Development of suitable slime waste management systems for sustainable iron mining in India

Funding Agency	University Grants Commission- India
Sanctioned Amount	Rs. 7 Lakhs
Project Duration	3 years 6 months
Project Status	Completed

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Brief Description of the Project

Characterization of the iron ore lump, iron ore fine and iron ore slime from Donimalai Iron ore deposits, situated in the Bellary district – state of Karnataka, India, belonging to the National Mineral Development Corporation (NMDC Ltd.) was studied. The processing of iron ore using the wet processing method produces a larger amount of micro fines, which were currently discarded as waste due to the presence of large amounts of Silica and Alumina as gangue minerals than their permissible limit, i.e. according to Indian context less than 2% alumina and silica level can be directly fed into the blast furnace. Iron ore with above the desirable limit of alumina and silica can be beneficiated or discarded as waste.

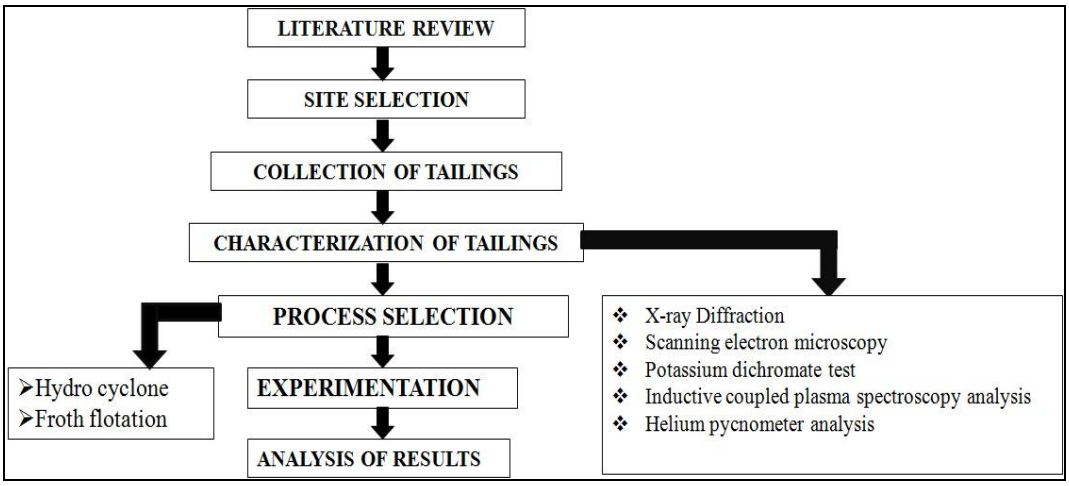
The present research work is to characterize the slime which was currently discarded as waste and to evaluate the beneficiation prospective of Iron ore slime. The slime from the tailing dam were collected and processed, and subjected to XRD (X-ray diffraction) analysis, SEM-EDS (Scanning Electron Microscope - Energy Dispersive Spectroscopy) analysis and quantitative mineralogical assessment using potassium dichromate test and ICP-AES (Inductive Coupled Plasma Spectroscopy- Atomic Emission Spectroscopy) analysis.

The micromorphology study of the iron ore with its corresponding chemical composition was found out using SEM-EDS analysis. From which we can able to find the liberation characteristics and mineralogical texture which helps to develop a proper beneficiation flow sheet. Followed by the potassium di chromate test and ICP-AES analysis the Fe (iron) % has found to be ranging from 49.60-56.3%whereas the alumina (Al_2O_3) ranges from5.85 -9.07%, in case of Silica (SiO_2) it ranges from 10.10-13.20%. From this we can able to see there is a maximum existence of iron bearing phase, i.e. hematite in the slime, which we are currently discarding as waste. Those slimes can be utilized like iron ore after subjected to the proper beneficiation technique.

The current research opens a wide idea about the need of beneficiation for the low grade iron ore slime and exploring the possible ways for industry to attain the zero waste production and also opens wide research topics on mineral processing and waste management.

Keywords: Slime, low grade iron ore, XRD (X-ray diffraction) analysis, SEM-EDS (Scanning Electron Microscope - Energy Dispersive Spectroscopy) analysis, ICP-AES (Inductive Coupled Plasma Spectroscopy- Atomic Emission Spectroscopy) analysis.

