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# MINERALS ENGINEERING

- A Global Alert Service

Issue No. 95, October 2012

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**Issue No. 95, October 2012**

**The bonding/strengthening mechanism of colemanite added organic binders in iron ore pelletization**

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International Journal of Mineral Processing, Jul, 2012, Vol. 110, pp. 90-100

The addition of boron compounds into pellet mix is proposed as a potential solution to overcome the insufficient compressive strengths of preheated and fired pellets produced with organic binders. Colemanite was tested as an alternative binder to bentonite either alone or in combination with some organic binders on magnetite pellets. The performances of the tested binders on pellet qualities: balling, wet pellet moisture content, drop number, compressive strengths and microstructure of pellets have been compared with the performances of reference bentonite binders. The results of the tests showed that the qualities of pellets are insufficient when organic binders and colemanite are used as binders alone. The former failed to provide sufficient preheated and fired pellet strengths, the latter failed in terms of wet and dry pellet quality. However, good quality wet, dry, preheated and fired pellets could be produced with the combination of these two binders. In addition, stronger pellets could be produced at lower firing temperatures like 1373 K thanks to addition of colemanite. The bonding mechanism of colemanite containing pellets was examined by scanning electron microscopy. It was found that the improved preheated and fired compressive strengths of colemanite-added pellets were due to the physical melting of colemanite at the contact point of magnetite grains during thermal treatment. (C) 2012 Elsevier B.V. All rights reserved.

10.1016/j.minpro.2012.04.010

**Application of artificial neural network to study the performance of jig for beneficiation of non-coking coal**

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FUEL, Jul, 2012, Vol.97, pp. 151-156

Non-coking coal is the major resource of energy in India. Apart from its utilization in energy sector, the other major application of this coal is in metallurgical sector. The resource of high quality of non-coking coal is not available as per demand; as a result beneficiation of non-coking coal is now becoming essential. Jigging is one of

the economical physical beneficiation processes for Indian high ash non-coking coal. At present scenario in coal washery in India, below 3 mm size is not being processed. Attempt has been taken to beneficiate the fine size non-coking coal fractions generated at different sizes of bed materials, feed rates and water rates using laboratory Denver mineral jig. The performance of jig was evaluated in term of  $E_p$  and imperfection value. Furthermore artificial neural network (ANN) model has been developed for determining combustible recovery and ash percent of the concentrate. The ANN architecture is made up of three layers (input - hidden - output). A back propagation algorithm was used for training of the ANN model. It has been observed that the predicted values by ANN model are in good agreement with the experimental results. (C) 2012 Elsevier Ltd. All rights reserved.

10.1016/j.fuel.2012.02.018

### **A study on the washability of the Azad Kashmir (Pakistan) coalfield**

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FUEL PROCESSING TECHNOLOGY, Jul, 2012, Vol. 99, pp. 75-81

Pre-combustion coal cleaning is one of the most effective methods for removing unwanted minerals and pollutants. Coals are cleaned at the mine site using water-based processes to remove non-combustible minerals and to lower the concentration of pollutants such as sulfur. This paper summarizes the washability study conducted under the coal quality evaluation and beneficiation project of Azad Kashmir (Pakistan) coalfield. The aim of the study was to investigate and interpret washability characteristics of Kotli coalfields. Washability parameters such as degree of washing and washability number were also calculated and compared. The coal samples of Kashmir coalfield belong to lignite (LigB) to high volatile bituminous (hvCb) category on the basis of proximate and gross calorific value analysis containing 8.80 to 85.2% ash, 4.70 to 85.7% fixed carbon and 4.63 to 34.3%, volatile matter. The majority of coal samples under investigation were found amenable to washing using gravity separation. As a result of present investigation 21.6, 22.4, 9.0, 52.1 and 42.3% of ash in the raw coal could be reduced to 7.7, 9.2, 4.8, 5.4 and 10.0% cumulative ash for the five samples. The optimum grade recovery conditions are also discussed in this paper. (c) 2012 Elsevier B.V. All rights reserved.

10.1016/j.fuproc.2012.02.003

### **Large-scale design and testing of an improved fine coal dewatering system**

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JOURNAL OF THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY, Jul, 2012, Vol. 112(7), pp. 673-676

Fine coal (-500  $\mu$  m) is notoriously difficult to dewater. It is not uncommon for a dewatered product to have a moisture content as high as 30 per cent after vacuum filtration. This poses several handling and financial problems to such an extent that a lot of fine coal is discarded onto slurry waste ponds. A novel way of dewatering fine

coal was developed at North-West University. It entails deliberately damaging the filter cake during dewatering to allow for an increased flow of air through the cake at the expense of the applied pressure differential. This method resulted in an average improvement in final cake moisture of between 3 per cent and 5 per cent when executed in the laboratory under controlled conditions. A device was designed that could be fitted onto existing belt filters that would damage the filter cake as it passes by. This device was tested on a vacuum belt filter installation at a coal beneficiation operation in the Waterberg coal field in South Africa. The results showed a 3 per cent reduction in final moisture of the cake, proving the validity of the method at full industrial scale.

### **Prediction of terminal velocity of solid spheres falling through Newtonian and non-Newtonian pseudoplastic power law fluid using artificial neural network**

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INTERNATIONAL JOURNAL OF MINERAL PROCESSING, Jul, 2012, Vol.110, pp. 53-61

Prediction of the terminal velocity of solid spheres falling through Newtonian and non-Newtonian fluids is required in several applications like mineral processing, oil well drilling, geothermal drilling and transportation of non-Newtonian slurries. An artificial neural network (ANN) is proposed which predicts directly the terminal velocity of solid spheres falling through Newtonian and non-Newtonian power law liquids from the knowledge of the properties of the spherical particle (density and diameter) and of the surrounding liquid (density and rheological parameters). With a combination of non-Newtonian data with Newtonian data taken from published data giving a database of 88 sets, an artificial neural network is designed. Analysis of the predictions shows that the artificial neural network could be used with good engineering accuracy to directly predict the terminal velocity of solid spheres falling through Newtonian and non-Newtonian power law liquids covering an extended range of power law values from 1.0 down to 0.06. (C) 2012 Elsevier B.V. All rights reserved. 10.1016/j.minpro.2012.03.012

### **Factors affecting electrical comminution performance**

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MINERALS ENGINEERING, Jul, 2012, Vol. 34, pp. 48-54

Factors affecting electrical comminution performance were investigated through experimental work and numerical simulations. The effects of feed size, under-sieve classification, incremental breakage and energy input level on particle pre-weakening and mineral liberation were tested with six ore samples. Using commercial software, COULOMB 3D, simulation was used to explore the trends between the electrical field distribution/intensity, and the ore particle electrical/mechanical properties. These results were used to interpret the differences in breakage and liberation for various ores. The results showed that the

induced electrical field is strongly dependent on the electrical properties of minerals, the grain size, the location of the conductive minerals in rocks, and the particle shape/orientation. Understanding how the machine-related factors and ore-related factors affect the electrical comminution performance will assist in the machine scale up development. (C) 2012 Elsevier Ltd. All rights reserved.  
10.1016/j.mineng.2012.04.011

### **The liberation effect of magnetite fine ground by vertical stirred mill and ball mill**

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MINERALS ENGINEERING, Jul, 2012, Vol. 34, pp. 63-69

