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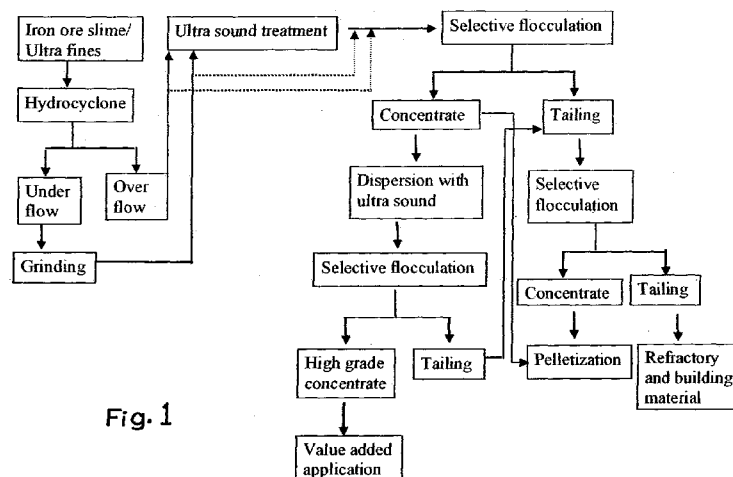
(54) Title: A PROCES FOR PRODUCING HIGH PURITY Fe_2O_3 FOR VALUE-ADDED APPLICATIONS INCLUDING BLAST FURNACE FEED FOR A POOR-GRADE IRON ORE SLIME

Fig. 1

(57) Abstract: The invention relates to a process for producing high purity Fe_2O_3 for value-added applications including blast furnace feed from a poor-grade iron ore slime, comprising the steps of separating through a non-selective dispersion of iron-containing ultra fines having different particle sizes ranging between 100 micron to 100 nm, into coarser and finer categories in a plurality of hydrocyclones of different sizes, wet-grinding the coarser category with a particle size of more than 15 microns under varied concentration to convert into finer category with a particle size of less than 15 microns; and allowing the produced fines in a single beneficiation step to undergo a selective flocculation by adapting a modified starch which generates a first concentrate containing around 68.5% Fe, 0.8% alumina, and 1% silica, and a first tailing containing around 29.8% Fe, 20.5% alumina, and 19.67% quartz; allowing the first concentrate to undergo a further dispersion followed by a further selective flocculation to produce high grade concentrate and a second tailing, the high grade concentrate being suitable for value-added applications; and allowing the first tailing to undergo a selective flocculation to produce a second concentrate and a second tailing, the second tailing being suitable as material for refractory and building construction, wherein the second concentrate suitable for peptization.

A PROCESS FOR PRODUCING HIGH PURITY Fe_2O_3 FOR VALUE-ADDED APPLICATIONS INCLUDING BLAST FURNACE FEED FOR A POOR-GRADE IRON ORE SLIME

FIELD OF INVENTION

The present invention generally relates to a method of producing a concentrate containing very high purity iron oxide with very low alumina and silica from a poor grade iron ore fines. More particularly, the invention relates to a process for producing high purity Fe_2O_3 for value added applications including blast furnace feed from a poor grade iron ore slime.

BACKGROUND OF INVENTION

Quality of the raw materials for the iron and steel industries plays an important role in the downstream processes. The fines generated in the iron ore mines and also in the iron ore washing plants do not satisfy the stringent specifications of raw materials to be used either for value added application or blast furnace.

Iron ore are beneficiated all over the world for which several techniques are being used namely spiral, floatex density separators, jigs, multi-gravity separator, low and high intensity magnetic separator, flotation, selective

dispersion and flocculation and many more with advanced technologies. Iron ore production entails generation of fines (10-25%) containing high alumina (6-8%), which is unsuitable for direct use in the blast furnace. Assuming an annual production of 150 tons of iron ore, the iron values to the tune of 15-25 million tones is lost every year. The main drawback for use of iron ore ultra fines is that high level of clay are associated with it. As a consequence, this ultra fines being rejected and getting wasted including causing environmental hazards. The particle size of these ultra fines is not suitable to beneficiate it by known beneficiation processes such as (i) gravity or (ii) magnetic separation.

The known beneficiation processes separate minerals from the mixture of two oxides. But, iron ore ultra fines are mixtures of different oxides, which have no utility . It is mixed with goethite, silica, alumina, alumina silicate,refractory minerals.