Methodologies/Approaches Adopted



Sample collection

1. Iron ore lump (-80 mm +10mm),
2. Classifier fines (-10mm).
3. Tailings from tailing pond were collected from the site; flowingly it was further processed and dried for the further analysis.

Sample preparation

1. The lump ore and fine samples were subjected to crushing and grinding followed by pulverization in order to attain <150microns.
2. The tailing sample was initially taken in buckets and allow the tailings to settle in order to remove the excess amount of water in the sample
3. Followed by placing the sample in hot pan and allow them to remove the excess amount of water
4. The dried samples were subjected to grinding and pulverization and subjected to analysis.

Analysis

1. X ray diffraction
2. Potassium di chromate test
3. Inductive coupled plasma- Atomic Emission Spectroscopy
4. Particle size analysis
5. Scanning electron microscopy with Energy dispersive X ray spectroscopy.
6. Helium Pycnometer

Liberation studies of the collected iron ore slime.

Selection of beneficiation technique.

Carrying out beneficiation process through hydro cyclone method.

Project Highlights

The project was chosen as an initiative for sustainable mining in iron ore mines in India, and trying to utilize the discarded waste as a product for blast furnace feed for iron and steel making.

Project Achievements

Fig.1: Hydro cyclone test rig for beneficiation

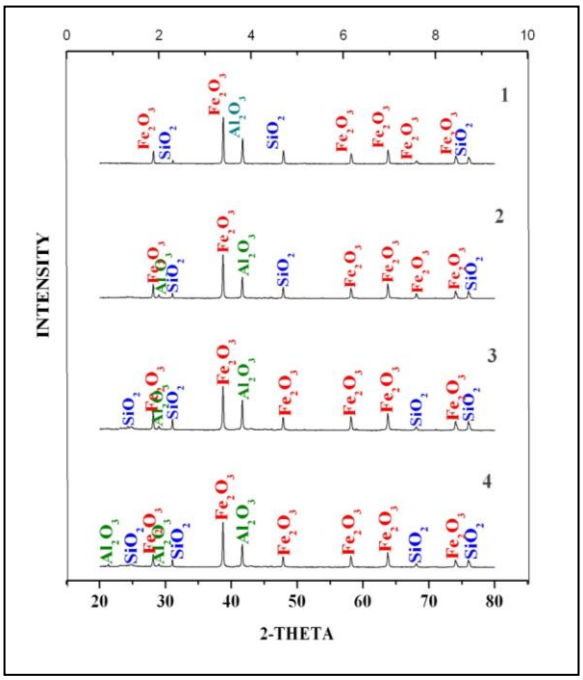


Fig. 2: Xrd analysis of 1. Lump ore, 2, unprocessed slime 3. Overflow of hydro cyclone 4. Final product

Table 1: Potassium dichromate analysis for total Fe % in beneficiation study

Sample	Fe %
Overflow (stub cyclone)	58.21
Underflow (stub cyclone)	50.2
Overflow hydro cyclone	62.04
Underflow hydro cyclone	54.21

Table 2: Parameters used in hydro cyclone test rig during beneficiation of tailings

Cyclone size (inch)	Vortex (mm)	Spigot (mm)	Feed pressure (bar)	Inlet dia (mm)	Recovery (%)
2 (stub cyclone)	3	4.7	0.2-1.2	5.0462	58
2 (hydro cyclone)	8	2.2	0.2-1.2	5	36

Publications

1. Utilization of Iron Ore slime in India –An review, Journal of International Academic Research for Multidisciplinary, Impact Factor 1.625, ISSN: 2320-5083, Volume 2, Issue 12, January 2015.
2. Beneficiation study of Donimalai iron ore slime by Hydro cyclone (PP-19) presented in IIMR-15 Workshop held in CSIR-Central Glass & Ceramic Research Institute (CSIR-CGCRI), Kolkata, India held on June 25- 27, 2015.

Project Staff

Project fellow: Muthaimanoj.P, M.E, Registered for PhD

Plan of Future Project Proposal based on the Current Project

1. Mathematical modelling for hydro cyclone selection and increasing the recovery rate.
2. Effect of viscosity on the cut (d50) size of Hydrocyclone Classifiers.
3. Characterising the effect of microwave radiation on the magnetic properties of iron ore slime.
4. Study on Effect of Ultrasound Pre-Treatment on Froth Flotation Performance