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Effect of grinding aids on the grinding energy consumed during grinding of calcite in a stirred ball mill

Choi, H; Lee, W; Kim, DU; Kumar, S; Kim, SS; Chung, HS; Kim, JH; Ahn, YC
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Minerals Engineering, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, JAN. 2010, Vol. 23(1), pp. 54-57.

A series of wet-grinding experiments has been carried out on inorganic powders by a stirred ball mill to systematically investigate the grinding characteristics. The grinding power consumed for a given grinding time was considered, as well as the effect of grinding aids on particle size. The grinding energy consumed, defined as the integral of the grinding power over time, was also investigated. The grinding aids were found to influence the product size and decrease the grinding energy. This is attributed to the prevention of agglomeration and coating of the sample powder onto the ball and grinding chamber wall. The grinding process seemed to be controlled by the force of agglomeration of the ground products. It was demonstrated that the particle size and grinding consumption energy could be decreased by the addition of grinding aids. 10.1016/j.mineng.2009.09.011

Enhancing mineral beneficiation by high intensity power ultrasound

Pandey, JC; Raj, M; Sinha, M; Bandyopadhyay, N

TMS 2010 139th Annual Meeting & Exhibition - Supplemental Proceedings, Vol 3: General Paper Selections
TMS 2010 Annual Meeting Supplemental Proceedings on Materials Processing and Properties, FEB 14-18, 2010, Seattle, WA, MINERALS, METALS & MATERIALS SOC, WARRENDALE, 2010. pp. 525-532.

The paper highlights the attempts made at R & D of Tata Steel Ltd. to reduce impurities from iron ore such as alumina, silica and phosphorous under the influence of high intensity power ultrasound using 20 KHz frequency and 220 Watt power. The laboratory trials indicated 5 minutes treatment time for iron ore slurry containing 1:10 solid/liquid ratio could reduce alumina from 1.72 to 1.12 % and silica from 1.70

to 1.34 % whereas no significant reduction in phosphorous was observed. Scanning Electron Microscope (SEM) micrographs revealed the locations on the surface where the alumina phase in the microstructure detached due to ultrasonic treatment for 5 minutes. The possible reason appears to be the cavitation and streaming under the influence of high intensity power ultrasound. Based on the laboratory results, a pilot scale plant to treat 100 Kg of ore/coal has been set up to implement it in the plant.

Aluminium extraction and leaching characteristics of Talcher Thermal Power Station fly ash with sulphuric acid

Niva Nayak, Chitta R. Panda

Fuel, Volume 89, Issue 1, January 2010, Pages 53-58, ISSN 0016-2361, http://dx.doi.org/10.1016/j.fuel.2009.07.019.

Although fly ash disposal is of environmental concern the quality of residues can be improved with respect to high value applications. Fly ash is considered as a potential source of aluminium and other strategic metals. Leaching and metal extraction behaviour of fly ash collected from Talcher Thermal Power Station have been thoroughly studied using sulphuric acid as extractant. The chemical and mineralogical composition of post-leached samples have been determined. Aluminium extraction by direct leaching at low acid concentration and ambient temperature is not suitable for high recovery. The extraction efficiency of aluminium increases significantly at a higher solid:liquid ratio. It is evident that the leachability of metals from fly ash depends on the nature of leaching medium, solid:liquid ratio, temperature and leaching time.

Heavy metal migration during electroremediation of fly ash from different wastes—Modelling

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Journal of Hazardous Materials, Volume 175, Issues 1–3, 15 March 2010, Pages 366-371, ISSN 0304-3894, http://dx.doi.org/10.1016/j.jhazmat.2009.10.012.

