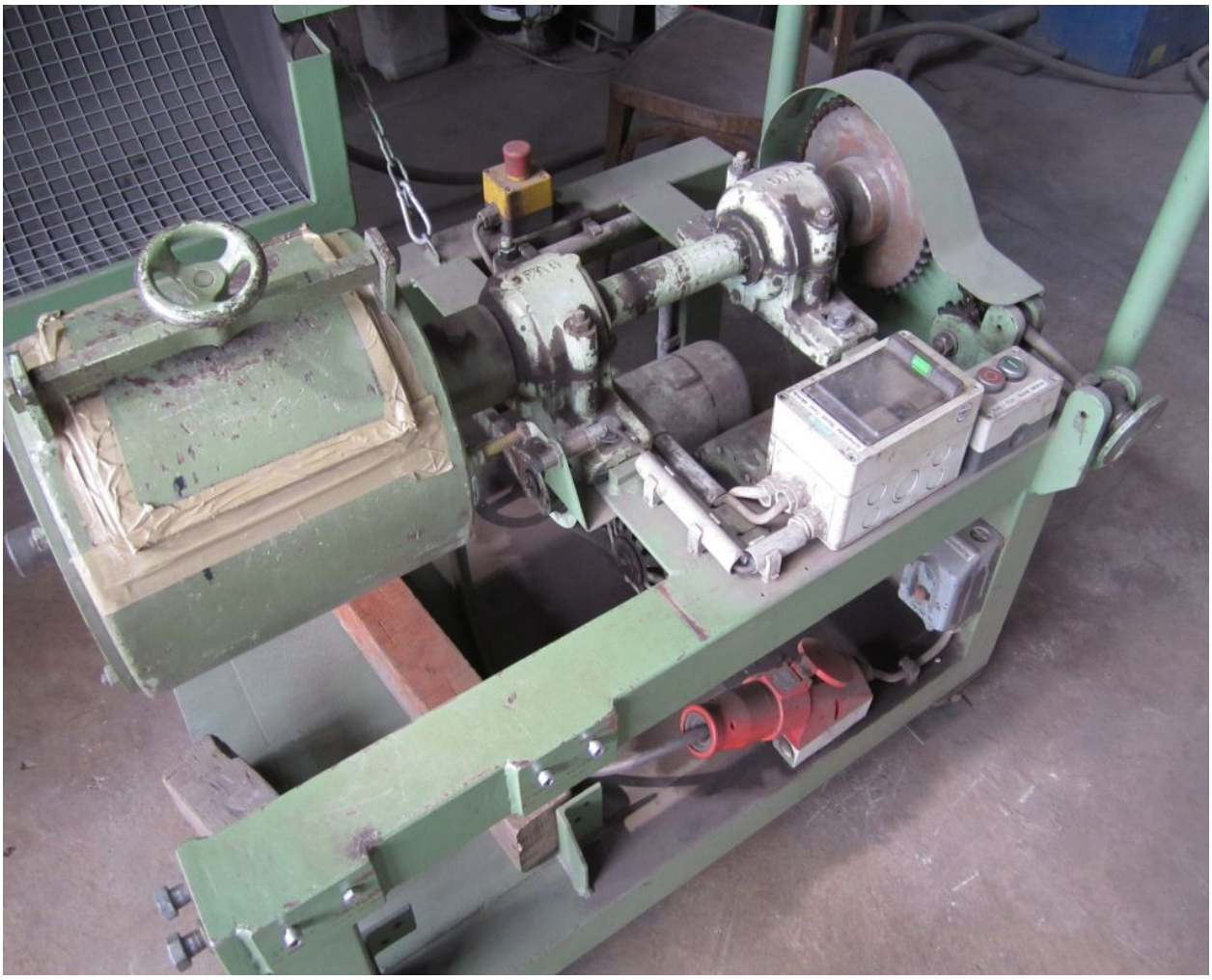
Vibration Screen	Length	1830 mm
Derrick	Width	520 mm
Model K 24 - 72W - 3S	Screens	several steel and polyurethane panels
	Cut size	~44 to 500 µm
	Oscillation	3000 min^{-1}

