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R. Singh

A. Das

N.G. Goswami

Compilation: A.K. Sahu

INDIAN INSTITUTE OF MINERAL ENGINEERS

C/o Mineral Processing Division

CSIR-NATIONAL METALLURGICAL LABORATORY

JAMSHEDPUR 831 007, JHARKHAND WEBSITE: www.iimeindia.com

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CSIR-National Metallurgical Laboratory

Jamshedpur 831 007, Jharkhand

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Pre-weakening of mineral ores by high voltage pulses

Wang, E; Shi, FN; Manlapig, E
f.shi@uq.edu.au
Minerals Engineering, APR, 2011, Vol. 24(5), pp. 455-462

A new comminution method has been developed by applying high voltage pulses at specific energy 1-3 kWh/t to pre-weaken mineral particles, leading to reduction in energy consumption in the downstream grinding process. Four ore samples were tested using high voltage pulses and conventional crushing in parallel for comparison. Evidence of cracks and microcracks measured with X-ray tomography and mercury porosimetry supported the principle of high voltage pulses induced damage on rocks in the electrocomminution process, which resulted in energy saving up to 24% found in this study. Ore surface texture and mineral properties affected the efficiency of high voltage pulse breakage. The feasibility of the electro-comminution and its benefits need to be investigated case by case.
10.1016/j.mineng.2010.12.011

Transient state analysis by simulation in a closed grinding circuit

Rodriguez, BA; Menendez-Aguado, JM; Coello-Velazquez, A; Dzioba, BR
maguado@uniovi.es
Minerals Engineering, APR, 2011, Vol. 24(5), pp. 473-475

A study was carried out to analyse the behaviour of internal flows in a closed grinding circuit. The study was performed through mathematical modelling, using the Cumulative Based Kinetic model and obtaining the necessary parameters at laboratory scale with various minerals. Particle size variations in all flows of the circuit were analysed with the aim of comparing the time it takes to reach a steady state. Results show in all cases that product flow reaches a steady state before the whole circuit does, mainly because the recirculation flow reaches a steady state with slower pace. More research at lab and industrial scale is being planned to try to corroborate this result.
10.1016/j.mineng.2010.12.005

Leaching of potential hazardous elements of coal cleaning rejects

Silva, LFO; Izquierdo, M; Querol, X; Finkelman, RB; Oliveira, MLS; Wollenschlager, M; Towler, M; Perez-Lopez, R; Macias, F
felipeqma@yahoo.com.br
Environmental Monitoring And Assessment, APR, 2011, Vol. 175, pp. 109-126

The geochemical characteristics of coal cleaning rejects (CCR) in Santa Catarina State, Brazil, were investigated. Around 3.5 million ton/ year of coal waste are dumped in Santa Catarina State. Coal beneficiation by froth flotation results in large amounts of CCR composed of coaly and mineral matter, the latter characterised by the occurrence of sulphide minerals and a broad array of leachable elements. The total and leachable contents of more than 60 elements were analysed. Atmospheric exposure promotes sulphide oxidation that releases substantial sulphate loads as well as Ca2 + , K (+) , Mg2 + , Cl (-aEuro parts per thousand) and Al3 + . The metals with the most severe discharges were Zn, Cu, Mn, Co, Ni and Cd. Most trace pollutants in the CCR displayed a marked pH-dependent solubility, being immobile in near-neutral samples. The results highlight the complex interactions among mineral matter solubility, pH and the leaching of potentially hazardous elements.
10.1007/s10661-010-1497-1

Optimization of a Multi Gravity Separator to produce clean coal from Turkish lignite fine coal tailings

Ozgen, S; Malkoc, O; Dogancik, C; Sabah, E; Sapci, FO
esabah@aku.edu.tr
FUEL, APR, 2011, Vol. 90(4), pp. 1549-1555

In this study, the beneficiation of two lignite tailings by Multi Gravity Separator (MGS) was investigated. The tailings samples from the Tuncbilek/Kutahya and Soma/Manisa regions have ash contents of 66.21% and 52.65%, respectively. Significant operational parameters of MGS such as solid ratio, drum speed, tilt angle, shaking amplitude, wash water rate, and feed rate were varied. Empirical equations for recovery and ash content were derived by a least squares method using Minitab 15. The equations, which are second-order response functions, were expressed as functions of the six operating parameters of MGS. The results showed that it is possible to produce a coal concentrate containing 22.83% ash with a recovery of 49.32% from Tuncbilek coal tailings, and a coal concentrate containing 22.89% ash with a recovery of 60.01% from Soma coal tailings. (C) 2010 Elsevier Ltd. All rights reserved. 10.1016/j.fuel.2010.11.024