Fly ash is an airborne material which is considered hazardous waste due to its enrichment on heavy metals. Depending on the waste from which they are originated, fly ash may be further valorised, e.g. as soil amendment or concrete and ceramics adjuvant, or landfilled, when defined as hazardous material. In any case, heavy metal content has to be decreased either for fly ash valorisation or for complying with landfill criteria. The electrodialytic (EDR) process is a remediation technique based on the principle of electrokinetics and dialysis, having the aim to remove heavy metals from contaminated solid media. EDR was here applied to fly ashes from the combustion of straw (ST), from the incineration of municipal solid waste (DK and PT) and from the co-combustion of wood (CW). A statistical study, using F tests, Bonferroni multiple comparison method and a categorical regression, was carried out to determine which variables (“Ash type”, “Duration”, “Initial pH”,

"Final pH", "Acidification" and "Dissolution") were the most significant for EDR efficiency. After establishing these, the selected variables were then used to characterize some kinetic parameters, from metals migration during EDR, using a biregressional design. Cd, Cr, Cu, Ca and Zn migration velocity and acceleration to the electrodes (anode and cathode) were then considered. Cd and Cu migration to the cathode were found to be significantly influenced by "Ash type", "Duration", "Final pH" and "Dissolution".

Solvent extraction of zinc from ammoniacal/ammonium chloride solutions by a sterically hindered beta-diketone and its mixture with tri-n-octylphosphine oxide

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Hydrometallurgy, JAN, 2010, Vol. 100, pp. 116-121

The extraction of zinc from ammoniacal/ammonium chloride solutions using a sterically hindered beta-diketone, 4-ethyl-1-phenyl-1,3-octadione (XI-55, HA) as the extractant has been investigated in the presence or absence of tri-n-octylphosphine oxide (TOPO, B). The results indicate that the mixture of XI-55 and TOPO shows evident synergistic effects on zinc extraction. Zinc is extracted as ZnA2(B) by the mixture and the stability constant of ZnA(2)B is 2.08. Thermodynamic parameters Delta H, Delta S and Delta G are determined. which shows that the extractions of zinc by both XI-55 extraction system and the XI-55-TOPO synergistic extraction system are exothermic driven. The concentration of total ammonia has great influence on the extraction constants and distribution ratio for both extraction systems. FT-IR studies on zinc loaded organic phases confirm the non-extractability of zinc ammine complexes.
10.1016/j.hydromet.2009.10.013

Spectroscopic study on oxidative dissolution of chalcopyrite, enargite and tennantite at different pH values

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Hydrometallurgy, JAN, 2010, Vol. 100, pp. 144-151

Chalcopyrite (CuFeS(2)) occurs sometimes in association with As-bearing copper ores, such as enargite (Cu(3)AsS(4)) and tennantite (Cu(12)As(4)S(13)), especially in deep ore bodies. To employ oxidative pretreatment for recovering copper resources from these minerals, it is important to characterize the surface properties of enargite and tennantite as well as chalcopyrite. The minerals were oxidized in 0.013% H(2)O(2) with O(2) bubbling at pH 2.5, and 11 followed by analysis with X-ray photoelectron spectroscopy. Elemental sulfur was formed most significantly at pH 2 in all sulfide mineral samples. Enargite was the most stable under the oxidative

conditions. Arsenic in enargite was partly oxidized at pH 5. Substantial proportion of copper in tennantite was oxidized from Cu(I) to Cu(II) at pH 11. The dissolution rate of Cu from tennantite at pH 2 was by far the fastest, and incongruent dissolution of Cu occurred with suppression of As and S in tennantite. These selective differences in the oxidation may be of use in designing a flotation process for separation of these sulfide minerals.
10.1016/j.hydromet.2009.11.007

Recovery of cobalt sulfate from spent lithium ion batteries by reductive leaching and solvent extraction with Cyanex 272

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Hydrometallurgy, JAN, 2010, Vol. 100, pp. 168-171

Cobalt sulfate was recovered from crushed and screened prismatic type spent lithium ion batteries (LIBs) containing 5-20% Co, 5-7% Li, 5-10% Ni, 15% organic chemicals, and 7% plastics together with Cu, Al, Fe, and Mn. Cobalt was reductively leached from the - 16 mesh fraction in 1 h by stirring with 2 M H(2)SO(4) and 6 vol.% H(2)O(2), at 60 degrees C and 300 rpm using a solid/liquid ratio of 100 g/L to give a cobalt concentration of 28 g/L, corresponding to a leaching efficiency of > 99% Metal ion impurities such as copper, iron, and aluminium were precipitated as hydroxides from solution by adjusting pH to 6.5. Cobalt was then selectively extracted from the purified aqueous phase by equilibrating with 50% saponified 0.4 M Cyanex 272 at an equilibrium pH similar to 6 The McCabe-Thiele plot predicted 99.9% cobalt extraction in a 2 stage counter-current operation with A/O ratio of 1/2. Separation factors for the extraction of Co/Li and Co/Ni at pH 6 were close to 750. The stripping of the loaded organic phase with 2 M H(2)SO(4) produced a solution of 96 g/L Co from which pure pigment grade cobalt sulfate could be recovered by evaporation/recrystallisation. Overall. 92% cobalt could be recovered from the spent lithium ion batteries.
10.1016/j.hydromet.2009.10.010