Appendix E-12

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Bond Ball Mill

Length	305	mm	
Diameter	305	mm	
$N_{critical}$	91	%	
Rotation	70	1/min	
Sample Volume	0,7	l	
Balls	20,125	kg	± 0,5 %



Appendix E-13

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Laboratory rod mill / Laboratory ball mill

Volume	5,7 l (315 mm x Ø 152 mm)
Rod charge	Stainless steel rods, Ø 1.8 mm, 5 kg
Ball charge	Ceramic balls, Ø 10-20 mm, 3 kg

Appendix E-14

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

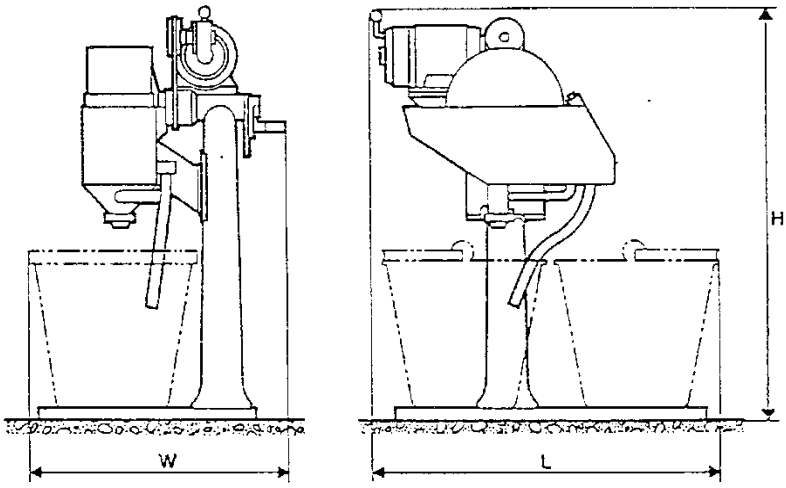
Laboratory Low Intensity Magnetic Separator

Sala Blue Ribbon
(1-stage separator,
especially for Rougher stage)

Diameter	200	mm
Width	100	mm
Field strenght	1200	Gauss on drum surface
Tank	Countercurrent	

SALA

MAGNETIC WET SEPARATOR—WS, lab - Blue Ribbon Separator
General dimensions in mm.



Appendix E-15

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Ball mill

Length	1800	mm	
Diameter	1100	mm	
$N_{critical}$	72	%	
Balls	35 - 25	mm	
Energy consumption	2-14,4	kW_{net}	depending on grinding ball charge