An efficient beneficiation technology is thus needed which is enabled to effectively produce two valuable products from the waste which are respectively suitable for fine magnetic particles for value added application and making building material, refractory material, nano paint or nano coolant. Large quantities of ultra fines are generated during mining and washing of iron ores. If the alumina content of the slimes can be reduced to below 2%, in the beneficiated product, the following benefits can be derived immediately:

- (1) High mine out put.
- (2) Optimum utilization of the natural resources
- (3) Reduction at the environmental hazard generated due to storage and disposal of the unsuitable products.
- (4) Higher productivity in the blast furnace and the sinter plant
- (5) Interface in production of value added products like application in medical science, paint formulation, removal of hazardous element from contaminated water and soil.

Due to ultrafiness of the particles, a process-selection from among the established techniques has become difficult. Accordingly, it requires a more dominating property than gravity or magnetic separation of such ultra fines. The selective flocculation process is known to be adapted to separate iron oxide as red mud from bauxite. It is expected that such a process could be considered to beneficiate such ultra fines. Also this process can be deployed to improve the brightness of selectively separated silica. Thus, a selective flocculation of these fines could be a viable option for efficient separation of alumina and silica from the iron bearing minerals.

OBJECTS OF INVENTION

It is therefore an object of the invention to propose a process for producing high purity Fe_2O_3 for value added application and blast furnace feed from a poor grade iron ore slime, which eliminates the prior art disadvantages.

Another object of the invention is to propose a process for producing high purity Fe_2O_3 for value added application and blast furnace feed from a poor grade iron ore slime, which provides a first grade of product containing only very low amount of alumina and silica adaptable for high-valued product or blast furnace feed.

A further object of the invention is to propose a process for producing high purity Fe_2O_3 for value added application and blast furnace feed from a poor grade iron ore slime, which provides a second grade of product containing high alumina and silica suitable for making building or refractory material.

SUMMARY OF THE INVENTION

According to the invention, various grades of rejected ultra fines can be separated out into two categories, (i) a concentrate for value-added applications including blast furnace feed by the selective flocculation followed by pelletization process, the concentrate can be further separated into a good concentrate and a high grade concentrate, the later requiring a two-step selective flocculation process; and (ii) a tailing (with rich in alumina and silica) containing mostly as sillimanite and quartz by selective dispersion and selective flocculation process. Both the alumina and silica levels in the ultra fines are in the range of 2.5 to 14wt%. The alumina and silica levels in the

concentrate can be dropped down to a level of 0.8 whereas both the alumina and silica level in the tailing can be up to 21 wt% with varying level of yield of concentrate. The concentrate is most suited as the feed material for iron making through the blast furnace route, whereas the tailing is most suited as the feed material to make building material. The tailing material may be potentially suited for other applications like feed material for formulation of nano paint and nano coolant. Added advantage is that this process is environmental and eco friendly with zero waste.

Accordingly, the invention provides a process for producing a high purity Fe_2O_3 for value added application and blast furnace feed from a poor grade iron ore slime . The process provides a concentrate containing a very high purity iron with very low alumina and silica from the slime containing high alumina and silica generated in the iron ore mines and the iron ore washing plants. According to the process, all the oxide minerals are dispersed and subsequently flocculated selectively under specific conditions. Two products are produced in this process, namely a concentrate, and a tailing. The concentrate contains 68.5% Fe with only around 0.8% alumina and 1.0% silica from the slime containing around 54.5% Fe, 7.61 % alumina and 7.42% silica. This concentrate is suitable for value added applications like in medical science, paint formulation, removal of hazardous elements from contaminated water and soil, and also as the blast furnace feed. The tailing are generated

in this process contains 29.8% Fe with 20.5% Al_2O_3 and 19.68% SiO_2 present mainly as the sillimanite and quartz. This tailing can be utilized as building and refractory material. This process is environmental friendly with zero waste.

Thus the inventive process can effectively produce two valuable products from the ultra fines of iron ore. One product is suitable for fine magnetic particle application or for pelletization whereas the other product is suitable for refractory making, nano paint or nano coolant.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

Figure 1- schematically illustrates in the form of a flow-chart of the process steps according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

According to the invention, the difference in surface charge of the iron bearing minerals and the gangue minerals is utilized first to separate out a first part of the gangue minerals present in the ultra fines. In the second stage, the materials from the first stage is subjected to a selective flocculation by adapting modified starch. By this process, the concentrate

gets converted and suitable for use as the raw material for blast furnace, and the tailing containing high alumina and silica suitable for use as the building materials.

