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The effect of using different comminution procedures on the flotation of Platinum-Group Minerals

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Minerals Engineering, JUL, 2011, Vol. 24(8), pp. 731-736

The use of High Pressure Grinding Rollers (HPGR) has been widely reported to have major benefits in the treatment of minerals such as iron ore and diamonds. To date there have been few investigations into its use in the treatment of ores containing Platinum-Group Minerals (PGMs). HPGRs are known to reduce energy consumption and wear costs and improve the throughput in the circuit. In the present investigation the effect of the comparative use of HPGR and conventional crushing in combination with either dry or wet rod milling on the flotation of PGMs was studied using batch flotation. Previous studies of a base metal sulphide had shown that either HPGR or conventional crushing followed by dry milling produced the highest grades and recoveries (Palm etal., 2010). However in the present study it was observed that a similar treatment of Platinum-Group Minerals produced the poorest results and the highest grades and recoveries were obtained for the case of conventional crushing in combination with wet milling. The HPGR showed no advantages in terms of flotation performance and dry milling produced particularly poor flotation results. The results were investigated further using various surface characterization techniques in order to determine the reason for the decrease in grades and recoveries of platinum when using dry milling and HPGR as opposed to the case for base metal sulphides. The feed and product samples were analysed using ToF-SIMS, XPS and MLA. The paper will propose reasons to explain the different flotation behaviour of the two ore types following the various comminution processes focusing on the surface characteristics of the ores, the particle size distribution and the pulp chemistry.
10.1016/j.mineng.2011.01.001

Characterization of phosphoric acid- and lime-stabilized tropical lateritic clay

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Environmental Earth Sciences, JUL, 2011, Vol. 63(5), pp. 1057-1066.

The effect of calcium-based stabilizers such as lime on the geotechnical properties of tropical soils has been reported by many researchers. However, the amount of literature available on the micro-structural, molecular, and leaching characteristics of lime and in particular phosphoric acid-stabilized lateritic clays has been limited. This research was carried out in an attempt to identify the time-dependent soil-chemical reactions. In addition, the possible mechanisms that contributed to the stabilization process were discussed in the light of various spectroscopic and microscopic techniques such as X-ray diffractometry (XRD), energy-dispersive X-ray spectrometry (EDAX), field emission scanning electron microscopy (FESEM), Fourier transform infrared spectroscopy (FTIR), and nuclear magnetic resonance spectroscopy (NMR) etc. Based on the results it was found that in lime-treated samples, the coating action of free iron oxides on clay particles imposed inhibitive effects on the dissolution of clay alumina. On the other hand, in phosphoric acid-stabilized soil, due to the increase in solubility of metal oxides and also the subsequent release of clay alumina the formation of cementitious compounds were more feasible. From engineering point of view, the phosphoric acid-stabilized lateritic soil showed the highest degree of improvement with an approximately threefold strength increase in comparison with the natural soil over an 8-month curing period. 10.1007/s12665-010-0781-2

A review of the effects of the grinding environment on the flotation of copper sulphides

W.J. Bruckard, G.J. Sparrow, J.T. Woodcock
International Journal of Mineral Processing, Volume 100, Issues 1–2, 8 July 2011, Pages 1-13, http://dx.doi.org/10.1016/j.minpro.2011.04.001.

The reported effects of the grinding method and grinding medium upon the flotation performance of sulphide minerals has shown that the pulp chemical environment, the ore composition, the properties and type of the grinding media, the size reduction method employed, pre-conditioning stages prior to flotation, and reagent interactions during grinding (and conditioning) can influence the subsequent flotation process. These factors are reviewed and discussed in relation to the flotation of copper sulphide minerals. Galvanic interactions between sulphide minerals and steel grinding media increase iron levels, lower the dissolved oxygen concentration in the slurry, and result in the formation of iron hydroxides. These changes can be deleterious to copper flotation. It has been shown that chrome alloy balls can have beneficial effects on flotation performance in some systems by limiting the formation of hydroxides in the pulp. As well, galvanic interactions between the sulphide minerals can occur, depending on the mineralogy of the ore, and they can influence the separation efficiency in flotation. While reagent additions, such as collector, lime, or cyanide, during milling can alter the pulp chemistry during grinding, there is little clear evidence in the literature that their addition during grinding has any strong influence on the subsequent floatability of copper sulphide particles. Improvements in copper recovery by flotation following fully

autogenous milling in comparison with conventional milling using steel rod and ball mills at the same grind size have been noted in several laboratory and plant studies.