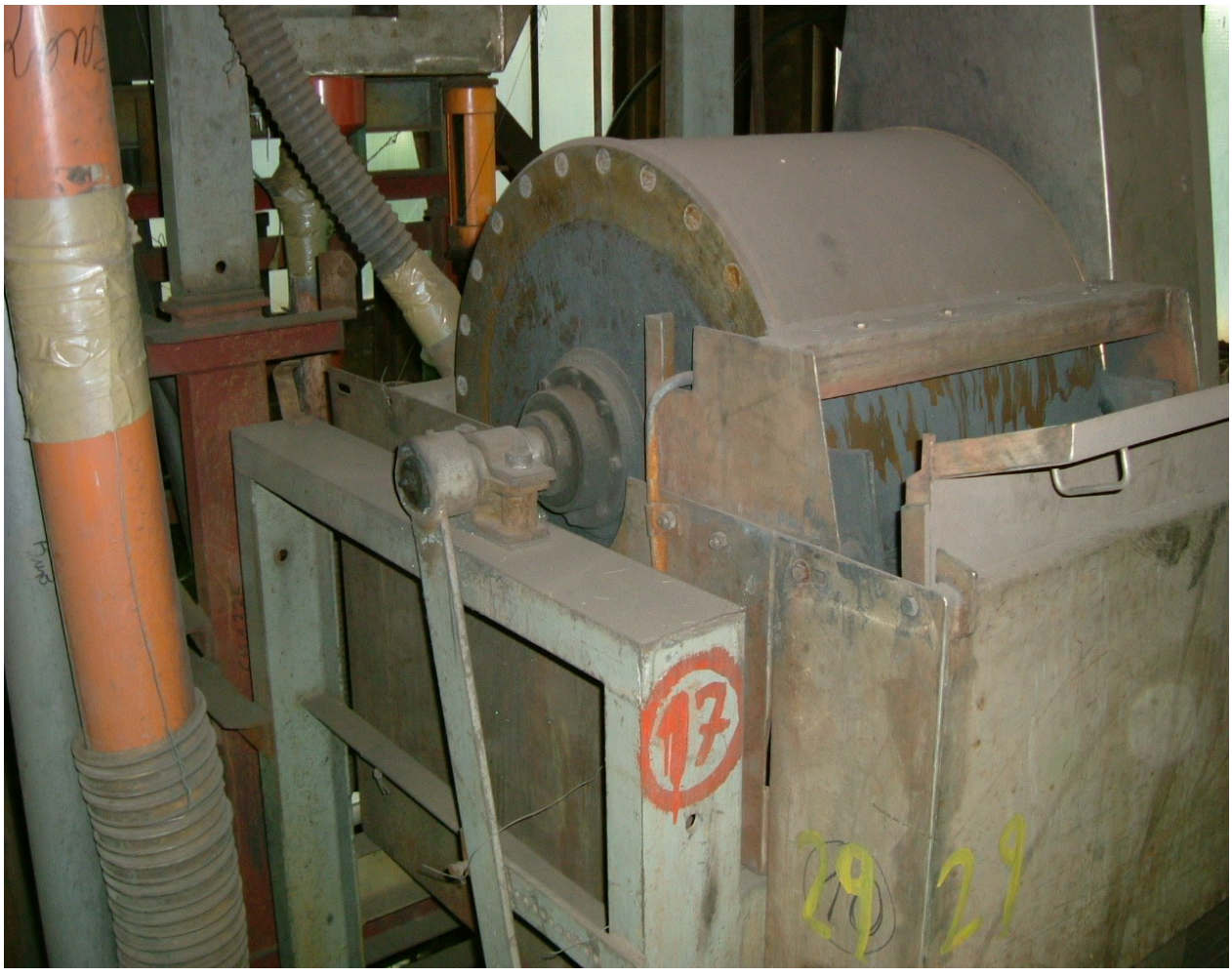
Appendix E-16

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Pilot Plant low Intensity Magnetic Separator

Thune Type
(2-stage separator,
especially for Cleaner stages)

Diameter	600	mm
Width	300	mm
Field strenght	500	Gauss in 30 mm distance
Pulpflow	6-8	m³/h for each stage
Tank	Countercurrent	