Trace element concentration reduction by beneficiation of Witbank Coalfield no. 4 Seam

Bergh, JP; Falcon, RMS; Falcon, LM
bergh.kobus@gmail.com
Fuel Processing Technology, APR, 2011, Vol. 92(4), pp. 812-816

South Africa remains the 5th largest producer and joint 4th largest exporter of coal in the world. It is also a major supplier of coal to the European Union. This is significant as the European Union has recently supported the environmental lobby that threatens the combined full scale use of coal in Europe and other first world countries. This promotes the development of clean coal technologies in order to counter the ever increasing number of environmental constraints threatening the export market. One critical development in clean coal technologies is coal beneficiation, which allows the reduction of mineral content. Permian coals from South Africa have characteristically high ash and inertinite contents and therefore require further beneficiation. The no. 4 Seam in the Witbank Coalfield is no exception, and it can be described as containing higher inertinite content and minerals compared to the no. 2 Seam in the same Coalfield. Beneficiation, therefore, is an important requirement for improving the quality of the coal, especially for export purposes. With the increase in environmental legislation and the drive towards "clean coal" a concern is raised in terms of the performance and marketability of export coal produced from the no. 4 Seam in the Witbank Coalfield. This seam is economically significant and remains an important source of export steam coal. Due to the nature and composition of the no. 4 Seam, coal beneficiation is essential to reduce the mineral content to be in line with export quality specification levels. This paper focuses on the association of the trace elements within the seam with the organic and inorganic components and possible methods of trace element reduction by removal using coal beneficiation techniques. The techniques investigated include reduction by dense medium beneficiation and flotation. The associated mineral reducibility investigations included mineralogical distribution and liberation analysis. By studying the relationship between coal mineralogy, petrography and trace element distribution, methods of optimum trace element reduction established. Furthermore, the distribution of mineralogical and organic components of sulphur in the Witbank Coalfield No. 4 seam was found to bear unique relationships with trace elements of special concem. By assessing the distribution and occurrence of trace element concentrations during washability and floatability tests, data was produced which could now be used in the promotion of saleable coal products from no. 4 seam in the Witbank Coalfield.
10.1016/j.fuproc.2010.09.035

Robust HPGR model calibration using genetic algorithms
Hasanzadeh, V; Farzanegan, A
a.farzanegan@kashanu.ac.ir; afarzanegan@gmail.com
Minerals Engineering, APR, 2011, Vol. 24 (5), pp. 424-432

Mathematical modeling and simulation techniques are widely used to design and optimize comminution circuits in mineral processing plants. However, circuit performance predictions are prone to errors due to inaccurate calibration of models used in simulations. To address this problem, the authors applied a method based on genetic algorithms (GA) for estimation of HPGR (high pressure grinding rolls)

model parameters. In this research, a simulation algorithm was developed and implemented in MATLAB (TM) based on published HPGR models to test and demonstrate GA application for model calibration. The GA toolbox of MATLAB was used to obtain the optimal values of HPGR model parameters. The authors successfully validated simulator predictions against HPGR data sets at laboratory and industrial scales. The results indicate that GA is a robust and powerful search method to find the best values of HPGR model parameters that lead to more reliable simulation predictions. (C) 2010 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2010.12.004

Selective and temperature responsive flocculation: A comparison of fine particle flotation techniques

Elizaveta Forbes, Shear
International Journal of Mineral Processing, Volume 99, Issues 1–4, 8 May 2011, Pages 1-10.

Mineral flotation is a process whereby valuable hydrophobic mineral particles are recovered from low grade mineral pulp by means of attachment to air bubbles. Particles smaller than 10 μm have a low probability of collision with bubbles, due to their tendency to be caught in streamlines created by a rising bubble. This review focuses on the techniques aimed at increasing the effective size of ultrafine mineral particles through aggregation, as an aid in improving flotation performance. These techniques are: shear flocculation, selective polymer flocculation and temperature responsive flocculation. Each technique is evaluated in terms of its mechanisms and its efficacy at improving the flotation of fine mineral particles.
http://dx.doi.org/10.1016/j.minpro.2011.02.001.