Altered mineralogy associated with stirred tank bioreactor leaching of a black schist ore

Bhatti, TM; Bigham, JM; Riekkola-Vanhanen, M; Tuovinen, OH
Hydrometallurgy, JAN, 2010, Vol. 100, pp. 181-184

The purpose of this work was to investigate changes in mineralogical composition resulting from the bioleaching of a black schist ore that contained pyrrhotite. pyrite, sphalerite, pentlandite, and chalcopyrite as the main sulfide minerals. The ore also contained quartz, mica (phlogopite), and feldspars as matrix minerals and graphite as an accessory phase. Ground black schist samples were leached with a mixed culture of iron- and sulfur-oxidizing bacteria in stirred tank reactors at pH 1.5, 2.0, 2.5, and 3.0 for 18 days at 30 degrees C. Leach residues from these experiments

were characterized for mineralogical composition by X-ray diffraction (XRD). At pH 1.5. ferric iron precipitation was minimal based on XRD analysis. Jarosite precipitates were most abundant in solids from bioleaching at pH 2. Phlogopite. the main mica mineral, was completely transformed to an expandable phase. vermiculite. at pH 2 Phlogopite weathering released K from the mica interlayer positions and provided K for K-jarosite precipitation, thus shifting the reactions toward mica weathering and K-jarosite formation. XRD patterns also showed the presence of elemental sulfur and gypsum and changes in sulfide mineral phases depending on the pH of the leach solution.
10.1016/j.hydromet.2009.11.010

Evaluation of a Pilot-Scale, Plate-and-Frame Filter Press for Dewatering Thickener Underflow Slurries from Bituminous Coal-Cleaning Plants

Verma, Shubham; Klima, Mark S.
International Journal of Coal Preparation And Utilization, Vol. 30(1), Jan-Feb, 2010, pp. 1-19

Laboratory testing was conducted to evaluate the performance of a pilot-scale, plate-and-frame filter press for dewatering bituminous coal slurries. The fully automated filter press is manufactured by T.H. Minerals and is equipped with a hydraulic system, which operates the plate and diaphragm feed pumps. The filter press is capable of achieving an operating pressure of up to 1035kPa. The unit contains a single set of plates having a filtration area of 0.45x0.45m. Thickener underflow samples were collected from two bituminous coal-cleaning plants located in Pennsylvania. The first sample (Plant 1) was nominal -840 mu m and had an ash value of 39.2%. It contained approximately 34% of -25 mu m material with an ash value of 64.5%. The second sample (Plant 2) was nominal -150 mu m and had an ash value of 17.5%. It contained approximately 65% of -25 mu m material with an ash value of 20.9%. Testing was conducted to evaluate the effects of filter time, air-drying time, and air-blow pressure on filtrate flow, filtrate solids content, final cake moisture, and filter press unit capacity. For Plant 1, product moistures ranged from 23.5% to 25.6% with filtrate solids content ranging from 1% to 2% solids by weight. The unit capacities ranged from 45kg/hr/m2 to 70kg/hr/m2. For Plant 2, product moistures ranged from 16.1% to 21.6% with filtrate solids less than 0.1% by weight. The unit capacities ranged from 117kg/hr/m2 to 168kg/hr/m2. In both cases, low cake moistures were associated with lower unit capacities. The results indicate that the filter press is capable of producing handleable filter cakes without the use of additional flocculants. 10.1080/19392691003776392

Investigation of Breakage Behavior of Coal in a Laboratory-Scale Stirred Media Mill