Appendix E-17

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Wet screen

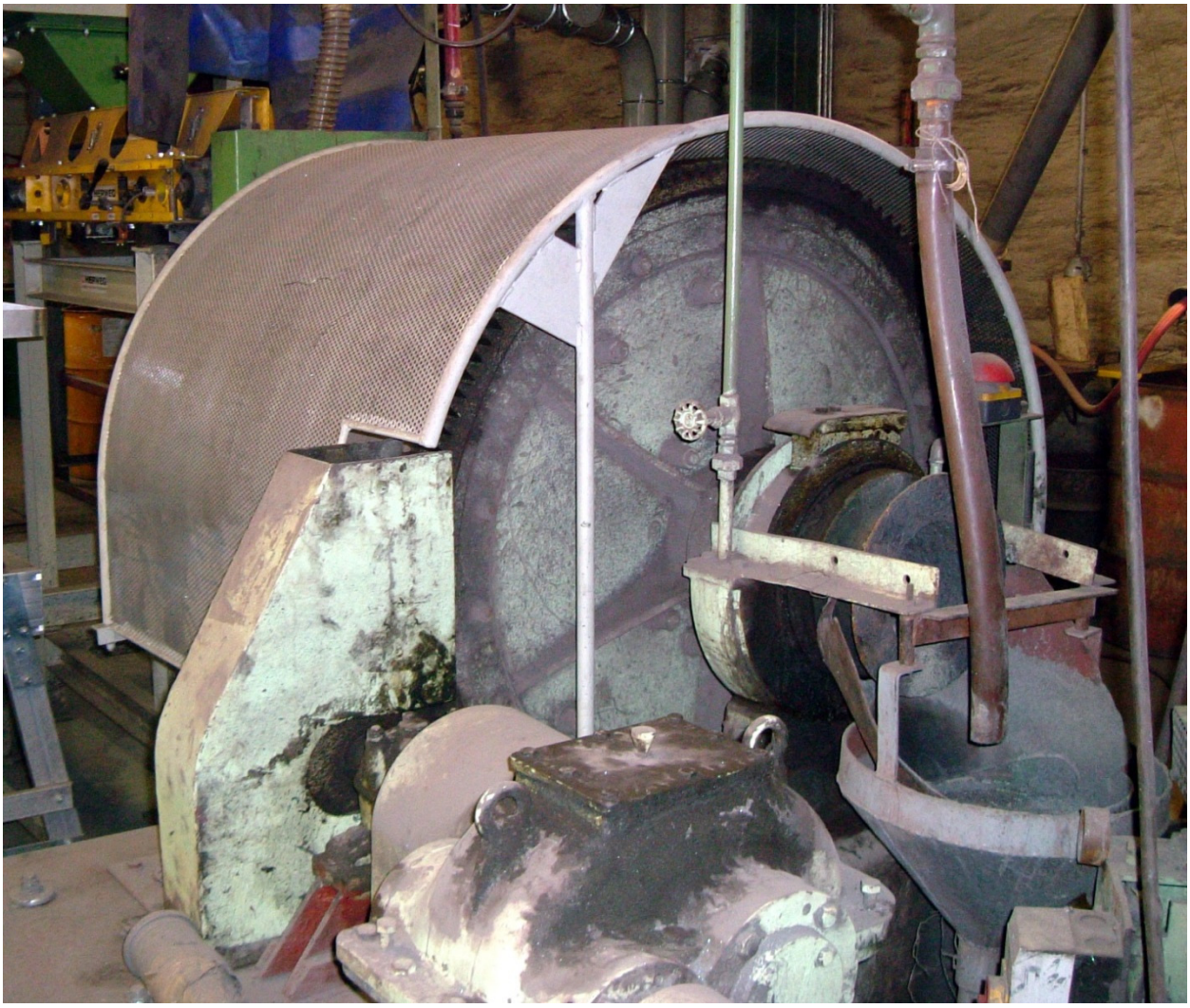
Vibration Screen	Length	620 mm
Derrick	Width	520 mm
Model K 48 - 96 MS-J	Screens	several steel and polyurethane panels
	Cut size	~33 to 350 µm
	Oscillation	3000 min^{-1}