In situ observation of quartz particles entrained into magnetite coagulates in a uniform magnetic field

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Minerals Engineering, JUL, 2011, Vol. 24(8), pp, 963-966

The entrainment of fine quartz particles into magnetite coagulates in a uniform magnetic field was studied through in situ observation using a video microscope. It is shown that the mechanisms for this entrainment are attributed to the magnetic coagulation of locked quartz-magnetite particles with free magnetite particles, the entrainment of free quartz particles into magnetite pearl chains, and wrapping of magnetite circular chains round free and locked quartz particles. (C) 2011 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2011.03.022

Mechanism for Removal of Organic Sulfur from Guiding Subbituminous Coal by Electrolysis

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Energy & Fuels, AUG, 2011, AMER CHEMICAL SOC, WASHINGTON, Vol. 25(8), pp. 3687-3692.

Ash in Guiding subbituminous coal (GSBC) was removed by treatment with dilute acids. The treated GSBC (TGSBC) was extracted with isopropanol (IP) to afford IP-extractable fraction (IPEF). TGSBC was sequentially extracted with petroleum ether, carbon disulfide, acetone, and methanol. Octane-1-thiol and thiophene were selected as model compounds (MCs) for organic sulfurs in GSBC. MCs and extracted residue (ER) of TGSBC were electrolyzed in an aqueous NaCl solution. Reaction mixtures from the electrolysis of MCs were extracted with cyclohexane. The electrolyzed extracted residue (EER) was extracted with the same method as TGSBC. The extracts were analyzed with gas chromatography/mass spectrometry (GC/MS). ER and EER were analyzed with Fourier transform infrared (FTIR) spectrometry. Three organic sulfurs were detected in IPEF from TGSBC with GC/MS. FTIR analysis shows that ER electrolysis increased oxygen-containing functional groups but decreased organic sulfurs. Disulfide, sulfoxide, sulfone, and sulfonic acid were detected by GC/MS and FTIR analyses. The mechanism for removal of organic sulfur during GSBC electrolysis was discussed. 10.1021/ef200844a

Energy efficient comminution under high velocity impact fragmentation

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Minerals Engineering, AUG, 2011, Vol. 24(10), pp. 1053-1061

In mining operations, comminution processes are responsible for most of the energy used during mineral recovery. Low fragmentation efficiency of comminution in the range of 1-2% (Tromans, 2008) occurs due to the quasi-static nature of the process which is typically accompanied by low impact velocities. Accurate estimation of efficiency requires a measurement system to account for fractal parameters such as surface roughness and fracture surface area. Continuum breakage models of single particles fail to estimate the actual stress transformation that affects bulk material during comminution. In order to study comminution in a dynamic regime at higher strain rates than those of conventional equipment, a compressed-air apparatus designed to launch a projectile at velocities as high as 450 m s(-1) has been developed to measure the quantitative nature of high-speed impacts on aggregated rock samples. A method to calculate the energy efficiency is also presented. The results of experiments conducted on three materials suggest the energy efficiency of rock breakage can be improved by two or three times under high velocity impact for the same energy input level. The paper reports an empirical model of impact velocity and energy input and discusses the advantages and limitations of this model.
10.1016/j.mineng.2011.05.006

Relevance of Nitrospira for nitrite oxidation in a marine recirculation aquaculture system and physiological features of a Nitrospira marina-like isolate

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Environmental Microbiology, SEP, 2011, Vol. 13(9), pp. 2536-2547

In biofilters of recirculation aquaculture systems (RAS), nitrification by lithoautotrophic microorganisms is essential to prevent the cultivated organisms from intoxication with ammonium and nitrite. In moving-bed biofilters nitrifying microorganisms are immobilized together with heterotrophic bacteria in dense biofilms on carrier elements like plastic beads. Analyses of fatty acid profiles of these biofilms from a marine biofilter revealed a high abundance of Nitrospira-related lipid markers (8-12% of total fatty acids). Further results of a labeling experiment with C-13-bicarbonate in mineral salts medium with 3 mM nitrite confirmed that Nitrospira is the major autotrophic nitrite oxidizer in the biofilter system. According to 16S rRNA gene sequence analyses the nitrite-oxidizing community in the biofilter consisted of at least two different representatives of Nitrospira, one of which could be successfully isolated. The marine isolate 'Ecomares 2.1' belongs to cluster IVa and showed 98.8% 16S rRNA gene sequence similarity to Nitrospira marina, whereas the enrichment 'M1 marine' is only distantly related (94.0% 16S rRNA gene sequence similarity to N. marina). In laboratory experiments, the isolate exhibited remarkable tolerances against high substrate and product concentrations (30 mM nitrite and 80 mM nitrate) as well as ammonium (50 mM). During the isolation process a strong tendency of this strain to develop biofilms became apparent. Thus, Ecomares 2.1 seems to be well adapted to the

attached lifestyle in biofilters and the nitrogenous load prevailing in the effluent waters of RAS. Both members of Nitrospira could be detected by PCR-based methods in environmental samples of marine and brackish RAS biofilters and are therefore considered to be characteristic for these engineered ecosystems.
10.1111/j.1462-2920.2011.02525.x