A magnetite middling was used to compare the liberation effect of the magnetite fine ground by a vertical stirred mill and a ball mill. The magnetite middling contained a high content of magnetite intergrowth with the particle size mainly distributed in the range of 40-150  $\mu\text{m}$ . The new generated -38  $\mu\text{m}$  products were concentrated by magnetic separation. Particle size distribution, the degree of mineral liberation and section micrograph of new generated -38  $\mu\text{m}$  products were measured by laser particle size analyzer, mineral liberation analyzer (MLA) and scanning electron microscope respectively. It was found that stirred milling improved the degree of liberation of magnetite selectively. The degree of liberation of magnetite in new generated -38  $\mu\text{m}$  product of stirred milling is 8.1% points higher than that of ball milling and stirred milling mainly improved the degree of liberation of magnetite in +10 to -38  $\mu\text{m}$  size fractions. In the size fractions with identical P80, the degree of liberation of the magnetites in the products of stirred milling is greater than that of ball milling, with the value varied from 2.4% to 29.1% points. The iron grade of magnetic separation concentrate of stirred milling is 5.2% points higher than that of ball milling. The average particle size of new generated -38  $\mu\text{m}$  products by stirred milling is finer when comparing with that by ball milling. The stirred mill was fit to use for fine grinding the middling with a high content of complex intergrowth, especially appropriated for milling P80 10-30  $\mu\text{m}$  minerals to liberate more valuable metals. (C) 2012 Elsevier Ltd. All rights reserved.  
10.1016/j.mineng.2012.04.004

### **Unique challenges of clay binders in a pelletised chromite pre-reduction process**

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MINERALS ENGINEERING, Jul, 2012, Vol. 34, pp. 55-62

Ferrochrome producers strive towards lower overall energy consumption due to increases in costs, efficiency and environmental pressures. In South Africa, in particular, higher electricity prices have placed pressure on ferrochrome producers. Pelletised chromite pre-reduction is most likely the ferrochrome

production process option with the lowest specific electricity consumption currently applied. In this paper, the unique process considerations of clay binders in this process are highlighted and demonstrated utilising two case study clays. It is demonstrated that the clay binder has to impart high compressive and abrasion resistance strengths to the cured pellets in both oxidising and reducing environments (corresponding to the oxidised outer layer and pre-reduced core of industrially produced pellets), while ensuring adequate hot strength of pellets during the curing process. The possible effects of the clay binder selection and the amount of binder addition on the degree of chromite pre-reduction achieved were also investigated, since it could have substantial efficiency and economic implications. The case study results presented in this paper indicated that it is unlikely that the performance of a specific clay binder in this relatively complex process can be predicted, based only on the chemical, surface-chemical and mineralogical characterisation of the clay. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2012.03.021

### **Beneficiation of coal pond ash by physical separation techniques**

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JOURNAL OF ENVIRONMENTAL MANAGEMENT, Aug, 2012, Vol. 104, pp. 77-84

In this study, investigations to develop a beneficiation process for separating coal pond ash into various products were undertaken. To this end, coal pond ash samples with different particle size ranges were tested in terms of their washability characteristics in a float-and-sink analysis. It was found that coal pond ash was heterogeneous in nature consisting of particles that varied in terms of their size and composition. However, it can be made more homogenous using a gravity separation method. Therefore, the possibility of separating coal pond ash was tested on standard equipment typically used for gravity concentration. To increase the separation efficiency, coal ash was separated according to the size of the particles and each size fraction was tested using equipment appropriate for the corresponding sizes. A hindered-settling column and a shaking table were tested for their ability to treat the 1.19 x 0.074 mm size fraction, and a Falcon concentrator was evaluated for its ability to treat the -0.074 mm size fraction. The results showed that various marketable products, such as lightweight aggregate, sand and high-carbon fuel, can be recovered from coal pond ash using simple physical separation techniques. (C) 2012 Elsevier Ltd. All rights reserved.

10.1016/j.jenvman.2012.03.034

### **Investigation of optimum conditions in coal-oil agglomeration using Taguchi experimental design**

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FUEL, Aug, 2012, Vol. 98, pp. 259-264

The present study was undertaken to optimize the oil agglomeration process parameters for maximum recovery of coal fines using analysis of mean (ANOM) statistical approach based on the Taguchi parameter design methodology. The various operational parameters considered during the current study were the type of coal, type of oil, coal particle size and pulp density. The study reported a maximum recovery of 91.03% under the following optimum conditions: low ash high sulphur coal, Karanja oil, coal particle size of +75-200  $\mu$  m and pulp density of 3% (wt./vol.). The percentage contribution of each process parameter towards the agglomerate yield determined using Analysis of Variance (ANOVA) approach was found to be of the following order: coal particle size (55.35%) > type of coal (17.84%) > pulp density (16.50%) > type of oil (8.41%). The most influential process parameter appeared to be coal particle size which has been the primary criteria used for selection of particular process for coal washing. Linear regression analysis carried out using the SPSS 19.0 statistical software further supported the same. Further, a mathematical model was also developed to predict the agglomerate yield by oil agglomeration under the given set of boundary conditions. The experimentally obtained yields were in close agreement with the predicted yield of the model. The agglomerate yield (91.03%) obtained during the confirmation experiment carried out under optimum conditions was much higher than that observed in all the test runs and thereby, the authenticity of optimization was checked. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.fuel.2012.03.027

### **Acid leaching of uranium from a low-grade Indian uranium ore deposit**

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MINERALS & METALLURGICAL PROCESSING, Aug, 2012, Vol. 29(3), pp. 165-168

This paper discusses the leaching behavior of uranium from a low-grade unconformity-related uranium ore occurring in the northwestern part of the Kadapa basin in southern India. This is the major unconformity-related deposit located in India. The U<sub>3</sub>O<sub>8</sub> assay of the ore is about 0.06%. The chief uranium-bearing phase is uraninite, and the ore also has a minor quantity of coffinite. The carbonaceous matter, as well as the porous titanium phases occurring in the ore, is also radioactive. The major gangue mineral is quartz, followed by minor quantities of sericite, chert, chlorite and feldspar. Detailed parametric variation studies were carried out on the ore to optimize conditions for sulfuric acid leaching of uranium values. Based on the laboratory results, preliminary design criteria were developed for process engineering. About 82% of uranium values were leached under conventional atmospheric leaching conditions. Uranium values present in the carbonaceous matter and the other refractory phases were solubilized only after roasting the leach residue. This process improved the overall leach recovery to about 89%. Minerals & Metallurgical Processing, 2012, Vol. 29, No. 3, pp. 165-168. An official publication of the Society for Mining, Metallurgy, and Exploration, Inc.

### **Method to establish theoretical yield-grade relation for Indian iron ore slime through quantitative mineralogy**

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MINERALS & METALLURGICAL PROCESSING, Aug, 2012, Vol. 29(3), pp. 144-147

Conventional characterization methods are inadequate for Indian iron ore slime. As an alternative method, QEMSCAN was used to find the liberation characteristics. This method predicted low theoretical yield for a typical concentrate. This is due to predominance of a mineral phase and wide variation in its chemical composition. The database of QEMSCAN was then modified so that it recognized three broad subtypes of the major mineral phase. The new dataset is used to establish the theoretical yield-grade relation for the concentrate. This information on liberation characteristics depicts the beneficiation prospects of the slime. The proposed method will find its use in characterization of the vast reserves of low-grade Indian iron ore, which is similar to slime in its mineralogical composition and liberation characteristics. The outcome of this study helps in formulating the road map for beneficiation of the vast amount of iron ore in India that exists in the form of slime and low-grade ore. Minerals & Metallurgical Processing, 2012, Vol. 29, No. 3, pp. 144-147. An official publication of the Society for Mining, Metallurgy, and Exploration, Inc.