Appendix E-18

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Ball mill

Length	735	mm
Diameter	725	mm
$N_{critical}$	74,3	%

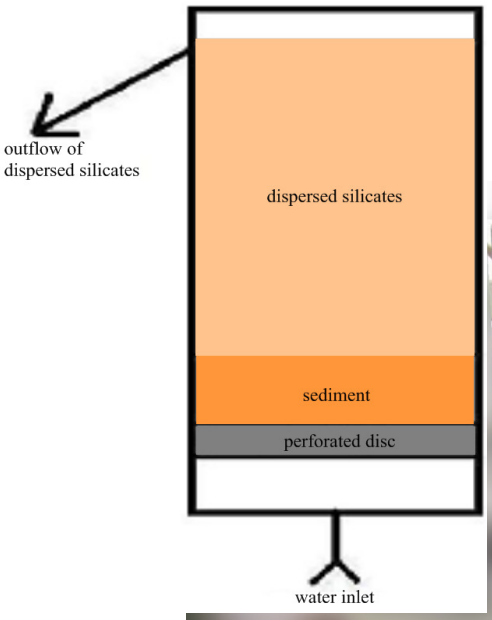


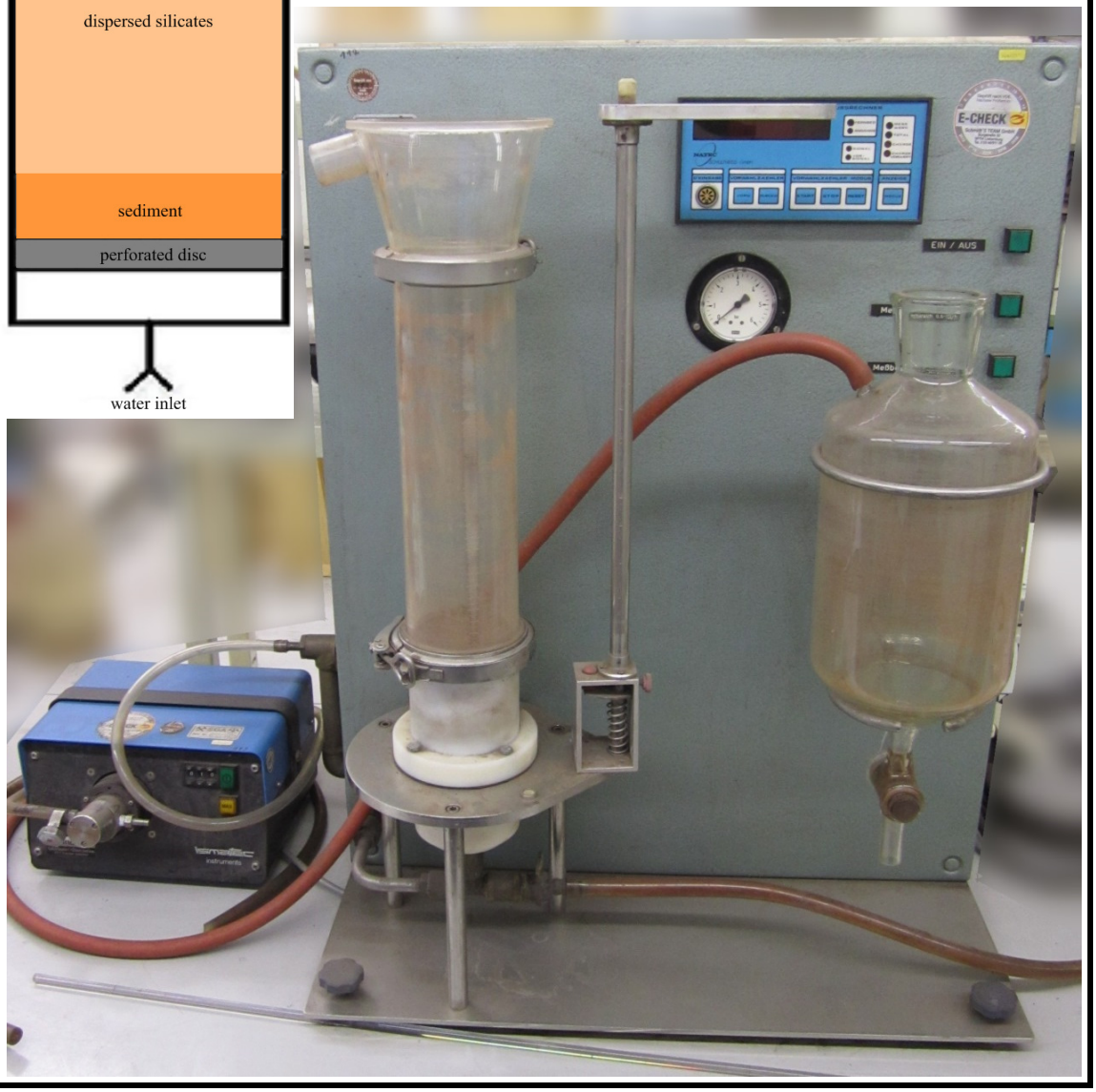
Appendix E-19

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Dynamic up-stream hydrosizer (laboratory scale)

tube diameter	30-90 mm
tube height	200-300 mm
reagent for silicate dispersion	Na-Silicate
reagent for hematite/ magnetite flocculation	Starch





Appendix E-20

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Pilot Plant Spiral Separation

1 stage spiral concentrator

WW6PLUS

Manufacturer	CPG Resources Mineral Technologies PTY (ltd)	
Brand name	WW6PLUS	
Spiral outer diameter	600	mm
Spiral inner diameter	110	mm
Spiral gradient	ca. 20	degree

Single stage,
consisting of 1 unit spiral unit
type WW6PLUS,
7 turns.