Dry Cleaning of Pulverized Coal Using a Novel Rotary Triboelectrostatic Separator (RTS)

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International Journal of Coal Preparation And Utilization, 2011, Vol. 31(3-4), pp. 187-202

Coal cleaning is often conducted using wet physical separation processes such as heavy medium vessels or spirals at coal preparation plants to remove impurities such as ash, sulfur, and mercury. However, the resultant clean coal product still contains a significant amount of impurity due to the fact that impurities are not well liberated from coal particles ranging from several millimeters to inches in size at which wet cleaning processes take place. A cleaner coal product can be obtained if a dry process is avaialble to further clean pulverized and thus better liberated fine coal at the power plant prior to its combustion. In this study, a novel rotary triboelectrostatic separator (RTS) was investigated for its application to dry cleaning of fine coal samples acquired from the power plants in the state of Illinois. The proprietary RTS is characterized by an innovative high-efficiency rotary charger, charger electrification, laminar air flow, etc. Compared to existing triboelectrostatic separators, the RTS offers significant advantages in particle charging efficiency, solids throughput, separation efficiency, applicable particle size range, etc. Important process parameters such as charger rotation speed, injection and co-flow rate, and feed rate were investigated for their effects on separation performance.
10.1080/19392699.2011.574945

Fluidization Characteristics of a Gas-Paigeite-Powder Bed to be Utilized for Dry Coal Beneficiation

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International Journal Of Coal Preparation And Utilization, 2011, Vol. 31(3-4), pp. 149-160

The physical properties of paigeite powder were investigated and the characteristics of a gas-solid fluidized bed using the powder were studied. The intent was to expand the choice of medium solids appropriate for fluidized bed dry coal beneficiation. Experimental results show that paigeite powder has a low density, a high saturation magnetization, and a small coercivity. Under suitable

technical and operating conditions the fluidization performance of paigeite powder with either a narrow, or a specified wide, size range is good. A gas-paigeite fluidized bed, formed from 0.074-0.3mm paigeite, was used to separate 6-13mm, hard-to-wash coal at a separating density of 1.5g/cm3. The ash content of this coal was reduced from 22.37% to 9.88%, with a clean coal recovery of 60.64% and a probable error, E, value of 0.075g/cm3. This indicates good separation performance of the fluidized bed.
10.1080/19392699.2011.574938

Performance Optimization of the FGX Dry Separator for Cleaning High-Sulfur Coal

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International Journal of Coal Preparation & Utilization, 2011, Vol. 31(3-4), pp. 161-186

The main goal of the present study was not only to deshale (remove pure rock) raw coal extracted from Illinois mines but also to assess the maximum ash separation efficiency and sulfur rejection achievable using the FGX Dry Separator for cleaning raw coals of varying cleaning characteristics. A Model FGX-1 Dry Separator with feed throughput capacity of 10 tph was extensively tested at the Illinois Coal Development Park using multiple coal samples having distinctly different cleaning characteristics. Statistically designed experimental programs were conducted to indentify critical process variables and to optimize FGX Dry Separator performance by systematic adjustments of critical process variable parameters. The coal-cleaning performance of the FGX Dry Separator was evaluated for the particle size range of 4.75-63.5mm in most cases, although FGX Dry Separator feed consisted of nominal 7minus;63.5mm run-of-mine coals.

Deck vibration frequency, longitudinal deck angle, feeder frequency, and baffle plate height were identified as critical process variables for the FGX Dry Separator. The best cleaning performance obtained from the FGX Dry Separator was described by specific gravity of separation (SG50) and probable error (Ep) values of 1.98 and 0.17, respectively. For a relatively easy-to-clean coal (having a Cleaning Index of 0.72), only about 0.42% of the clean coal (i.e., 1.6 float fraction) present in the feed was lost to the tailings stream. For a relatively difficult-to-clean coal (having a Cleaning Index of 0.53), about 0.98% of the clean coal present in the feed was lost to the tailings stream. The positive impact of having fine materials in the FGX feed stream was also noted in this study. A modified log-logistic partition model was developed using experimental data reported in literature and validated using new experimental data generated in this study. The results showed that this model could be effectively used to predict the FGX Dry Separator coal-cleaning performance.
10.1080/19392699.2011.574943