Samanli, S.; Cuhadaroglu, D.; Ucbas, Y.; Ipek, H.
International Journal Of Coal Preparation And Utilization, Vol. 30(1), Jan-Feb, 2010, pp. 20-31

Coal obtained from the Catalagzi thermal power station was prepared into a -2360 +1700 mu m mono size fraction and ground for different times in a laboratory-scale stirred media mill. The breakage behavior was investigated and an attempt was made to determine optimum grinding conditions. Three stirring rates (1440, 720, and 360rpm) and three ball sizes (6, 4, 2.36mm) were utilized in the grinding studies. It was determined that for effective grinding not only the mill's mechanical properties but also the material properties have to be taken into consideration in order to determine breakage functions more accurately. At longer grind times, oversize material mainly composed of shale, which is comparatively difficult to grind. As a result of this, breakage rate slows down and a deviation from first-order breakage behavior occurs in the grinding stage. 10.1080/19392691003776418

Improved Techniques for Hyperbaric Filtration of Fine Coal Slurry

Yang, J.; Wang, X. H.; Parekh, B. K.
International Journal Of Coal Preparation And Utilization, Vol. 30(1), Jan-Feb, 2010, pp. 32-43

Dewatering of fine clean coal slurry is one of the most important unit operations of a coal-cleaning circuit. However, an efficient and economic dewatering method is still eluding the coal industry. In this study hyperbaric (high pressure) filtration studies were conducted on a froth flotation product obtained from a coal preparation plant processing Pittsburgh No. 8 seam coal. The fine coal slurry (42 weight percent minus 25 mu m) could be dewatered to a low moisture (24%) using 482kPa (70psi) pressure. This article describes two novel approaches for improving dewatering of the fine coal slurry using hyperbaric filtration, such as using a modified filter support and split-size dewatering. The modified filter support system and the split-sizing at 25 mu m (500mesh) provided 21.5% and 15.9% moisture filter cake, which was about 10% and 34% improvement in moisture reduction in the filter cake moisture, respectively. Combining both the approaches with the addition of a nonionic flocculant provided a filter cake with 10.5% moisture, which was about a 56% improvement in moisture reduction. 10.1080/19392691003776434

Structural Parameters of Perhydrous Indian Coals

Khare, Puja; Baruah, B. P.
International Journal Of Coal Preparation And Utilization, Vol. 30(1), Jan-Feb, 2010, pp. 44-67

Higher hydrogen content of perhydrous coals exhibits a different composition and physicochemical properties in comparison with normal coals. In the present investigation, a structural study of perhydrous coals and coke was done using FTIR and HPLC data. These coals have high volatile matter with high-calorific values and low-moisture content. The structural study suggests that the major structural units of these coals are simple phenols with para-alkyl substituted derivatives. They have

high alkyl substitution groups and low aromatic compounds. The structural studies reveal that these coals contain high amounts of low-molecular weight PAH compounds with 1-2 ring structures. These 1-2 ring structures have high H/C ratios as compared to large ring polyaromatic hydrocarbons (PAHs). It may also be one of the reasons for high H/C ratios in these coals. The alkyl groups contribute significantly to their high volatile matter (VM) contents. The presence of alcoholic groups found in pyrolytic products may also be due to the conversion of catechol-like structures to those of cresols. Coal properties, such as moisture, VM, H/C ratio, and CV, do not correlate with the rank as normally classified. A definite relationship has been found between the characteristics of these coals, char/cokes, and aromatic characters (fa, Har). 10.1080/19392691003781616

Feedback Concept in the Ore-forming Systems

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Resource Geology, 2010, Vol. 60(1), pp. 109-115.