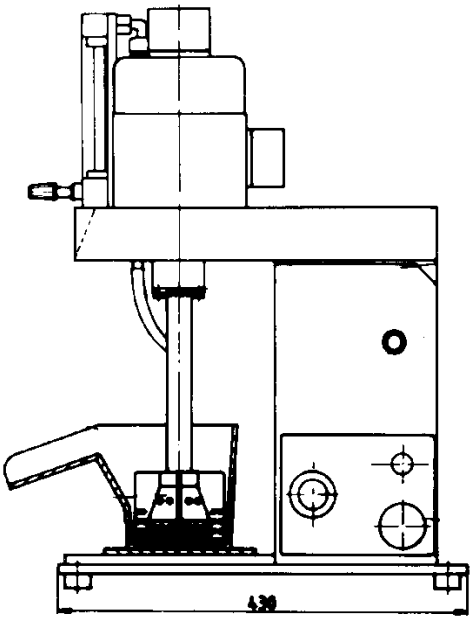
Appendix E-21

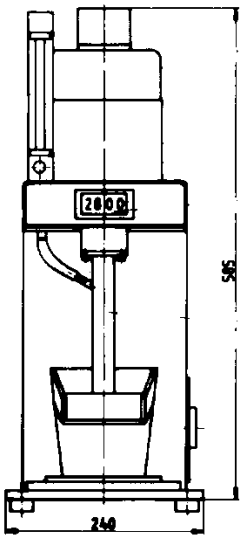
Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