Beneficiation and agglomeration process to utilize low-grade ferruginous manganese ore fines

Singh, V; Ghosh, TK; Ramamurthy, Y; Tathavadkar, V
veerendra.singh@tatasteel.com
International Journal Of Mineral Processing, May, 2011, Vol. 99, pp. 84-86

Characterisation, beneficiation and agglomeration studies were carried out to develop a utilization strategy for typical Indian low grade manganese ore fines. The major mineral phases found are pyrolusite, hematite. goethite, clay, feldspar and quartz. QEMSCAN and Sink-Float studies suggested that 40% of manganese minerals are in liberated form, whereas 30% are locked with iron minerals. Classification followed by two-stage high intensity magnetic separation (1.7 & 1.1 Tesla) process can recover 35-40% material of ferromanganese grade with 47-49% Mn recovery. The recovered material was briquetted adding molasses (7%). cement (3%) and bentonite (1%) to use in the submerged arc furnace for metallurgical applications. A

cost effective process flow sheet has been developed to utilize these fines. (C) 2011 Elsevier B.V. All rights reserved. 10.1016/j.minpro.2011.03.003

Binding effects in hematite and magnetite concentrates

Kawatra, SK; Halt, JA
skkawatr@mtu.edu
International Journal Of Mineral Processing, May, 2011, Vol. 99, pp. 39-42

An industrial taconite facility, 'Plant F', processed both magnetite and hematite ores during the year. The concentrates were pelletized with a binder, bentonite. Plant personnel believed less bentonite was required to make hematite pellets. Thus, the authors intended to quantify in-plant observations through bench-scale pelletization tests. As-received magnetite and as-received hematite were pelletized and tested for wet-drop number and dry-crush strength. Hematite pellets exceeded industrial minimum wet-drop and dry-crush values of 5 drops and 22 N/pellet without bentonite addition, while magnetite pellets exceeded industrial minimum values at a bentonite dose of 6.6 kg/t (0.66%). It is known that finer particles increase pellet strength, so additional magnetite was ground to a similar particle size distribution as the as-received hematite. The ground magnetite was pelletized and tested for wet-drop number and dry-crush strength. Wet drop and dry crush values increased after grinding the magnetite concentrate. However, they were significantly less than hematite pellets at similar bentonite doses. Consequently, particle size effects were not the dominant cause for higher strengths in the hematite concentrate.
10.1016/j.minpro.2011.03.001

A study of hydrocyclone classification of coal fines by CFD modeling and laboratory tests

Torno, S; Torano, J; Gent, M; Menendez, M
gentmalcolm@uniovi.es
Minerals & Metallurgical Processing, MAY, 2011, Vol. 28(2), pp. 102-109

The elimination of ultrafine (<10 mu m) clay particles is essential to the treatment of abandoned coal-washing plant tailings for the recovery of the remaining coal fraction by enhanced gravity processing. Effective hydrocyclone classification is required to remove this fraction. The highly variable composition and particle size distribution of such wastes creates significant difficulties in the operation of hydrocyclones for such classifications. Hydrocyclone laboratory investigations and their plant setup require lengthy or time-consuming tests. The use of empirical models of such classifications frequently requires modification to correspond to actual operating conditions. Results of the evaluation of computational fluid dynamics (CFD) modeling to predict hydrocyclone classification of coal-washing plant tailings are presented. Results of the standard k-epsilon turbulence, SSG turbulence and large eddy simulation CFD models are compared with the results

obtained from analyzed hydrocyclone classifications. The CFD models tested are shown to be very effective in the simulation of hydrocyclone classifications for the determination of the classification particle size and adequate for determining the efficiency index values for many applications. The large eddy simulation model was identified as the most precise, but it is recommended that all three models be improved simulations of classifications above and below the classification particle size.