Stability Study of an Air Dense Medium Fluidized Bed Separator for Beneficiation of High-Ash Indian Coal

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International Journal of Coal Preparation And Utilization, 2011, Vol. 31(3-4), pp. 127-148

Indian high ash noncoking coal contains a substantial quantity of near-gravity materials (NGM). The presence of NGM needs beneficiation in dense medium separation process. Air dense medium fluidized bed separator (ADMFBS) uses the magnetite medium to improve the separation efficiency of beneficiation of high NGM coal. Stability of the particulate fluidized bed in this system is the essential prerequisite for the separation of heavy and light particles. In this study, the characterization of medium and particulate fluidized bed was assessed to maintain the nonbubbling condition. Stability of the fluidized bed was characterized by different expressions like fluidization index, particulate expansion function, Froude number of particle, Reynolds number of particle, and pressure drop ratio using the minimum fluidization velocity, minimum bubbling velocity, pressure drop of distributor and bed, bed porosity, air viscosity, aspect ratio, density of air, and density of medium. It was found that the fluidization indexes of this system for different experimental runs are around 1 to 2. The system was scaled up from laboratory to pilot scale, having a feed throughput capacity of 600kg/hr. Indian high ash noncoking coal at particular size (-25+6mm) was used in continuous operation. The partition number was calculated based on washability data of product and reject. The Ep and imperfection value for the pilot-scale ADMFBS was found to be 0.12 and 0.071, respectively. 10.1080/19392699.2011.574936

Beneficiation of Fine Coal Using the Air Table

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International Journal of Coal Preparation And Utilization, 2011, Vol. 31(5), pp. 203-222

The increased mechanization in the underground coal-mining industry has increased the volume of fine size coal and waste (refuse) in the mined coal. Processing of run-of-mine (ROM) coal is generally done using water away from mine and in some cases the coal has to be transported a long distance to the preparation plant. Dry processing of coal can be economical as it will not utilize water and no dewatering or drying of the product will be required. The goal of this study was to develop a dry separation process for processing of coal finer than 6.3mm [image omitted]. The coal sample from a mine located in Western Kentucky was used for the study. Statistical design experiments were conducted to assess the effects of operating parameters of the dry separator on product yield for a given ash content. Tests conducted with 6.3x3.35mm (and 3.35x1.4mm size fractions showed that the air

table was able to reduce the ash from 27% to 10%-12% ash with a clean coal yield of 75%-80%. The ash rejection was about 77%-80% with a combustible recovery of around 95% indicating excellent separation efficiency. The pyritic sulfur rejection was 43%. The heat content of the 6.3x1.4mm (1/4 inchx14 mesh) coal fraction increased from 23997kJ/kg to 29595kJ/kg. The pyritic sulfur was reduced by about 33% with a product yield above 80%. 10.1080/19392699.2011.574948

Grindability characteristics of lateritic and karst bauxites

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International Journal Of Mineral Processing, Sep, 2011, Vol. 100, pp. 96-103

The Bayer process is the most frequently used method for the production of alumina from bauxite worldwide. The aim of the process is to grind and dissolve the alumina-rich minerals into hot caustic solution, than to separate the insoluble phases. These are followed by precipitation and calcination to produce alumina (Al2O3). After the crushing step the bauxite has to be ground usually in spent liquor at 60 ... 100 degrees C in a tumbling ball mill for dissolution. Due to the above special circumstances the determination of the specific grinding energy or the Bond work index for designing new grinding facilities and the optimization of the existing operations (grinding ball charge, filling ratio, revolution number, operating of classifier, etc ....) was not reliable when the traditional laboratory mills (Hardgrove-, Bond-. Zeisel mill) and procedures were used. To meet the requirements based on the standard grindability tests suitable methods and apparatuses were developed at the Institute of Raw Material Preparation and Environmental Process Engineering, University of Miskolc, called Universal Hardgrove- and Bond mill. This paper presents briefly these laboratory apparatuses and methods and shows the most important results of the systematic research work carried out recently concerning the grindability of lateritic and karst bauxites. Parallel experiments were performed using the Universal Hardgrove- and Bond mill and the measurement data were compared. The samples originated from three continents worldwide: Africa (Boke), Australia (Weipa) and Europe (Greece and Hungary). The results show good correlation between the developed methods. Temperature and caustic media are very important affecting parameters to the Bond work index, which can be demonstrated by the above mentioned developed laboratory mills and methods. (C) 2011 Elsevier B.V. All rights reserved. 10.1016/j.minpro.2011.05.006