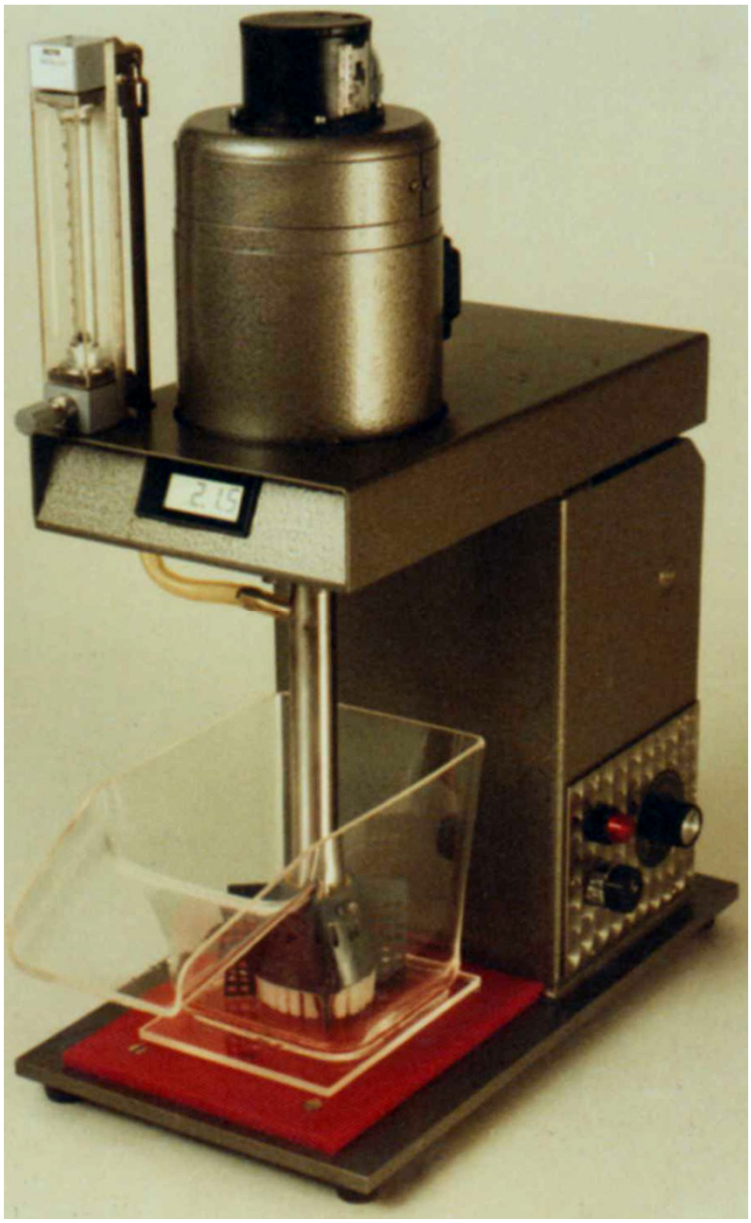
Laboratory flotation cell

Fahrenwald Denver

Cells	½, 1, 2 ltr.
Airflow	up to 80 l/h
Agitator	up to 3000 min^{-1}







Appendix E-22

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

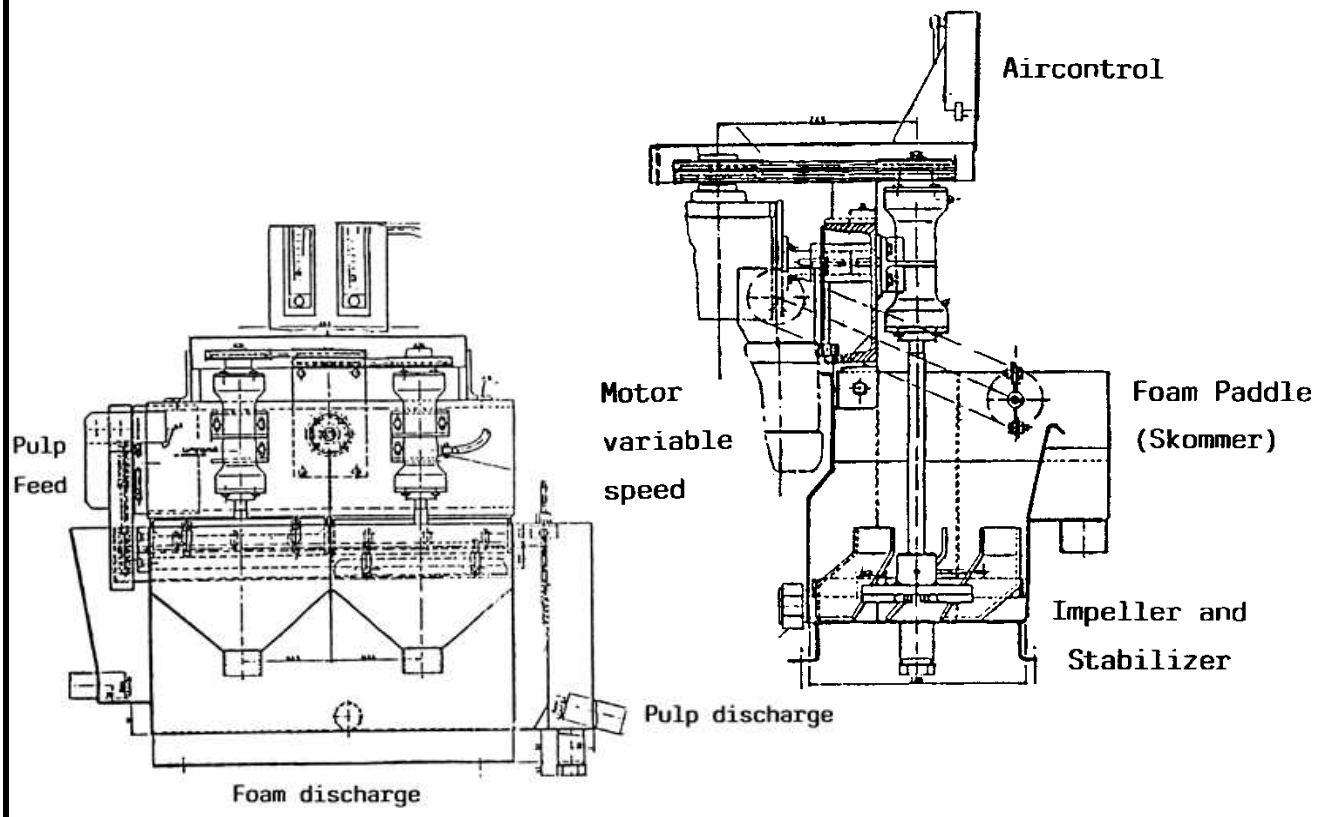
Mixing vessel

Appendix E-23

Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

Agitation Flotation Cells

Numbers of cells	3	3
Volume of cells	each 2 x 50 l	each 2 x 20 l
Airflow	up to 2400 l/h	up to 2000 l/h
Rpm	up to 2000	up to 2000