As shown in figure-1, a non-selective dispersion followed by a selective flocculation process is proposed to separate out different levels of iron containing ultra fines into (i) an iron rich concentrate, and (ii) a tailing having high level of clay and refractory materials. The ultra fines are processed according to the invention include the ground rejected material of various beneficiation processes and hydro cyclone over-flow. The processable iron containing ultra fines is the mixture of Fe, Si and Al oxides with different particle size. The alumina and silica level of each includes in the range of 2.5 to 14 wt%. The particle size of the ultra fines is in the range of 100 micron to 100nm, and separated into coarser (more than 15 micron) and finer (less than 15 micron) categories, by adapting a hydro-cyclone of different sizes. The coarser particles are caused to undergo wet grinding under varied concentration to make it finer, finer particles being more suitable for the process because they offer better liberation and better floc formation. The dispersant used in the process includes different non-selective dispersant with different dosages for example, sodium silicate and sodium hexameta phosphate. The dosages of the dispersant are selected in the range of 20 to 150000 ppm, preferably in the range of 20 to 10000 ppm. The flocculant

includes different starch solutions under varied dosage. The starch includes potato, wheat and maize. The starch solution comprises plain including *caustic starch solution with varied concentration of caustic* for example, in the concentration range of 0.1 to 10 wt%. The process can be implemented under varied pH conditions. The range of pH solution includes 2.5 to 11, preferably 8-10. The concentration of the ultra fines includes in the range of 2 to 25wt%, with varied settling time for example, between 10 seconds to 20 hours. The process includes different mixing processes to break agglomerated particles, the mixing process comprises magnetic stirring, mechanical stirring or mixing the ultra fines in solution using ultrasonic treatment. The ultrasonic treatment includes a treatment time in the range of 1 to 300 minutes under variable ultrasonic power. The solvent includes double distilled water, distilled water, tap water and industrial process water . The industrial process water includes different degree of contamination with different metallic and non-metallic ions and bacteria.

We Claim:

1. A process for producing high purity Fe_2O_3 for value-added applications including blast furnace feed from a poor-grade iron ore slime, comprising the steps of:

- separating through a non-selective dispersion of iron-containing ultra fines having different particle sizes ranging between 100 micron to 100 nm, into coarser and finer categories in a plurality of hydrocyclones of different sizes, wet-grinding the coarser category with a particle size of more than 15 microns under varied concentration to convert into finer category with a particle size of less than 15 microns; and allowing the produced fines in a single beneficiation step to undergo a selective flocculation by adapting a modified starch which generates a first concentrate containing around 68.5% Fe, 0.8% alumina, and 1% silica, and a first tailing containing around 29.8% Fe, 20.5% alumina, and 19.67% quartz;

- allowing the first concentrate to undergo a further dispersion followed by a further selective flocculation to produce high grade concentrate and a second tailing, the high grade concentrate being suitable for value-added applications; and
- allowing the first tailing to undergo a selective flocculation to produce a second concentrate and a second tailing, the second tailing being suitable as material for refractory and building construction, wherein the second concentrate suitable for pelletization.

2. The process as claimed in claim 1, wherein the ultra fines constitutes the mixture of Fe, Si, and Al-Oxides, and wherein the aluminium and silica comprises 2.5 to 14 wt%.