Feedback, one of the most fundamental processes existing in nature, is present in almost all dynamic systems. Feedback concepts have been utilized almost exclusively by engineers. Nevertheless, this theory is applicable to formulating and solving problems in geology, particularly in the ore-forming systems. Feedback is distinctly operative in the generation of two groups of mineral deposits: (i) Mineral deposits showing rhythmic structures/textures, such as layered chromite deposits, re-opened veins with banded structure/texture, Mississippi Valley-type deposits with alternate bands/crusts of barite and galena, proximal volcanogenic massive sulfide deposits with mineralized layers of breccia clasts, and banded iron formations with alternate silica and magnetite and/or hematite bands, and (ii) mineral deposits lacking visible rhythmic structures/textures, but showing evidence of rhythmic process(es), such as in porphyry base metal deposits. There is an alternation of positive and negative feedback mechanisms in the ore-forming systems discussed here, which implies the involvement of feedback loops of negative sign. 10.1111/j.1751-3928.2010.00118.x

General analytical concept and design methodology to producing a clay - based polymer nanocomposite

El-Sheikhy, RA; Al-Shamrani, MA
Characterization And Control Of Interfaces For High Quality Advanced Materials Iii
3rd International Conference on Characterization and Control of Interfaces for High Quality Advanced Materials, 2009, Kurashiki, JAPAN, AMER CERAMIC SOC, WESTERVILLE, 2010, Vol. 219, pp. 165-174

Due to the natural properties of low cost, environmentally friendly clay minerals as nano-materials with a high aspect ratio and large surface area, clay platelets are

very convenient filler and reinforcing materials in matrix materials such as polymers to produce advanced nano-composites with unique properties. Clay-based polymer nano-composites can have new and different properties that make them suitable for many different industrial and commercial applications, such as in automotive, medicine, electronics, sensors, construction, packaging, coatings, drugs, biomedical engineering, and others. Production of these nano-composite materials involves several steps of material preparation, mixing, and processing. Basically, the design of these nano-composites depends on a simple concept and the mechanism of strengthening a material with weak properties by adding a small amount of another material with strong properties. Reinforcing the main material (polymer) with a certain ratio (5%- 15%) of filler (nano-clay), will transform the polymer into an advanced functional material. The morphology, characterization, and analysis of these materials are based on that concept. There have been problems and difficulties in manufacturing these nano-composites. In the current study, a new point of view is taken involving a new concept, a new mechanism, new techniques for mixing and processing, and new methods of analysis and characterization. This study utilizes a new approach to understand and control the interfacial bond strength between the clay nano-fibers and the polymer, voids and inclusions, the de-bonding process between the fibers and the polymer, fiber orientation, fiber distribution and intensity, fracture, and cracks. This study uses natural Saudi nano-clay and polymers to solve the problems and difficulties with clay/polymer nano-composites that previous studies encountered.

Identification of the dominant Cu ore minerals providing soluble copper at Canariaco, Peru through Cu isotope analyses of batch leach experiments

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Hydrometallurgy, FEB, 2010, Vol. 101, pp. 15-19

The copper isotope composition of leach solutions and head mineral material from Canariaco was monitored in standard batch leach experiments to determine the dominant mineral providing copper during leaching. Copper isotope ratios are reported as delta(65)Cu parts per thousand = (((65)Cu/(63)Cu(sample)/(65)Cu/(63)Cu(NIST) (976) (standard)) -1)* 10(3). Two sigma errors for all the analyses are +/- 0.15%. (determined by multiple analyses of the samples) and mass bias was corrected through standard-sample-standard bracketing. To identify the dominant minerals providing Cu during leaching, Cu isotopic fractionation factors (defined as Delta(liquid-solid) = delta(65)Cu(liquid) - delta(65)Cu(solid)) were calculated. Two types of ore were tested, ores containing enargite/chalcopyrite and ores containing covellite/chalcopyrite/chalcocite. The fractionation factors of the four ore minerals are distinctly different and the calculated fractionation factors from the batch experiments represent mixtures of each phase. Fractionation factors varied between -1.03 and 0.91. A negative linear relationship (r(2) = 0.9) between soluble copper and calculated fractionation factors

exists for both ore types and can be interpreted as follows. For the enargite/chalcopyrite trend, the most soluble Cu ores (only 40% recovered Cu) appear to be derived from enargite mineralization. For the covellite/chalcocite/chalcopyrite ores, the most soluble Cu (at 80% recovered Cu) appears to be derived from covellite rich ores. Less than 10% chalcocite is present in the ores and chalcopyrite dominates the ores with less soluble copper. The results clearly demonstrate the application of copper isotope fractionation between solutions and solids during leaching to identify the bulk mineralogy that provides the soluble copper in the sample.
10.1016/j.hydromet.2009.11.005