Large particle effects in chemical/biochemical heap leach processes - A review

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Minerals Engineering, SEP, 2011, Vol. 24(11), pp. 1172-1184

The application of heap leach technology to recovery of economically important metals, notably copper, gold, silver, and uranium, is wide-spread in the mining industry. Unique to heap leaching is the relatively coarse particle size, typically 12-25 mm top size for crushed and agglomerated ores and larger for run-of-mine dump leaching operations. Leaching from such large particles is commonly assumed to follow shrinking core type behaviour, although little evidence for the validity of this assumption exists. This review investigates the current state of knowledge with respect to the understanding of the characteristics and mineralogy of large particles and how these influence leaching in a heap context and the tools to characterize these. This includes the study of ore and particle properties, visualization techniques for ore characterization, the connection between comminution and leaching behaviour, as well as particle models within heap leach modelling. We contend that the economics of heap leaching are strongly governed by the trade-off between the slow rate and limited extent of leaching from large particles and the cost of crushing finer. A sound understanding of the underlying large particle effects will therefore greatly inform future technology choices in the area of heap leaching.
10.1016/j.mineng.2011.04.002

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

Dhal, B and Das, N N and Thatoi, Hruayanath and Pandey, B D (2011) *Bioremediation of CR(VI) from Contaminated Chromite Mine Overburden Soil and its Management.* In: 15th International Conference on Nonferrous Metals 2011, 8-9 July 2011, Kolkata.

Extensive mining of chromite ores from Sukinda area of Orissa has resulted in pollution due to natural oxidation of chromite from the stockpiled overburden dumps affecting the nearby areas with the toxic Cr(VI) species. Amongst the various physico-chemical treatment approaches, native microorganisms which are already adapted to toxic metal stress conditions can play a significant role in bio-remediation of Cr(VI) from contaminated mine soil. An attempt was made for the bioreduction of Cr(VI) using a highly tolerant Bacillus sp. isolated from chromite mine soil. Under the optimized conditions of pH -7. 0, Bacillus sp. (4.05 x 107 cell mV') reduced more than 98% of Cr(VI) from the soil sample in 16 h at 60% pulp density(PD). The fitting of time course reduction data to the exponential rate equation yielded rate constants in the range 4.923x10-1 h-1 - 2.141 x10-1 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/4261/

Sinha, Manish K and Sahu, S K and Meshram, Pratima and Pandey, B D and Kumar, Vinay (2011) *Solvent extraction and separation of copper and zinc from a pickling solution.* In: 15th International Conference on Nonferrous Metals 2011, 7-8 July 2011, Kolkata, India.

Solvent extraction studies of copper and zinc have been carried out using Versatic 10 acid and Cyanex 272 separately from a model brass pickle liquor. Various parameters for the extraction and separation of copper and zinc such as effect of pH, extractant concentration, phase ratio etc. have been optimized. It was observed that copper was almost completely extracted into the organic phase comprising of 30% Versatic 10 acid at the equilibrium pH of 5.0 using the phase ratio of 1:1 whereas, zinc extraction was noticed at above pH 5.0. On the other hand the pH0.5 values were 3.5 and 4.6 for zinc and copper respectively with 20% Cyanex 272. The difference in pH0.5 value of 1.10 indicated the possible separation of Zn and Cu. By McCabe Thiele diagram number of stages required for the counter current extraction of copper and zinc has been determined for both the solvents. The stripping study showed that 1 mol/L H2SO4 was sufficient to strip metal ions in a single contact from each of the extractant. http://eprints.nmlindia.org/4070/

Abhilash, and VenkatRaman, R and Mehta, K D and Pandey, B D (2011) *Isolation and growth kinetic studies of novel isolates from Indian Ocean nodules.* Indian Journal of Marine Sciences, 40 (5). pp. 648-652.

Marine isolates from sea nodules can be worthy catalysts to explore the possibilities of faster bioleaching of low index ocean nodules mined from Indian Ocean. The native microbes were isolated from Indian Ocean Nodules in Artificial Sea water Nutrient Broth at pH 7.0. Organisms have been found to tolerate up to 7% salt concentration. These species were found to be typically elongated gram positive bacilli and having a good generation time (0.7-1.3 h). The faster growth kinetics was found to useful in sequential adaptation on various metal concentrations. Both species exhibited good resistance towards 1000 ppm Ni (II) concentration; whereas resistance towards Cu(II) and Co(II) could only been seen at a metal concentration of 100 ppm thereby proving their efficacy in metallurgical applications. http://eprints.nmlindia.org/4299/

Chi, Tran D and Lee, Jae-chun and Pandey, B D and Yoo, Kyoungkeun and Jeong, Jinki (2011) *Bioleaching of gold and copper from waste mobile phone PCBs by using a cyanogenic bacterium.* Minerals Engineering, 24. pp. 1219-1222.