### **Recent advances in the application of X-ray computed tomography in the analysis of heap leaching systems**

Dhawan, N; Safarzadeh, MS; Miller, JD; Moats, MS; Rajamani, RK; Lin, CL  
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MINERALS ENGINEERING, Aug, 2012, Vol. 35, pp. 75-86

Heap leaching technology is moving forward rapidly as it satisfies most techno-economic considerations and provides several benefits such as low cost, cleaner environment and product, flexibility, and diversified process conditions. Factors such as proper feed preparation, adequate mineralogical analysis, implementation of eco-comminution, and the precise use of characterization tools should be undertaken in order to provide for a successful heap leach process. In view of the important role of comminution and agglomeration in heap leaching systems, both of which have to do with particle size distribution (PSD), improved characterization methods have become of significance in the design and operation of heap leaching systems. An increase in fundamental understanding using advanced characterization tools such as X-ray computed tomography (CT) will make heap leach technology even more adaptable to ever-increasing complex ores in the foreseeable future. High pressure grinding rolls (HPGRs) may become more popular in heap leach operations since they offer several advantages over conventional crushing technologies such as lower energy consumption and increased particle damage. The potential applications of X-ray CT to heap leaching technology and future directions are reported. 10.1016/j.mineng.2012.03.033

### **Recovery of iron from zinc calcines by reduction roasting and magnetic separation**

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MINERALS ENGINEERING, Aug, 2012, Vol.35, pp. 57-60

A new method to recover iron from high iron-bearing zinc calcine was developed. Zinc ferrite ( $ZnFe_2O_4$ ) in zinc calcine was decomposed to zinc oxide and magnetite after roasting under a reducing atmosphere at temperatures over 700 degrees C. A mineral dressing by magnetic separation was used to recover magnetite from the roasted products. The effects of the roasting temperature and magnetic induction intensity on the grade and recovery of iron were investigated. Ultrasonic treatment and mechanical milling played an important part in breaking the encapsulated magnetic phases before magnetic separation. The results show that iron recovery increases with roasting temperature and magnetic induction intensity, and ultrasonic treatment and mechanical milling promote the recovery of iron by 20% compared to the roasted zinc calcine subjected to magnetic separation at the same magnitude. (C) 2012 Elsevier Ltd. All rights reserved.

10.1016/j.mineng.2012.05.014

### **Swirl flow agitation for scale suppression**

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International Journal of Mineral Processing, Sep, 2012, Vol. 112, pp. 19-29

Scale formation is a serious problem in the mineral processing industry. To better understand the options available for mitigating this problem, a novel scale-velocity model is proposed in this paper for slurry systems commonly found in mineral processing plants. The new qualitative scale growth model predicts that at very low fluid velocities the scale growth rate is enhanced by an increase in fluid velocity due to the mass transfer-controlled scale growth. At higher fluid velocities, the scale growth rate decreases with increasing fluid velocity due to the increased flow erosion effect, for slurry systems. This suggests the potential of particulate erosion as a scale suppression mechanism. The model predicts the existence of an optimal slurry flow velocity, where scaling rate and equipment erosion rate are both zero. The optimal fluid velocity value is proposed to be used as the main parameter to improve engineering design of mineral processes in terms of scale suppression. A novel agitator design, swirl flow technology (SFT), developed and patented by CSIRO and Queensland Alumina Ltd (QAL) in Australia was introduced as an agitator design that better meets requirements for scale suppression than a widely used conventional draft-tube agitator system. SFT agitation has been installed in gibbsite precipitators at QAL's alumina plant for a decade. As shown by CFD simulations and laboratory measurements, swirled flow agitation generates more uniform velocity distribution and higher velocity values at the wall than conventional agitators for the

same power input: this reduces the maximum growth rate of scaling in the tank leading to significantly prolonged precipitator's service life. Based on the full-scale operational experience at QAL, it can be suggested that SFT agitation roughly halves the scale growth rate as compared to that measured in the conventional draft tube agitator systems. (c) 2012 Elsevier B.V. All rights reserved.  
10.1016/j.minpro.2012.07.007

### **Flotation of molybdenite fines as hydrophobic agglomerates**

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SEPARATION AND PURIFICATION TECHNOLOGY, Sep, 2012, Vol. 98, pp. 451-455

The flotation of molybdenite fines as hydrophobic agglomerates has been studied through micro-flotation and microscopy observations in this work. The hydrophobic agglomeration was achieved with a strong mechanical conditioning and a small amount of kerosene addition. The experimental results showed that floc-flotation is much more effective than conventional flotation for the beneficiation of molybdenite fines. At the same flotation time, floc-flotation reached the flotability of 90%, while conventional flotation only did 35%. The most important parameters in the floc-flotation were mechanical conditioning strength and kerosene addition. A good floc-flotation could be achieved by applying a high-speed stirring for a short time. The kerosene enhancement of the floc-flotation closely correlated with droplet size of kerosene emulsion. The smaller were the droplets, the better the floc-flotation was. (C) 2012 Elsevier B.V. All rights reserved. 10.1016/j.seppur.2012.06.016

### **Exergetic and environmental analysis of a pulverized coal power plant**

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ENERGY, Sep, 2012, Vol. 45(1), pp. 195-202

This paper presents the results of exergetic and environmental analysis of a typical pulverized coal power plant located in Brazil. The goal was to quantify both the exergy destruction and the environmental impact associated with a thermal power plant. The problem boundary consists of the entire coal delivery route, including mining and beneficiation, transport, pre-burning processes and the power plant. The used data were obtained mainly from field measurements taken in all system processes, from mining to the power plant. The study focused only on the operation period. Previous works have shown that the construction and decommissioning periods contribute less than 1% of the environmental impact. The exergetic analysis was based on the second law of thermodynamics while the environmental analysis was based on life cycle assessment (LCA) using SimaPro 7.2, focussing on the climate change and acidification impact categories. The CO<sub>2</sub>-eq emission was 1300 kg per MWh. The highest degree of environmental impact occurred during the combustion process. The exergetic and environmental analysis provides a tool to

evaluate irreversibilities and the environmental impact, identifying the most significant stages and equipment of the entire power generation process. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.energy.2012.01.080

### **Hypolithic microbial communities: between a rock and a hard place**

Chan, YK; Lacap, DC; Lau, MCY; Ha, KY; Warren-Rhodes, KA; Cockell, CS; Cowan, DA; McKay, CP; Pointing, SB

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ENVIRONMENTAL MICROBIOLOGY, Sep, 2012, Vol. 14(9), pp. 2272-2282

Drylands are the largest terrestrial biome on Earth and a ubiquitous feature is desert pavement terrain, comprising rocks embedded in the mineral soil surface. Quartz and other translucent rocks are common and microbial communities termed hypoliths develop as biofilms on their ventral surfaces. In extreme deserts these represent major concentrations of biomass, and are emerging as key to geobiological processes and soil stabilization. These highly specialized communities are dominated by cyanobacteria that support diverse heterotrophic assemblages. Here we identify global-scale trends in the ecology of hypoliths that are strongly related to climate, particularly with regard to shifts in cyanobacterial assemblages. A synthesis of available data revealed a linear trend for colonization with regard to climate, and we suggest potential application for hypoliths as biomarkers of aridity on a landscape scale. The potential to exploit the soil-stabilizing properties of hypolithic colonization in environmental engineering on dryland soils is also discussed. 10.1111/j.1462-2920.2012.02821.x

### **Characteristics of Minimum Fluidization Velocity for Magnetite Powder used in an Air Dense Medium Fluidized Bed for Coal Beneficiation**