Comminution environment and gold particle morphology: Effects on gravity concentration

Ofori-Sarpong, G; Amankwah, RK
gad164@psu.edu; rkamankwah@umat.edu.gh
Minerals Engineering, MAY, 2011, Vol. 24(6), pp. 590-592

In many laboratories and processing plants, different comminution equipment are used in preparing gold ores for gravity concentration. For malleable metals such as gold, particle shape changes in response to the forces applied during comminution, and these shapes can influence gravity concentration. In this study, the morphology of gold particles milled in different equipment was investigated. The disc and hammer mills generated cigar-shaped and globular particles respectively. The vibratory pulveriser created flaky particles while the ball mill formed a mix of flaky, folded and irregularly shaped particles. Gravity concentration produced enrichment ratios of 28.3, 24.0, 23.6 and 21.7 for the hammer mill, disc mill, ball mill and vibratory pulveriser respectively. The results show that the comminution equipment utilized should be taken into consideration in decisions regarding gravity gold recovery.
10.1016/j.mineng.2011.02.014

Engineering cyber infrastructure for U-Pb geochronology: Tripoli and U-Pb_Redux

Bowring, JF; McLean, NM; Bowring, SA
bowringj@cofc.edu; nmclean@mit.edu; sbowring@mit.edu
Geochemistry Geophysics Geosystems, Jun, 2011, Vol. 12

In the past decade, major advancements in precision and accuracy of U-Pb geochronology, which stem from improved sample pretreatment and refined measurement techniques, have revealed previously unresolvable discrepancies among analyses from different laboratories. One solution to evaluating and resolving many of these discrepancies is the adoption of a common software platform that standardizes data-processing protocols, enabling robust interlaboratory comparisons. We present the results of a collaboration to develop cyber infrastructure for high-precision U-Pb geochronology based on analyzing accessory minerals by isotope dilution-thermal ionization mass spectrometry. This cyber

infrastructure implements an architecture specifying the workflows of data acquisition, statistical filtering, analysis and interpretation, publication, community-based archiving, and the compilation and comparison of data fromdifferent laboratories. The backbone of the cyber infrastructure consists of two open-source software programs: Tripoli and U-Pb_Redux. Tripoli interfaces with commercially available mass spectrometers using standardized protocols, statistical filtering, and interactive visualizations to aid the analyst in preparing raw data for analysis in U-Pb_Redux. U-Pb_Redux implements the architecture by orchestrating the analyst's workflow with interactive visualizations and provides data reduction and uncertainty propagation that support data interpretations. Finally, U-Pb_Redux enables production of publication-ready graphics and data tables, the archiving of results, and the comparative compilation of archived results to support cooperative science.
10.1029/2010GC003479

Backfilling technology of substituting waste and fly ash for coal underground in china coal mining area

Huang, YL; Zhang, JX; Zhang, Q; Nie, SJ
huangyanli6567@163.com
Environmental Engineering And Management Journal, JUN, 2011, Vol. 10(6), pp. 769-775.

As one of the very few countries using coal as its dominant energy resources, China has the coal production exceeding one thirds of in the world, added to it are the problems of environmental damages and soil resource destructions result from the solid waste, such as mining waste discharged in the process of coal production and fly ash deserted from the electric power plant etc. In this paper, the mineral ingredient of waste and fly ash was tested by X-ray Diffraction. Meanwhile, the deformation characteristics of the backfilling bodies with different waste and fly ash mixture ratio was tested by MTS815.02 electro-hydraulic servo rock mechanical test system, the optimal mixture ratio of waste and fly ash was 1:0.3, and it proposes that the backfilling body should be firstly tamped after being backfilled into the goaf. Moreover, technological framework for backfilling technology of substituting waste and fly ash for coal underground was expatiated, and the system layout of substituting waste and fly ash for coal was introduced systematically. Ultimately, the engineering application results witnessed the solution for the problems of environmental damages and soil resource destructions result from the waste and fly ash, based on the effective control of the strata and ground, and the environmental benefits and economic benefits with high production and recovery.