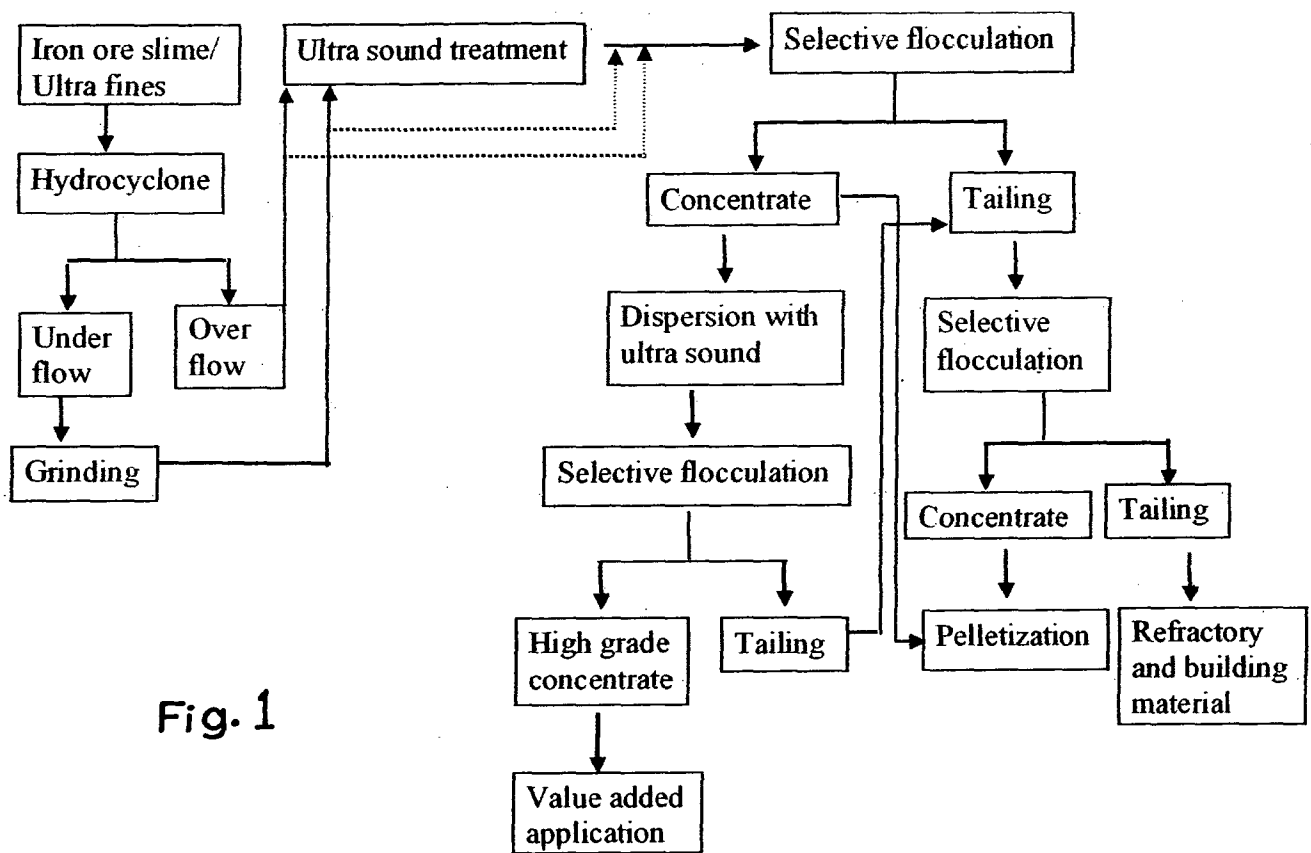
3. The process as claimed in claim 1, wherein the dispersant comprises non-selective dispersant applied with different dosages.

4. The process as claimed in claim 1 or 3, wherein the dispersant comprises sodium silicate and sodium hexameta phosphate.
5. The process as claimed in claim 1 or 4, wherein the dosages of the dispersant is selected in the range of 20 to 15000 ppm, preferably in the range of 20 to 10000 ppm.
6. The process as claimed in claim 1, wherein the starch includes potato, wheat, maize, and wherein the starch solution comprises a plain including a caustic starch solution with varied concentration of caustic starch for example, in the concentration range of 0.1 to 10.0 wt%.
7. The process as claimed in claim 1, wherein the process is enabled to be implemented under varied pH-concentration for example, in the range of 2.5 to 11, preferably in the range of 8-10.

8. The process as claimed in claim 1, wherein the concentration of the ultrafines is in the range of 2 to 25 wt% with varied settling time for example, between 10 seconds to 20 hours.

9. The process as claimed in claim 1, wherein the ultrasonic treatment comprises a treatment time in the range of 1 to 100 minutes under variable ultrasonic power, and wherein the solvent comprises one of a double-distilled water, tap water, and industrial process water.

10. A process for producing high purity Fe_2O_3 for value-added applications including blast furnace feed from a poor-grade iron ore slime, as substantially described and illustrated herein with reference to the accompanying drawings.



INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2010/000535

A. CLASSIFICATION OF SUBJECT MATTER

INV. B03D1/018
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 307 938 A (LILLMARS GLENN [US]) 3 May 1994 (1994-05-03) column 3, line 54 - column 4, line 66	1-9
Y	US 3 292 780 A (FROMMER DONALD W ET AL) 20 December 1966 (1966-12-20) column 2, line 59 - column 4, line 7; figure 1	1-9
Y	AU 495 911 B2 (THE HANNA MINING COMPANY) 28 July 1977 (1977-07-28) page 6, line 14 - page 8, line 4; figure 1	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search

8 November 2010

Date of mailing of the international search report

30/11/2010

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2010/000535

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 10
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/IN2010 /000535

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 10

Claim 10 has been drafted in such a way that said claim as a whole is not in compliance with the provisions of clarity and conciseness of Article 6 PCT, as it is particularly burdensome for a skilled person to establish the subject-matter for which protection is sought. The non-compliance with the substantive provisions is to such an extent that no meaningful search of claim 10 could be carried out at all (Article 17(2) PCT and PCT Guidelines 9.30).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IN2010/000535

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5307938	A	03-05-1994	NONE	
US 3292780	A	20-12-1966	NONE	
AU 495911	B2	28-07-1977	AU 1049476 A	28-07-1977