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PARTICLE & PARTICLE SYSTEMS CHARACTERIZATION, Sep, 2012, Vol. 29(4), pp. 228-237

Accurate determination of minimum fluidization velocity of medium particle is essential for proper designing and operation of an Air Dense Medium Fluidized Bed Separator for coal beneficiation. Significantly different values of minimum fluidization velocity have been obtained from different available correlations. So, it is necessary to develop a suitable correlation for this specific purpose. In this study, the minimum fluidization velocities of different size magnetite powders are investigated in a 15 cm diameter fluidized bed. Three correlations are derived from the fundamental principles for the theoretical prediction of these minimum fluidization velocities. The adequacy and reliability of each of these correlations is tested by adopting a statistical analysis approach and the most suitable correlation is selected. The predictive capability of this selected correlation is verified by using the data available in the literature. The results show that this new correlation is in very well agreement with these experimental data and shown to be applicable for

practical purpose. Moreover, this study reveals that the correlation developed from the basic particle properties and bed characteristics can predict more accurate results. 10.1002/ppsc.201100020

### **Effect of MgO in the form of magnesite on the quality and microstructure of hematite pellets**

Srinivas Dwarapudi, Tamal K. Ghosh, Vilas Tathavadkar, Mark B. Denys, D. Bhattacharjee, R. Venugopal

*International Journal of Mineral Processing, Vol. 112–113, 10 Sept 2012, pp. 55-62*

MgO addition to pellets improves their high temperature properties by improving the oxide and slag phases. In the present study, effect of MgO, in the form of magnesite flux, on pellet quality, melt formation and microstructure during the induration was examined. Fired pellets with varying MgO contents (0 to 3.0%) were tested for cold crushing strength, reduction degradation index, reducibility and swelling characteristics. Optical microstructural studies with image analysis were carried out to estimate the amount of different phases. SEM-EDS analysis was done to measure the chemical analysis of oxide and slag phases. X-ray mapping was also carried out to understand the distribution of CaO, MgO, SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub> in different phases. From the results, it was observed that with increasing MgO, RDI and swelling characteristics of pellets were found to be improved. Reducibility of the pellets improved substantially in the range of 0.5 to 1.5% MgO. Formation of magnesioferrite phase and high melting point slag formed during induration could be attributed to the improved quality of pellets. Pellets with 2 to 3% magnesite addition, to get 1.0 to 1.5% MgO, exhibited optimum metallurgical properties among all the pellets studied.

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

**Abhilash, and Kumari, Neha and Pandey, B D (2012) *Isolation of native extremophiles from indian bauxite and red mud for mineral beneficiation. In: XXVI International Mineral Processing Congress (IMPC) 2012 Proceedings, September, 2012, New Delhi.***

Different methods of utilizing refractory bauxite and disposing red mud are practiced throughout the world, but none of them are known to be environmentally innocuous due to the complexity and /or high cost, and none has been found to be feasible on an industrial scale. Under these conditions, the use of bioleaching process seems promising. The present study emphasizes on the isolation of native extremophiles from the source Indian bauxite and red mud, with their detailed cellular and physio- chemical, and biochemical characterization. These organisms were tested for their ability to thrive in physically or geochemically extreme conditions. The gram positive capsule rich mesophiles and thermophiles were tested for removal of gangue minerals from the bauxite and red mud samples. <http://eprints.nmlindia.org/6118/>

**Agarwal, Sanjay and Sahu, K K and Godiwalla, K M and Jana, R K (2012) *Manganese distribution between alloy & slag phases in making Fe-Si-Mn alloy from polymetallic sea nodules. In: XXVI International Mineral Processing Congress (IMPC) 2012 Proceedings, September, 2012, New Delhi.***

Polymetallic sea nodule is a good source of manganese having 22.3% Mn, 5.4% Fe, 6.14% Si, 1.1% Cu, 1.15% Ni, 0.076% Co & others. These nodules are available in plenty on the sea beds, generated over thousands of years. Nodules mainly consist of manganese dioxide and iron oxide phases and other metals are entrapped in the complex cage of these Mn-Fe oxides phases. World-wide research is going on sea nodules as an alternative future source of many metals, which has led to intensified efforts to develop practical and economical processes for recovery of these metals. Very little attempt has been made world over on manganese extraction from sea nodules. We at CSIR-NML, India have developed a direct reduction smelting process of nodules to recover manganese as Fe-Si-Mn alloy. This alloy is extensively used in the steel industry as deoxidizer and as an alloying element to make different grades of steel. Lab scale experiments were conducted to study the manganese distribution between Fe-Si-Mn alloy and FeO-SiO<sub>2</sub>-MnO-CaO-Al<sub>2</sub>O<sub>3</sub>-MgO slag at different temperatures by varying the basicity of the slag. The direct reduction smelting of nodules is carried out on 1 kg scale in 50 kVA electric arc furnaces to have Cu, Ni and Co alloy and Mn rich slag. This manganese rich slag is further treated in 50 kVA arc furnace to produce Fe-Si-Mn alloy. The composition of Fe-Si-Mn alloy obtained is

in the range of Mn: 60-65%, Si: 14-17%, C: 1- 2%, S: 0.03% and the balance iron which is acceptable grade for industrial use. The equilibrium amount of MnO in the final slag is controlled by the temperature of the final melt and the silica, lime, alumina content of the final slag. Increasing the basicity of the slag plays a major role in minimizing the loss of MnO to slag, increasing the amount of SiO<sub>2</sub> of the slag, increases the manganese loss in the slag. Increasing the CaO/ Al<sub>2</sub>O<sub>3</sub> ratio of the slag decreases the manganese loss in the slag. Increasing the MgO/CaO ratio of the slag increases the manganese loss in the slag. Thus by adjusting the desired content of the slag, we have maximum recovery of the manganese in the Fe-Si- Mn alloy. <http://eprints.nmlindia.org/6103/>

**Agrawal, A and Kumari, S and Parveen, M and Sahu, K K (2012) *Exploitation of Copper Bleed Stream for the Extraction and Recovery of Copper and Nickel by Bis(2,4,4-trimethylpentyl)phosphinic Acid*. Mineral Processing and Extractive Metallurgy Review: An International Journal, 33 (5). pp. 339-351.**

Bleed streams from copper electrolysis/electrowinning processes potentially contain high amounts of acid, copper, and nickel which need an effective treatment before disposal. A systematic study was carried out to optimize the parameters for the extraction and recovery of metal values using bis(2,4,4-trimethylpentyl)phosphinic acid (Cyanex 272) diluted with kerosene. Since pH has a major role to play in the separation of Cu from Ni, a 60% saponified solvent was used for extraction studies. With an increase in equilibrium pH from 3.32 to 5.48 and extractant concentration from 5 to 20%, there is an increase in the percentage extraction of metal ions. With a solvent concentration of 20%, the separation factor for Cu with respect to Ni ( ) increases from 39.1 to 118.8 with the increase in pH from 3.3 to 5.5. Loading capacity of 20% Cyanex 272 was found to be 30.8 g/L Cu and 0.024 g/L Ni. After scrubbing of coextracted Ni(II) with 15 g/L H<sub>2</sub>SO<sub>4</sub>, the loaded organic containing 30.59 g/L Cu(II) and 4 ppm Ni(II) was stripped with 75 g/L sulfuric acid. A McCabe-Thiele plot shows the requirement of two counter-current stages at an O:A ratio of 1:1 for extraction and two counter-current stages at O:A ratio of 2:1 for the stripping of copper. Results of the present investigation indicate the possibility of the use of saponified Cyanex 272 for the extraction, separation, and recovery of copper and nickel from the actual spent copper bleed streams. <http://eprints.nmlindia.org/5628/>