Appendix E-24

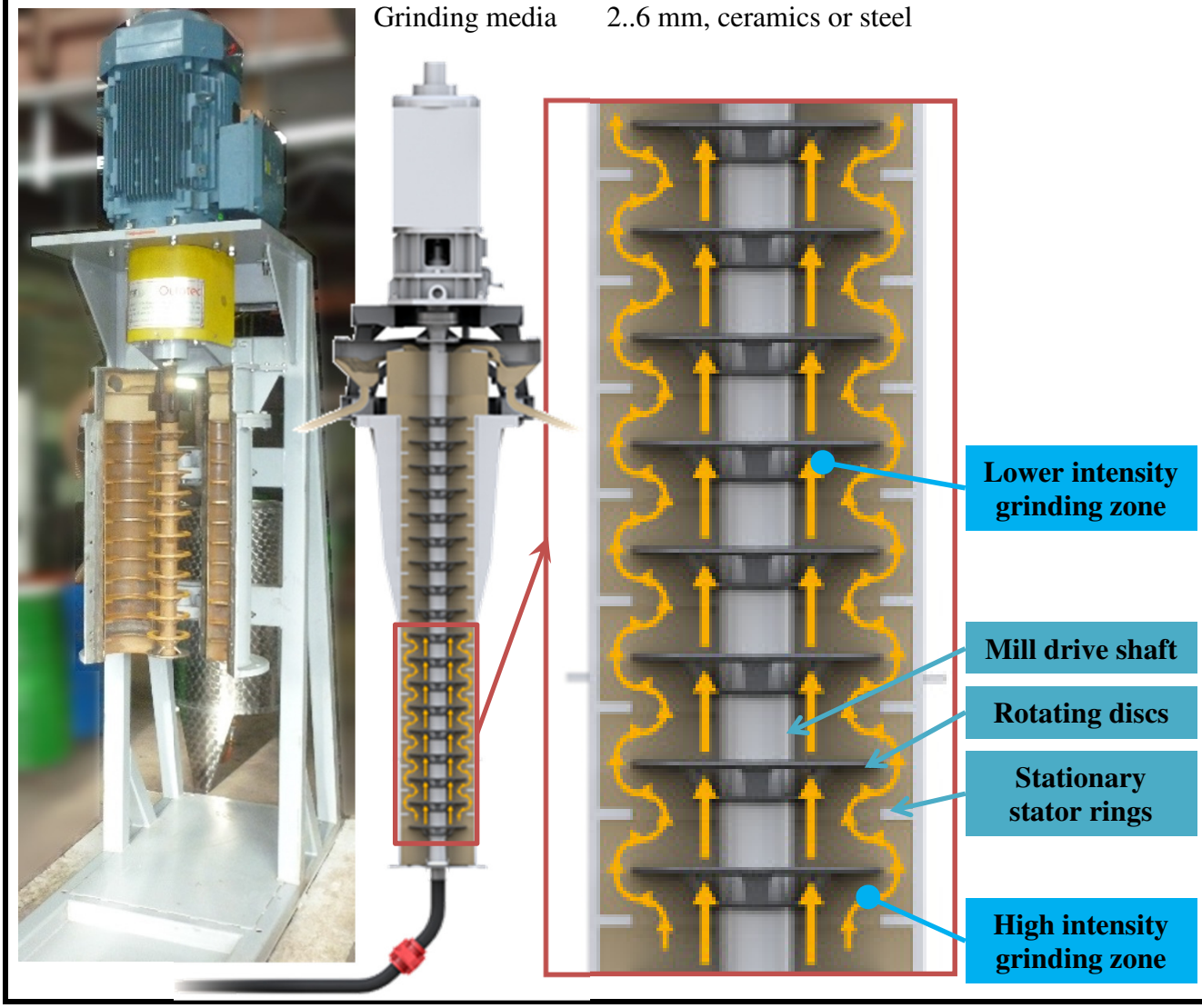
Nordic Iron Ore AB
Blötberget - 8 t Pilot sample (2015/16)

HIG-Mill
High Intensity Grinding Tower Mill

Outotec / STM Minerals

HIG 25

Gross volume	25 l
Nominal power / speed	13 kW / 510 rpm
Max. power / speed	30 kW / 800 rpm
Operating mill speed range	0..700 rpm
Typical flow rate range	150..500 liter/hour
Slurry density	40..60 w%
Grinding media filling level	40..80 %
Grinding media	2..6 mm, ceramics or steel



Appendix E-25