Chromobacterium violaceum (C. violaceum), a cyanide generating bacterium has been used to leach out gold and copper from the waste mobile phone printed circuit boards (PCBs) containing 34.5% Cu and 0.025% Au in YP (yeast extract and polypeptone with glycine) medium. The bioleaching was carried out in an incubator

shaker (150 rpm) at 30 C and 15 g/L pulp density in the pH range 8–11. Dissolution of gold and copper increased from 7.78% (0.225 ppm) to 10.8% (0.46 ppm) and 4.9% (419 ppm) to 11.4% (879 ppm) in 8 days with increase in pH from 8 to 11 and 8 to 10 respectively. Supplementing oxygen with 0.004% (v/v) H2O2 increased the copper leaching to 24.6% (1743 ppm) at pH 10 in 8 days whereas improvement in gold leaching was insignificant with the recovery of 11.31% Au at pH 11.0. The waste PCBs can thus be recycled in environmental friendly manner. http://eprints.nmlindia.org/3686/

Jha, Amrita Kumari and Kumari, Archana and Choubey, Pankaj K and Kumar, Vinay and Jha, Manis K (2011) *Waste lithium ion batteries - An alternative resource to recover lithium and cobalt.* Journal of Metallurgy and Materials Science, 53 (3). pp. 225-231.

Lithium is dominantly used in the lithium ion rechargeable batteries as electrochemical power sources in mobile phones due to its light weight, high energy density, high potential difference and good performance. These batteries are treated as waste when they reached their end-of-life. Due to the stringent environmental regulation and conservation of limited natural resources, the recycling of cobalt and lithium is necessary. Present paper reports the generation of varieties of lithium ion-batteries, its environmental effect and the global research work going on in this direction. Based on the experimental work and proof of concept a process flow-sheet has been proposed.

Jha, Manis K and Kumar, Abhishek and Kumar, Vinay and Lee, Jae-chun (2011) *Prospective scenario of e-waste recycling in India.* In: Proceeding of Second Symposium On Recycling of Electronic Waste II, 2011, Recycling of waste II.

However, India is rich in ores and mineral, but E-waste recycling is necessary due to the report of national and international studies, which cautioned on the generation, treatment and accumulation of e-waste in India. Current data indicate that the total domestic e-waste generation including imports is around 382979 MT, however waste available for recycling and actually recycled are 144143 MT and 19000 MT, respectively. In which recycling by non-formal and formal sector are 95% and 5%, respectively. On the other hand, India has developed expertise in handling verities of metallic wastes in an organized and safe man-ner. The development of individual process or combined pro-cesses for handling the e-waste is underway. Eco - friendly and energy-saving processes are necessary to comply with stringent environmental regulations.The paper includes the recent trend of e-waste generation, recycling process and its future prospects particularly in India. prospects particularly in India. http://eprints.nmlindia.org/2956/

Jha, Manis K and Lee, Jae-chun and Kumari, Archana and Choubey, Pankaj K and Kumar, Vinay and Jeong, Jinki (2011) *Pressure leaching of metals from waste Printed Circuit Boards using sulphuric acid.* Journal of Metals, 63 (8). pp. 29-32.

Printed circuit boards (PCBs) are essential components of electronic equipments which contain various metallic values. This paper reports a hydrometallurgical recycling process for waste PCBs, which consists of the novel pretreatment consisting of organic swelling of PCBs followed by sulfuric acid leaching of metals from waste PCBs. To recycle the waste PCBs, experiments were carried out for the recovery of copper from the crushed and organic swelled materials of waste PCBs using sulfuric acid leaching in presence of hydrogen peroxide under atmospheric and pressure condition. The leaching of PCBs at 90°C, pulp density 100 g/L under atmospheric condition, using 6M sulfuric acid resulted in the dissolution of a minor amount of copper due to the presence of plastic coating on the surface of metallic layers. On the other hand, when the liberated metal sheets from organic swelled PCBs were treated with dilute sulfuric acid of concentration 2M along with hydrogen peroxide in an autoclave under oxygen atmosphere, the percentage recovery of copper was found to increase from 59.63% to 97.01% with an increase in hydrogen peroxide concentration from 5 to 15% (v/v) keeping constant pulp density 30 g/L.
http://eprints.nmlindia.org/3819/

Kim, Eun-young and Kim, Min-seuk and Lee, Jae-chun and Pandey, B D (2011) *Selective recovery of gold from waste mobile phone PCBs by hydrometallurgical process.* Journal of Hazardous Materials, 198, pp. 206-215.