**Dey, Shobhana and Pani, S (2012) *Effective Processing of Low-Volatile Medium Coking Coal Fines of Indian Origin using Different Proces Variables of Flotation*. International Journal of Coal Preparation and Utilization, 32(6) . pp. 253-263.**

The low-volatile medium coking coal fines from the eastern part of the Indian coalfield was used for this study. The proximate analysis of the composite sample

designates that the fines contain about 25% ash, 21.4% volatile matter, and 52.4% fixed carbon. The ash in the size fraction of 0.5 +.15mm is lower (21.9%) than the -0.15mm fraction (29.7%). The flotation characteristic of the composite coal reveals that recoverable combustible at 15% ash is 27% and 43% at the 17% ash level. The low yield of the concentrate is due to the presence of fines comprising high ash. To enhance the yield, the -0.5+0.15mm and -0.15mm fractions were subjected to flotation separately. The effects of reagent dosage and aeration rate were studied with a composite and the -0.5+0.15mm fraction to produce low-ash clean coal. Release analysis carried out with -0.5+0.15mm coal improves the recovery of combustibles to 42% at 15% ash%. The spilt flotation of -0.5+0.15mm feed at the lower frother dosage and lower aeration favors generating the clean coal with low ash. The -0.15mm fraction was floated with collector using sodium silicate as a depressant. The products having different ash levels could be used in specific purposes. <http://eprints.nmlindia.org/6350/>

**Dey, Shobhana and Pani, S and Das, Avimanyu (2012) *Scanvenging of High-Value Product from High-Ash Medium Coking Coal: A Compulsion for Less Endowed Regions. International Journal of Coal Preparation and Utilization, 32(5) (0.289). pp. 238-251.***

Beneficiation of a high-ash (35%) medium coking coal to obtain a low-ash (12%) clean coal product is investigated. Characterization studies indicated that this coal can be processed after reducing the size to 1.18 mm in order to achieve reasonable yield of the clean coal at such a low target-ash level. The desired ash reduction is possible only after treating different size fractions of the -1.18 mm crushed coal separately. A gravity-based processing scheme comprising of a spiral-floatex circuit along with multigravity separator for the -1.18+0.5 mm fraction is developed to generate clean coal at 12% ash with 10.3% overall yield. Mechanical cell flotation circuit for the -0.5+0.15 mm size fraction resulted in additional 5.2% yield at 12% target ash level for the clean coal. A flotation circuit for the ultrafine fraction (-0.15 mm) is also developed using Jameson cell flotation that added further 4.4% yield in the overall mass recovery of the combustibles at the desired ash level. Thus, a total of 20% yield of the clean coal with 12% ash is achieved by treating various size classes separately. Application of the clean coal is recommended for metallurgical purpose. Out of the remaining 80% material, 35% is recovered at a 27% ash level that is recommended for use in sponge iron sector. The balance 45% with an ash level of 50% is marked for use in fluidized bed combustion for power generation. A complex flowsheet such as the one described in the present article is likely to be the future requirement for processing high-ash medium coking coals to a high-value low-ash product to enhance its utilization potential for metallurgical purpose <http://eprints.nmlindia.org/6351/>

**Dey, Shobhana and Pani, Santosh and Das, Avimanyu (2012) *Split flotation of LVMC coal to generate multiple products for complete utilization.* In: *International Mineral Processing Congress, 2012, 24-28 Sept 2012, New Delhi.***

A low volatile medium coking coal from Jharia coal field, India was used for this investigation. The proximate analysis of the sample shows that it contains about 25% ash, 21.4% volatile matter and 52.4% fixed carbon. The sizewise ash analysis of -0.5 mm coal indicates that -0.5+0.15 mm fraction contains lower ash (21.9%) than -0.15 mm fraction (29.7%). The flotation characteristics of the -0.5 mm coal were determined by release analysis. The study reveals that recovery of combustible at 15% ash is about 27% and 43% at 17% ash level. The low recovery is due to the presence of high ash in finer fraction. In order to improve the recovery, the -0.5 mm feed was classified into -0.5+0.15 mm and -0.15 mm fractions, and subjected to flotation separately. The recoverable combustible obtained from the release analysis of -0.5+0.15 mm at 15% ash level is 46%. The effect of collector dosage, frother dosage and aeration rate on flotation was studied. The responses of these variables in collectorless flotation of the -0.5+0.15 mm fraction containing low ash were also studied. A lower aeration and frother dosage favored the generation of clean coal with low ash. The ash content in the tailing stream from -0.5+0.15 mm flotation circuit is close to that of the original -0.15 mm fraction. The former is ground to -0.15 mm and the two fractions are processed together. As -0.15 mm fraction contains relatively higher ash, collector aided flotation using sodium silicate was performed to recover the clean coal with 17% ash. The products of the overall flotation circuit having different ash levels were recommended for use in different applications. The reject from -0.15 mm flotation circuit contained 56.4% ash which can be used for fluidized bed combustion (FBC). This eventually leads to complete utilization of coal. <http://eprints.nmlindia.org/6552/>

**Dey, Shobhana and Pani, Santosh and Mohanta, M K and Singh, Ratnakar (2012) *Utilization of Iron Ore Slimes: A Future Prospective.* *Separation Science and Technology*, 47 (5). pp. 769-776.**

In India, iron ores processing industries play a vital role in the Indian economy. During the washing and processing of iron ores, slimes less than 0.15 mm are generated and discarded into the tailing pond. These slimes need processing as they cannot be used directly in blast furnaces. In the present investigation, a typical iron ore slime sample containing 59.22% Fe, 4.76% SiO<sub>2</sub>, and 4.57% Al<sub>2</sub>O<sub>3</sub> was taken. The desliming operation was carried out by using 2'' Mozley hydrocyclone. The process variables used to attain the optimum condition of desliming include the spigot opening, the feed pressure, and the diameter of the vortex finder maintaining the pulp density at 10% solid. The deslimed sample was treated by different techniques including an enhanced gravity separator to achieve iron concentrate with 65% Fe so that it can be used for steel making through pelletization. The yield of the magnetic concentrate is about 46.8% with 65% Fe. To improve the yield, the

overflow from 2'' hydrocyclone and the rejects from magnetic separation were deslimed and processed to recover the iron values. The final concentrate is 74% yield with 64.8% Fe, 1.76% SiO<sub>2</sub>, and 1.8% Al<sub>2</sub>O<sub>3</sub>. <http://eprints.nmlindia.org/5040/>

**Dey, Shobhana and Parolis, L A S and Yorath, G (2012) *Quantification of Sulphydryl Collector-Mixture Used in Sulphide Ore Flotation*. Transaction of the Indian Institute of Metals, 65 (4). pp. 387-392.**

Sulphydryl collectors are used for the flotation of sulphide ores. Sometimes a combination of various types of sulphydryl collectors having different functional groups are used to improve the flotation performance. Usually UV spectrophotometry technique is used to quantify the unabsorbed amount (residual concentration) of single sul-phydryl collectors left after the adsorption or flotation studies. When a mixture of these collectors is present, UV spectrophotometry gives erroneous results as there is an interference of the spectra over the other. An alternative approach, ion-pairing chromatography (high performance liquid chromatography) gives encouraging results. This practice utilises the separation of chromatograms and determines the concentration of sulphydryl collectors spectrophotometrically. It can effectively quantify the mixtures of sulphydryl collectors of different functional groups and thus estimates the amount of chemicals needed for effective flotation, and also minimises the adverse effect of the same on the environment. <http://eprints.nmlindia.org/5811/>