Modern Process Mineralogy: Two case studies

Lotter, NO; Kormos, LJ; Oliveira, J; Fragomeni, D; Whiteman, E
nlotter@xstrataprocesssupport.ca
Minerals Engineering, JUN, 2011, Vol. 24(7), pp. 638-650

Process diagnosis, flowsheet design and optimisation are most effectively and efficiently achieved through the use of metallurgical testwork combined with modern quantitative mineralogical techniques. The integration of these two areas of study form the discipline known as process mineralogy. A brief history of the discipline is described along with the program now in place at Xstrata Process Support (XPS). Representative sampling protocols for orebodies, plant or test products, the use of geometallurgical unit classification, stratified sampling, high confidence metallurgical test programmes, concentrator sampling audits (Benchmark Surveys) and the use of quantitative mineralogy (QEMSCAN and EPMA) are key components of the strategy. Two case studies from Xstrata Nickel's Nickel Rim South Mine in Sudbury and its Raglan Concentrator in Quebec are described to show how mineralogical data can be integrated into metallurgical programs to assist mineral processing engineers to design and optimise flowsheets and how the use of quantitative mineralogy can be used to benchmark plant performance and enable predictions of performance ahead of plant changes. 10.1016/j.mineng.2011.02.017

Full-text Papers available in NML Eprints (http://eprints.nmlindia.org)

Das, Suchandan K (2011) *Mathematical Modelling of Carbonisation Process in Stamp Charged Coke ovens.* In: International Conference on Coal & Coke - 2011, April 7-8, 2011, Tata Steel, Jamshedpur, India.

In this study, mathematical models of coal carbonisation in the coke oven have been developed. Models for thermo-physical properties (e.g. specific heat, density, and thermal conductivity) and heat of carbonisation reaction of coal during thermal decomposition to coke have been constructed in terms of the changes in the chemical composition and structure. To have sufficient generality for the applications to coke oven practices, the model describes the kinetics of release of main volatile matter constituents, thereby permitting the changes in the mass and composition of solid residue to be estimated by element balances. Correlations for the parameters of the models are derived so that prediction of volatile matter evolution can be made from coal ultimate analysis and heating profile. The computer based model predictions are in reasonable agreement with the experimental data generated by conducting pertinent experiments and literature information. http://eprints.nmlindia.org/3320/

Dhal, B and Das, N N and Pandey, B D and Thatoi, Hruayanath (2011) *Environmental Quality of the Boula-Nuasahi Chromite Mine Area in India.* Mine Water and the Environment, 30 (3). pp. 191-196.

Chromite mining can create hostile conditions for organisms in the surrounding environment. Overburden soil and mine water samples were collected and analyzed for their microbial diversity, nutrient content, and water quality at the Boula-Nuasahi Mine. Most of the water parameters that were measured exceed national/international standards. The microbial population was low (soil: 45 ± 0.06 9 105 bacteria, 20 ± 0.03 9 105 fungus) and the overburden soils have a low nutrient (N, P, K) content. The metal ions were found to have leached to nearby agriculture lands, making them less fertile for crop production. Overburden dumps and seepage water were found to be the main sources of chromium pollution. http://eprints.nmlindia.org/2301/

Vaish, A K and Singh, S D (2011) *Development of Eco-friendly process for the recovery of Lead from lead battery scrap in small scale sector.* The Banaras Metallurgist, 16. pp. 149-157.

The lead battery scrap mainly constitutes of oxides and sulphates of lead. In Present investigation an attempt has been made fir better recovery of metallic lead from waste battery scrap after its necessary treatment. A mini cupola furnace along with comprehensive pollution control system has been developed at IVML to smelt about 200 Kg of lead battery scrap per hour. Simplified design has been developed for, fabric, filter to arrest fine purticulales of lead and impingement scrubber to absorb the oxides of sulphur as well as arrest the particulates of lead. The emission of lead was brought down < 10 mg/m3 and that of S02 < 300 mg/m3 as prescribed by Central Pollution Control Board, India and the recovery of lead was beyond 86.5%. This eco - friendly process is extremely suitable in small scale sector. http://eprints.nmlindia.org/3755/

Kim, Eun-young and Kim, Min-seuk and Lee, Jae-chun and Jeong, Jinki and Pandey, B D (2011) *Leaching kinetics of copper from waste printed circuit boards by electro-generated chlorine in HCl solution.* Hydrometallurgy, 107 (3-4). pp. 124-132.