The leaching of gold from the scrap mobile phone PCBs by electro-generated chlorine as an oxidant and its recovery by ion exchange process was investigated. The leaching experiments were carried out by employing separate leaching reactor connected with the anode compartment of a Cl2 gas generator. The leaching of gold increased with increase in temperature and initial concentration of chlorine, and was favorable even at low concentration of acid, whereas copper leaching increased with increase in concentration of acid and decrease in temperature. In a two-stage leaching process, copper was mostly dissolved (97%) in 165 min at 25 °C during the 1st stage leaching in 2.0 mol/L HCl by electro-generated chlorine at a current density of 714 A/m2 along with a minor recovery of gold (5%). In the 2nd stage gold was mostly leached out (93% recovery, ~67 mg/L) from the residue of the 1st stage by the electro-generated chlorine in 0.1 mol/L HCl. Gold recovery from the leach liquor by ion exchange using Amberlite XAD-7HP resin was found to be 95% with the maximum amount of gold adsorbed as 46.03 mg/g resin. A concentrated gold solution, 6034 mg/L with 99.9% purity was obtained in the ion exchange process.
http://eprints.nmlindia.org/4228/

Kulikova, M P and Kaminskii, Yu D (2011) *Influence of mechanical activation on alkylation and extractability of coal.* In: VI International Conference on Mechanochemistry and Mechanical Alloying (INCOME 2008), 1-4 December 2008, NML Jamshedpur, India, published in 2011.

Results of studies of influence of mechanical activation on alkylation and extractability of coal of the Kaa-Khem deposit have been presented. Samples of coal, on being heated in a neutral-reducing environment condition on a 300-400 °C interval, undergo moderate agglomeration. On heating of coal in a neutralreducing environment condition over 450-600°C interval, ebullition and removal of a highly boiling coal fraction occur. Mechanical activation decreases parameters of thermal destruction of coals. In response to mechanical activation reacting power of coal increases at the cost of formation of new pores and opening of inaccessible pores. The process of coal alkylation goes intensely in the case of preliminary mechanical processing of coal. This can best be done by vibration mill. Alkylation of activated charcoal increases solubility of coal. The regularities of changes of structure and properties of coals under mechanical activation and alkylation can be used in processes of processing of solid fuels. http://eprints.nmlindia.org/5127/

Mehta, K D and Kumar, Rakesh and Pandey, B D and Mehrotra, S P (2011) *Bio-dissolution of metals from activated nodules of Indian Ocean.* In: VI International Conference on Mechanochemistry and Mechanical Alloying (INCOME 2008), 1-4 December 2008, NML Jamshedpur, India, published in 2011.

The biodissolution of valuable metals from ferro-manganese nodules of Indian Ocean in presence of Aspergillus niger is a slow process. In order to improve the kinetics of bioleaching, the sea nodules were activated in high energy attrition mill thereby changing the granulometry and surface charge characteristics of the particles. The zeta potential, particle size distribution and surface area of the activated material were recorded and bioleaching was carried out by A.niger in the pH range 4.0-5.5. The mechano-chemical activation of the mixed particles (≤ 75 μm) of nodules in 10 min reduced almost 86 % material to ≤ 10 μm size with a change in zeta potential from -18 to -34 mV. Bioleaching of metals from the activated nodules was compared with that of the dissolution pattern of metals in presence of A.niger without any pretreatment as well as those under the chemical leaching conditions. The results showed the bio-recovery of more than 95% copper, nickel and cobalt each in 15 days time when the nodules activated for 10 min was leached at 5 % (w/v) pulp density, 4.5 pH and 35 °C temperature. Bio-leaching of these metals was observed to be similar from the nodules activated for 30 min. The non-activated nodules showed ≥ 89% metal recovery in 25 days under the above conditions. The mechano-chemical activation of sea nodules has thus been found to improve the kinetics of the process and has also resulted in to the availability of wider pH in the range of 4-5 for the processing. http://eprints.nmlindia.org/5128/

Rao, D S and Vijaya Kumar, T V and Bhaskar Raju, G and Prabhakar, S (2011) *Geochemical assessment of a siliceous limestone sample for cement making.* Chin. Journal Geochem, 30, pp. 33-39.