**Dhal, B and Das, N N and Thatoi, Hruayanath and Pandey, B D (2012) *Bacterial Reduction of Hexavalent Chromium from Contaminated Overburden Soil*. International Journal of Metallurgical Engineering, 1(5) . pp. 83-87.**

This study was focused for the bioreduction of Cr(VI) from chromite mine overburden soil using a highly tolerant Bacillus sp. isolated from chromite mine soil. Under the optimized conditions of pH ~7.0, Bacillus sp. ( $4.05 \times 10^7$  cell mL<sup>-1</sup>) reduced more than 98% of Cr(VI) from the soil sample in 16 h at 60% pulp density(PD). The exponential rate equation yielded rate constants in the range  $4.923 \times 10^{-1} \text{ h}^{-1}$  –  $2.141 \times 10^{-1} \text{ h}^{-1}$  for 20% and 60% PD respectively, which decreased with increase in Cr(VI) concentration. The bio-reduction was also carried out in absence of media at the higher pulp density (60%) as used in the chromite ore beneficiation plant. After bio-reduction the samples were characterized using FT-IR for the leaching of other valuable metals using bio-organic acids. <http://eprints.nmlindia.org/6581/>

**Hore, S and Das, Suchandan K and Singh, Ratnakar and Bhattacharyya, K K (2012) *Efficiency Study of a Water-Only Cyclone by Experimental and Data Modeling Techniques when Cleaning Indian Coal Fines*. International Journal of Coal Preparation and Utilization, 32 (4). pp. 193-209.**

Experiments have been conducted on a water-only cyclone in conjunction with washability studies for Patherdih and Munidih coal samples of Eastern India to characterize the cyclone efficiency. Data driven semi-empirical performance models have been developed using in-house experimental data. Washability studies on the Patherdih sample have been undertaken to determine the specific gravity of separation for a targeted coal quality. Size classification analysis has been conducted for the Munidih sample to estimate the cut-size. The Mayer and partition curves have been generated from float-and-sink analysis. Subsequently, reduced efficiency curves have been constructed using specific gravity as well as size classification data. The Rosin-Rammler and logistic distribution functions have been employed to model the data to generate the reduced efficiency curve, which characterizes the classification efficiency. Model parameters have been estimated for these distribution functions. Parametric sensitivity analysis was carried out by changing the operating parameters, namely, apex diameter, and feed inlet pressure and percentage solids in the feed to study the classification behavior. Model predictions were found to be in good agreement with the published literature. Efficiency mapping by the Rosin-Rammler distribution was found to be well suited for the Patherdih coal and both the Rosin-Rammler and logistic distributions are equally appropriate for Munidih coal. <http://eprints.nmlindia.org/5963/>

**Jha, Manis K and Choubey, Pankaj K and Jha, Amrita Kumari and Kumari, Archana and Lee, Jae-chun and Kumar, Vinay and Jeong, Jinki (2012) *Leaching studies for tin recovery from waste e-scrap*. Waste Management, 32(10) (IF-2.428). pp. 1919-1925.**

Printed circuit boards (PCBs) are the most essential components of all electrical and electronic equipments, which contain noteworthy quantity of metals, some of which are toxic to life and all of which are valuable resources. Therefore, recycling of PCBs is necessary for the safe disposal/utilization of these metals. Present paper is a part of developing Indo-Korean recycling technique consists of organic swelling pre-treatment technique for the liberation of thin layer of metallic sheet and the treatment of epoxy resin to remove/recover toxic soldering material. To optimize the parameters required for recovery of tin from waste PCBs, initially the bench scale studies were carried out using fresh solder (containing 52.6% Sn and 47.3% Pb) varying the acid concentration, temperature, mixing time and pulp density. The experimental data indicate that 95.79% of tin was leached out from solder material using 5.5 M HCl at fixed pulp density 50 g/L and temperature 90 C in mixing time 165 min. Kinetic studies followed the chemical reaction controlled dense constant size cylindrical particles with activation energy of 117.68 kJ/mol. However, 97.79%

of tin was found to be leached out from solder materials of liberated swelled epoxy resin using 4.5 M HCl at 90 C, mixing time 60 min and pulp density 50 g/L. From the leach liquor of solder materials of epoxy resin, the precipitate of sodium stannate as value added product was obtained at pH 1.9. The Pb from the leach residue was removed by using 0.1 M nitric acid at 90 C in mixing time 45 min and pulp density 10 g/L. The metal free epoxy resin could be disposed-of safely/used as filling material without affecting the environment. <http://eprints.nmlindia.org/5452/>

**Jha, Manis K and Kumar, Vinay and Jeong, Jinki and Lee, Jae-chun (2012) *Review on solvent extraction of cadmium from various solutions. Hydrometallurgy, 111-112 (IF-2.027). pp. 1-9.***

Cadmium has wide application in the manufacturing of alloys, batteries, pigments and metal plating. The solid and liquid waste is generated during the production and at the end of service life. The recovery and recycling of cadmium from these waste materials is necessary to gain the metal values and protect the environment from hazard. In hydrometallurgical processes, solvent extraction is an important process for the recovery of non-ferrous metals from different aqueous leach liquor and waste effluent/solutions. In present paper, the solvent extraction processes for the extraction and recovery of hazardous metal cadmium from aqueous solutions associated with commonly metallic and non-metallic ions, such as sulfate, chloride, nitrate and phosphate have been reviewed. Different process parameters, viz. pH, organic- to -aqueous ratio, kinetics of extraction and stripping to establish the conditions required for the extraction of cadmium and formation of a complex in the organic phase from different solutions, have been reported. The studies show the possibility of extraction and separation of cadmium from different solutions containing other metallic ions using anionic, cationic, solvating or mixed extractants. However, further attempts are also being made to develop selective organic extractants to recover cadmium efficiently on a commercial scale. The findings of these studies are also reported. <http://eprints.nmlindia.org/4316/>

**Jha, Manis K and Kumari, Archana and Choubey, Pankaj K and Lee , Jae-chun and Kumar, Vinay and Jeong, Jinki (2012) *Leaching of lead from solder material of waste printed circuit boards (PCBs). Hydrometallurgy, 121-124 (IF-2.027). pp. 28-34.***

Present work is focused on the selective leaching of lead from the soldering material present on the outer layer i.e. epoxy resin of waste PCBs, liberated through a novel pre-treatment technique of organic swelling using n-methyl-2-pyrrolidone. Nitric acid was found as a suitable leachant to dissolve lead. Initially, the effect of temperature, S:L ratio, leaching time and acid concentration on leaching of lead was investigated using fresh solder material containing 47.36% lead and remaining tin.