The leaching behavior of metals such as copper, zinc, lead and tin from waste printed circuit boards (PCBs) has been investigated using electro-generated chlorine in hydrochloric acid solution. The experiments were carried out by employing two different reactors: (a) a combined reactor facilitated with simultaneous Cl2 generation and metal leaching, and (b) a separate metal leaching reactor connected with the anode compartment of a Cl2 gas generator. Leaching efficiency in two reactors was compared for recycling of valuable metals from the PCBs. It was observed that the leaching rate of the metals increased with increase in current density, temperature and time in both reactors. The copper leaching rate gradually diminished when its dissolution was around 20 and 25% in the combined and separate reactor, respectively, which may be attributed to a decrease in surface

area of copper with leaching time and the formation of CuCl(s) on the surface. The leaching efficiency of copper was found to be lower in the combined reactor than that of the separate reactor. The dissolution kinetics of copper with electro-generated chlorine followed empirical logarithmic law controlled by surface layer diffusion. The leaching mechanism of copper was further corroborated by SEM-EDS study of the residue. The activation energy for copper leaching in the combined and separate reactors was calculated to be 24.5 and 20.7 kJ/mol, respectively in the temperature range 298–323 K. http://eprints.nmlindia.org/2925/

Nayak, B (2011) *Gold in the Beach Placer Sands of Chavakkad-Ponnani, Kerala Coast, India.* Journal of the Geological Society of India, 78 (4). pp. 345-348.

Although sporadic mining of placer gold from river beds is not uncommon in India, there is no documented literature on the occurrence of gold in the beach placer sand deposits of the country. While characterizing the heavy minerals of the Chavakkad-Ponnani (CP) beach placer sands along the North Kerala coast, the association of gold with the pyriboles in these sands has been observed. A native gold grain of about 25 micrometer was seen to occur as an inclusion within an amphibole of hornblendic composition. The pyriboles of the CP deposit are angular to sub-angular indicating a nearby provenance that may be in the upstream reaches of the Ponnani river in the districts of Malappuram and Palakkad or further north in the auriferous tracts of the Wynad-Nilambur or Attapadi regions. It is argued that the occurrence of native gold in CP deposit is not a freak occurrence and that it warrants thorough investigation of all the pyribole-ilmenite-rich placers to examine the possible presence of gold and its abundance in the beach placers of northern Kerala coast. http://eprints.nmlindia.org/4083/

Nayak, B and Das, Swapan K and Bhattacharyya, K K (2011) *Detrital and authigenic(?) baddeleyite (ZrO2) in ferromanganese nodules of Central Indian Ocean Basin.* Geoscience Frontiers, 2 (4). pp. 571-576.

Occurrence of baddeleyite (ZrO2) which is a rare mineral has been recorded in ferromanganese nodules of Central Indian Ocean Basin (CIOB). The mineral occurs either as independent isolated sub-rounded to elliptical grains or in clusters forming fine subhedral crystals (<3 microns) within ferromanganese concretionary growth-bands. The mode of occurrence, textural features and chemistry of the mineral suggest detrital and possibly an authigenic origin for baddeleyite. For authigenic origin it is proposed that zirconium might have got released either from the terrigenous sediments or the altered seafloor rocks forming halogen complexes and subsequently it has re-precipitated in the form of baddeleyite within manganese nodules under oxic to sub-oxic conditions. http://eprints.nmlindia.org/4188/

Singh, R K and Mehta, K D and Sharma, Mamta and Bhattacharyya, K K (2011) *Effect of Magnetic Field Intensity on Iron ore Separation Efficiency in slimes.* Journal of Sustainable Planet, 2 (3). pp. 44-49.

Due to mechanized mining and present system of washing, iron ore industries facing a problem of huge slime generation. A detailed characterization of the slime generated during processing of ROM, has been studied. This slime is then beneficiated using hydrocyclone followed wet high intensity magnetic separator to recover the valuables. Slime sample generated from ROM through scrubbing and sizing, has been assayed and found to contain 59.25% Fe, 5.14% Al2O3, 4.11%SiO2, and 4.83% loss on ignition (LOI). Mineralogy studies through XRD have indicated the presence of hematite and goethite as major iron bearing minerals whereas, gibbsite, kaolinite, quartz as major gangue minerals. The present work involves, separating the gangue mineral from valuable iron bearing mineral viz. hematite etc. as identified during characterization. Multi-stage processing has been carried out at different magnetic field intensity. Detailed Characterization of product sample has been carried out to study the effect of field intensity on separation efficiency. Based on theses results, a flow sheet has been suggested to improve the yield of the concentrate substantially which is suitable material for the production of iron ore pellet.