A low grade siliceous limestone sample from the Jayantipuram mine of Andhra Pradesh, India, has been investigated for its suitability for cement making. Petrological as well as X-ray diffraction pattern studies indicated that the limestone sample was crystalline and dominantly composed of calcite and quartz. They are simple in mineralogy, and yet they have variable silica and lime contents. Geochemical analysis results of twenty five hand picked samples indicated that the limestone from the Jayantipuram mine shows a wide range of variations in LOI (29.94% to 40.64%), SiO2 (6.14% to 27.18%), CaO (37.93% to 50.78%), Al2O3 (0.49% to 2.27%) and Fe2O3 (0.28% to 2.4%). MgO, K2O, Na2O, TiO2 and MnO2 are present in traces. CaO with LOI shows a strong positive correlation where as CaO with SiO2 shows a strong negative correlation because of mineralogical factors. The chemical composition of the limestone reflects its mineralogical composition. The distribution of various elements in the acid-soluble fraction has been studied by the factor analysis method in order to interpret in terms of their mineralogy, sedimentary environment and diagenesis. Mineralogy, recrystallization and other diagenetic changes are the main factors affecting the distribution of the elements and their mutual relationships in the limestone. The aim of this paper is also to analyze how significantly the two parameters, silica modulus and lime saturation factor, influence this low grade siliceous limestone sample from the Jayantipuram mine of Andhra Pradesh, India, for the cement making process from the geochemical data. http://eprints.nmlindia.org/4014/

Rao, D S and Vijaya Kumar, T V and Subba Rao, S and Bhaskar Raju, G and Prabhakar, S (2011) *Beneficiation of Low-Grade Limestone Sample.* Mining Science and Technology, 21, pp. 631-636.

Pilot scale column flotation studies were conducted on a low grade siliceous limestone ore. Silica content was reduced to less than 1% in the concentrate so that it became satisfactory for use in the paper or rubber industries. The limestone sample was crystalline and constituted primarily of calcite that contained quartz, feldspar, pyroxene, and biotite as gangue minerals. Quartz is the major silicate gangue whereas feldspar, pyroxene, and biotite exist in minor to trace quantities. Traces of pyrite were also observed within the sample. A reverse flotation process was adopted where the silicate gangue minerals were floated using two different commercial cationic collectors: Chem-750 F or Floatamine-D. The studies clearly suggest it is possible to produce a limestone concentrate assaying around 96–97% CaCO3 containing less than 1% SiO2. The effect of feed flow rate, percent solids, froth depth, and wash water on the grade and recovery of the CaCO3 concentrate is discussed. http://eprints.nmlindia.org/4397/

Rao, D S and Vijaya Kumar, T V and Subba Rao, S and Prabhakar, S and Bhaskar Raju, G (2011) *Effectiveness of sodium silicate as gangue depressants in iron ore slimes flotation.* International Journal of Minerals, Metallurgy and Materials, 18 (5). pp. 515-522.

The recovery of iron from the screw classifier overflow slimes by direct flotation was studied. The relative effectiveness of sodium silicates with different silica-to-soda mole ratios as depressants for silica and silicate bearing minerals was investigated. Silica-to-soda mole ratio and silicate dosage were found to have significant effect on the separation efficiency. The results show that an increase of Fe content in the concentrate is observed with concomitant reduction in SiO2 and Al2O3 levels when a particular type of sodium silicate at a proper dosage is used. The concentrate of 58.89wt% Fe, 4.68wt% SiO2, and 5.28wt% Al2O3 with the weight recovery of 38.74% and the metal recovery of 41.13% can be obtained from the iron ore slimes with 54.44wt% Fe, 6.72wt% SiO2, and 6.80wt% Al2O3, when Na2SiO3 with a silica-to-soda mole ratio of 2.19 is used as a depressant at a feed rate of 0.2 kg/t.
http://eprints.nmlindia.org/4102/

Vijayalakshmi, P and Bhaskar Raju, G and Gnanamani, A (2011) *Advanced Oxidation and Electrooxidation As Tertiary Treatment Techniques to Improve the Purity of Tannery Wastewater.* Industrial & Engineering Chemistry Research, 50 (17). pp. 10194-10200.

The option of electro-oxidation and advanced oxidation as tertiary treatment technique for the purification of tannery wastewater was explored. The TOC removal of 85% was achieved by UV/O3/H2O2 process, whereas it is hardly 50% by electr-ooxidation. However the power consumption to remove unit mass of TOC by electro-oxidation process was estimated to be 738 kW h/kg, which is ten times less than that of 7600 kW h/kg, required for advanced oxidation process. The kinetic data indicated that the degradation of organics by electro-oxidation is a current control process. To minimize the power consumption, we attempted a two-stage process involving electro-oxidation in the first stage and advanced oxidation in the second stage. The results indicated that the TOC removal by advanced oxidation became sluggish, when the wastewater was processed initially by electro-oxidation. However, the effluents processed by EO were found to be completely disinfected.
http://eprints.nmlindia.org/4000/