With 0.2 M HNO<sub>3</sub> at S:L ratio 1:100 (g/mL) and temperature 90 °C, 99.99% lead was leached in 120 min. Leaching kinetics followed  $1-(1-X)^{1/3}=Kct$  i.e. chemically controlled reaction model with activation energy 26.94 kJ/mol. Validation of lead leaching from solder of liberated epoxy resin of swelled PCBs indicates that 99.99% of lead could be leached out at 90 °C with 0.2 M HNO<sub>3</sub> in 45 min. Tin left in the residue of the liberated resin was further leached with 3.5 M HCl at 90 °C for 120 min at S:L ratio 1:20 (g/mL), which dissolve almost 98.74% tin. Then, metal free epoxy resin was washed with water to utilize it or dispose-of safely without affecting the environment. <http://eprints.nmlindia.org/5342/>

**Kumar, Vinay and Lee, Jae-chun and Jeong, Jinki and Shin, Doyun and Jha, Manis K and Kumar, Vinod (2012) *Enrichment of valuable metals from end-of-life printed circuit boards using mechanical recycling techniques*. In: XXVI International Mineral Processing Congress (IMPC) 2012 Proceedings, September, 2012, New Delhi.**

Large quantities of electrical and electronic equipments are discarded at the end-of-life (EOL) in different industries and house hold applications. Their disposal is creating a challenging environmental problem due to the presence of hazardous metals and non-metallic materials such as epoxy resins and plastics including brominated flame retardants etc particularly in printed circuit boards (PCBs). The recovery valuable metals and separation of hazardous materials from discarded PCBs will not only conserve the resources but also mitigate the environmental pollution. From a recycling point of view for a sustainable society, the studies have been carried out for the recovery of metal values from EOL-PCBs of DVD video players (DVD-PCBs) and vacuum cleaners (VC-PCBs) using physical beneficiation techniques. The concentration of the metals was found to be 43 wt.% and 30 wt.% in DVD-PCBs and VC-PCBs, respectively. Both the PCBs samples were ground in a hammer mill after cutting and their size analysis was carried out. The liberation of the metallic and non-metallic fractions was investigated under the microscope for different size fractions. Subsequently, froth flotation and pneumatic air separation studied were carried out to enrich the metallic constituents. The studies showed the enrichment of metals in coarser particles (-1000 +150 μm) and non-metals in the finer particles -150 μm following mechanical recycling process. A grade of 90 % with 75% recovery was achieved by froth flotation, but lower grade and recovery of 75% and 65% respectively were obtained by pneumatic separation with -1500 μm powders for DVD-PCBs. A grade of 86% metal was obtained by froth flotation with 76% recovery in the case of VC-PCBs. The lower grade of 65% with almost same recovery was achieved during pneumatic separation studies due to lower concentration of metals in VC-PCBs. The studies also showed that the froth flotation is an efficient process for enrichment of metals from both the samples. The process is environmental friendly as no chemicals are employed during entire processing. The higher recovery and grade of metal is expected to be obtained on a large scale beneficiation process. <http://eprints.nmlindia.org/6245/>

**Rath, R K and Mohanty, Sunati and Nayak, B and Singh, Ratnakar and Bhattacharyya, K K (2012) *A Comparative Study on Processing of High Alumina Hematite Iron Ore by Gravity, Magnetic and Flotation Methods*. In: International Mineral Processing Congress (IMPC - 2012), 24 - 28 September 2012, New Delhi, India.**

The low grade iron ore sample contains both lumps and fines. It is mostly hematitic iron ore and considerable amount of goethitic/limonitic material is also present in it. The major impurities present were quartz and clay. It is observed that the iron bearing phases are poorly liberated above 300  $\mu\text{m}$  and the liberation improves below 300  $\mu\text{m}$ . More than 80% liberation is achieved below 106  $\mu\text{m}$ . Based on the liberation data, the feed for the different beneficiation methods was prepared by stage crushed the ROM followed by grinding passing to 106 $\mu\text{m}$  and the ground material (-106  $\mu\text{m}$ ) was deslimed. The underflow was subjected to various beneficiation techniques such as tabling, enhanced gravity separator (EGS), wet high intensity magnetic separation (WHIMS) and flotation and the results are discussed. All the methods studied could able to produce pellet grade concentrate with iron content of 64.5%, however, a marginal higher yield was observed for WHIMS (81%). <http://eprints.nmlindia.org/6738/>

**Roy, Subrata and Mandal, S K and Das, Avimanyu (2012) *Segregation and Process Features in a Teeter Bed Separator as Revealed by High Speed Videography and Image Processing*. Mineral Processing and Extractive Metallurgy Review: An International Journal, 06 Aug 2012 .**

Gravity concentration in a liquid fluidized bed floatex density separator (FDS) was investigated through high speed videography and image analysis. Process performance in terms of yield and grade of the product for fine coal beneficiation in the FDS was established experimentally. The feed coal (-1.18 mm) with 36% ash was enriched to 24% ash at a mass yield of 65%. Coarsest underflow with a  $d_{50}$  of 700  $\mu\text{m}$  was obtained at 5.8 kPa bed pressure, 120 kg/h feed rate and 12 lpm teeter water flow. The lowest SG50 of 1.62 was obtained at 5.4 kPa, 15 lpm and 80 kg/h. At 9 lpm water flow, steady state was achieved in 400 sec when the voidage and suspension density distributions became constant. From the suspension density distribution, the SG50, 1.69 under this set of conditions, was estimated with reasonable accuracy. Increase in teeter water was shown to increase the time required for attaining steady state. It was established that particle size distribution at the bottom of the bed in the column offers a good indication of the separation performance. The influences of the operating variables on the axial steady state profile of the suspension density and voidage were also established. Image analysis is shown to be quite useful in collecting quantitative transient and steady state data that may be difficult to obtain otherwise. The process performances were adequately described using such transient and steady state observations. <http://eprints.nmlindia.org/5975/>

**Roy, Subrata and Vidyadhar, A and Konar, J and Das, Avimanyu (2012) *Metal Enrichment of Finely Ground Electronic Waste using Eddy Current Separation. Separation Science and Technology*, 47 (12). pp. 1777-1784.**

The applicability of Eddy Current Separation (ECS) in the processing of relatively fine (-1.0 mm) electronic waste is investigated. An in-depth understanding of the influences of the operating variables in the ECS is obtained by experimentation and optimization exercise. It is established that a high quality product can be generated with a high recovery of metal values in single stage operation of the ECS even for finely ground electronic waste. A high rotor speed helps in generating a purer product albeit with a lower mass yield. Conveyer belt speed does not have a substantial effect on the quality of the product but the mass yield increases with an increase in the belt speed. The mass yield improves when the feed rate increases but the product grade deteriorates. Material related variables such as particle size and specific gravity play significant roles in the horizontal deflection of the nonferrous metallic particles. It was established that below a size of 0.1 mm effective separation of metals is not possible in the ECS. Although particle shape plays a role, it may not be feasible to achieve separation based on shape in this size range. Mathematical models for the mass yield and product grade were established.

<http://eprints.nmlindia.org/5974/>

**Singh, Ranjeet K and Das, Avimanyu (2012) *Study of the separation features of fine coal cleaning in kelsey centrifugal jig. In: XXVI International Mineral Processing Congress (IMPC) 2012 Proceedings, September, 2012, New Delhi.***

Kelsey Centrifugal Jig was found to be promising for the beneficiation of fine coal particles. The present study was aimed at in-depth understanding of the separation features of Kelsey Jig through detailed experimentation. Beneficiation of fine coal of size 150 x 300  $\mu\text{m}$  was studied in a laboratory Kelsey Jig. The thickness of the ragging bed is found to be an extremely crucial parameter apart from the other process parameters such as rotational speed and pulsation frequency. A constant pulp density (25% solids) of the feed slurry was maintained in the study. The feed rate was also kept constant at 50 kg/hr dry solids. Silica sand of size -1.68+0.85 mm was used as ragging material to avoid the pegging of internal screen having an opening of 425  $\mu\text{m}$ . The rotational speed was found to have significant effect on the depth of the ragging bed and its porosity, which influenced the separation performance considerably. Pulsation was identified as the key factor in stratifying the coal bed and defining the misplacement as well as ragging bed porosity, which influenced the mass yield and quality of the products. Beneficiation studies were carried out with rotational speed varying between 900-1000 rpm while pulsation frequency was kept within 850-925 rpm. In a single pass through the Kelsey Jig 7-8% (absolute) reduction in the ash content of the feed material was observed at more than 55% mass yield. High rotational speed, moderate pulsation, and low ragging bed depth favored good cleaning. A high bed depth was found to facilitate rejection

of high ash materials. It was established that Kelsey Jig is effective in fine coal cleaning though a controlled operation is required in order to achieve superior performance. <http://eprints.nmlindia.org/6108/>

**Vidyadhar, A and Das, Avimanyu (2012) *Kinetics And Efficacy Of Froth Flotation For The Recovery Of Metal Values From Pulverized Printed Circuit Boards*. In: XXVI International Mineral Processing Congress (IMPC) 2012 , September 24-28, 2012, Hotel Ashok, Diplomatic Enclave, New Delhi.**

Printed circuit boards (PCBs) constitute a major part of electrical and electronic equipment containing valuable metals such as Cu, Ni, Au, Ag, Pd, Fe, Sn, Pb, etc. The concentration of base and precious metals in PCBs is observed to be several times more than those in their respective ores. Therefore, the recycling of PCBs is necessary to recover the valuable materials. However, the ultrafine particles pose a big challenge. Removal of them is suggested prior to processing by flotation. Froth flotation is observed to be a promising technique for rejecting the plastics from the comminution product. In the present work, enrichment of ground 1.0 mm PCB powder was investigated through flotation route by varying the operating variables such as frother dosage, pulp density, air flow rate and rotational speed of the impeller. The liberation studies indicate that excellent liberation of metal values is achieved from the non-metallic constituents at -1.0 mm size and below. The particulate system is quite rich in metal value with about 23% total metal content. The non-metallic constituents such as plastics are observed to possess strong hydrophobicity while the metal particles in the pulverized mass are hydrophilic in nature. Froth flotation kinetics is studied in depth with a view to facilitate high rejection of the plastics and identify optimum operating conditions for the same. A number of experiments are performed to establish the influence of the operating variables on flotation performance. The conditions for achieving higher yield of the metal-rich fraction with respect to a specified grade are discussed in the light of the experimental results. It is found that the requirement of reagents is negligible which could be a very important factor from the commercial stand point. Single-stage flotation increases the metal content from 23% to over 32% with a mass yield of around 75% and over 90% recovery of metal values. 32% of the materials in the feed could be effectively rejected in the float fraction losing less than 4% metal values. The dependence of kinetics on the process variables is also discussed. It was concluded that a high rotor speed helps in efficiently rejecting the plastics. Frother should be added to help stabilize the froth and enhance the kinetics. A moderate air flow is required while pulp density must be kept low for efficient pre-concentration. It is established that the entire -1.0 mm comminution product could be treated by flotation for generating a pre-concentrate. <http://eprints.nmlindia.org/6188/>

**Vidyadhar, A and Kumari, Neha and Bhagat, R P (2012) *Adsorption mechanism of mixed collector systems on hematite flotation*. Minerals Engineering, 26 . pp. 102-104.**

Adsorption mechanism of mixed cationic C12 amine and anionic sulphate/oleate collectors was investigated on hematite through Hallimond flotation studies. The flotation response of hematite independently with cationic and anionic collectors and with mixed cationic/anionic collector systems is assessed. Hallimond flotation response of hematite as a function of pH and collector concentration was investigated. The study revealed that hematite flotation recovery is maximum at acidic pH with sulphate, at neutral pH 6–7 with oleate, and at basic pH about 9.5 with C12 amine. It is the first time that the hematite flotation results show an increased adsorption of cationic collector in the presence of anionic collector apart from its own co-adsorption. Flotation results indicate the presence of oleate increased the C12 amine adsorption due to a decrease in the electrostatic head-head repulsion between the adjacent surface ammonium ions and thereby increasing the lateral tail-tail hydrophobic bonds. <http://eprints.nmlindia.org/4377/>

**Vidyadhar, A and Kumari, Neha and Bhagat, R P (2012) *Flotation Of Quartz And Hematite: Adsorption Mechanism Of Mixed Cationic/Anionic Collector Systems*. In: XXIV International Mineral Processing Congress (IMPC) 2012, September 24-28, 2012, Hotel Ashok, Diplomatic Enclave, New Delhi.**

Using pure quartz and hematite minerals, the adsorption mechanism of mixed cationic/anionic reagent schemes was investigated through Hallimond flotation studies. The flotation response of quartz and hematite independently with cationic and anionic collectors as well as with mixed cationic/anionic collector systems is assessed. The flotation response as a function of pH and collector concentration was investigated. The single mineral flotation tests in the presence of anionic collectors, quartz does not respond to flotation but the C12 amine flotation of quartz was observed to be pH and concentration dependent. It was observed that hematite flotation recovery is maximum at acidic pH with sodium dodecyl sulphate (SDS), neutral pH with oleate, and at basic pH about 9.5 with C12 amine. Flotation results with both quartz and hematite indicate an increased adsorption of cationic collector in the presence of anionic collector apart from its own co-adsorption. The incorporation of oleate in between C12 amine molecules decreases the electrostatic head-head repulsion and thereby increasing the adsorption of C12 amine due to attractive tail-tail hydrophobic bonds, besides forming a closely packed adsorbed layer enhancing the hydrophobicity. The increase in oleate concentration beyond C12 amine concentration leads to the formation of soluble diamine-oleate complex / precipitate and the adsorption of these species decreased the flotation since the alkyl chains are in chaotical orientation with a conceivable number of head groups directing towards the solution phase. <http://eprints.nmlindia.org/6191/>

**Vasumathi, N and Vijaya Kumar, T V and Subba Rao, S and Prabhakar, S and Bhaskar Raju, G (2012) Recovery of values from tailing ponds of iron ore washing plants. In: International Mineral Processing Congress (IMPC - 2012), 24 - 28 September 2012, New Delhi, India.**

Most of the Iron ore washing plants set up in India in the earlier days consist of sizing of the ore by dry / wet screening, washing and classification by screw classifiers. In this classical approach, iron values were lost in the form of fines and ultrafines into the tailing ponds as they had little commercial value in those days and accumulated in huge quantities over the years. As the high grade deposits are getting exhausted and the demand for high grade finer material for pellet making is ever increasing, focus is shifting towards recovering the values from the erstwhile tailing ponds by column flotation. This is also supposed to mitigate to certain extent the environmental problems caused by the ever expanding and unmanageable tailing dams. A case study is presented wherein a composite sample is prepared from samples drawn systematically from multi - locations in a sprawling tailing dam. Laboratory scale column flotation tests on this composite tailings sample, basically originating from two operating iron ore beneficiation plants of JSW Steel Ltd., one of the leading producers of steel in India, are found to be encouraging. De-sliming followed by reverse and cationic flotation tests using flotation column resulted in the concentrate of 61.88% Fe, 4.81% SiO<sub>2</sub>, 2.52% Al<sub>2</sub>O<sub>3</sub> and 3.30% loss on ignition (LOI) from the tailings analysing 57.86% Fe, 7.10% SiO<sub>2</sub>, 3.52% Al<sub>2</sub>O<sub>3</sub> and 6.14% LOI with 52% weight recovery. The causes for the quality improvement could be attributed to de-sliming of unliberated ultra fines of kaoline and hydrated iron oxides and their further reduction by efficient flotation process. The process and the cationic collector developed for this purpose are adopted in the new flotation plant created to treat these tailings. <http://eprints.nmlindia.org/6562/>