Recovery of rare earths from wet-process phosphoric acid

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Hydrometallurgy, FEB, 2010, Vol. 101, pp. 41-47

Phosphorite ores are a potential resource of rare earths (RE) as well as phosphate so the recovery of rare earths during the wet processing of phosphoric acid is important. This study investigates the influence of operating conditions and crystal modifiers on the leaching of RE and the solvent extraction of RE with organo-phosphorus reagents. The results indicate that lower temperature. higher concentration of phosphoric acid and larger liquid/solid ratio are beneficial to RE enrichment in the phosphoric acid. Surfactant additives which enhance the crystal growth of gypsum also enhanced RE leach recovery about 75% under optimized conditions. Studies on the solvent extraction of RE found that D2EHPA mixtures with neutral organo-phosphorus reagents were antagonistic and that Fe(3+) competed strongly over RE. Higher D2EHPA concentration, larger phase ratio, lower temperature and lower phosphoric acid concentration increased the RE extraction efficiency. A negative enthalpy change was found indicating an exothermic extraction reaction.
10.1016/j.hydromet.2009.11.017

Geochemical and mineralogical changes in compacted MX-80 bentonite submitted to heat and water gradients

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Applied Clay Science, FEB, 2010, Vol. 47, pp. 400-408

A 20-cm high column of MX-80 bentonite compacted at dry density 1.72 g/cm(3) with an initial water content of 16% was submitted to heating and hydration by opposite ends for 496 days (TH test). The temperature at the bottom of the column was set at 140 degrees C and on top at 30 degrees C, and deionised water was injected on top at a pressure of 0.01 MPa. Upon dismantling, water content, dry

density, mineralogy, specific surface area, cationic exchange capacity, content of exchangeable cations, and concentration of soluble salts and pH of aqueous extracts were determined in different positions along the bentonite column. In addition, the pore water composition was modelled with a geochemical software. The test tried to simulate the conditions of an engineered barrier in a deep geological repository for high-level radioactive waste. The water intake and distribution of water content and dry density along the bentonite were conditioned by the thermal gradient. Liquid water did not penetrate into the column beyond the area in which the temperature was higher than 100 degrees C. A convection cell was formed above this area, and liquid water loaded with ions and moving by advection evaporated towards cooler bentonite as it reached the area where the temperature was too high. In this area the precipitation of mineral phases took place. Advection, interlayer exchange and dissolution/precipitation processes conditioned the composition of the pore water along the column. In most of the column the pore water was Na-SO(4)(2-) and changed to Na-Cl type near the heater. The overall changes in cation content of the pore water could be explained by changes in the smectite interlayer and mineral phases equilibrium. The TH treatment did not cause significant alteration of the smectite or the other mineral phases of the bentonite. 10.1016/j.clay.2009.12.004

Gravity Separation of Coal in the Reflux Classifier - New Mechanisms for Suppressing the Effects of Particle Size

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International Journal Of Coal Preparation And Utilization, 2010, Vol. 30, pp. 130-144.

The Reflux Classifier was applied to the separation of coal and mineral matter over different size bands, -8+0.5mm, -2+0.25mm, and -2+0.075mm. The technology consists of a fluidized bed, with a system of parallel inclined channels above. Significant improvement in separation efficiency was achieved by exploiting new separation mechanisms that apply to particles of a given size within the inclined channels. For the coarsest size range, the use of a sufficiently large channel aspect ratio, defined by the channel length to gap ratio, leads to separation densities that are independent of the particle size, and in turn strong control of the cut point. For the finer particles, a new and powerful separation mechanism was exploited, leading to a major reduction in the variation of the particle separation density with particle size, and to a significant reduction in the Ep. The new separation mechanism, achieved through the use of appropriate, closely spaced, inclined channels leads to significant suppression of the effects of particle size in the particle size range -2+0.075mm, even at low solids concentration. For example, over the size range 0.25 to 2.0mm Ep values of 0.06 to 0.08 were obtained.
10.1080/19392699.2010.497094

A comparative study of slip velocity models for the prediction of performance of floatex density separator

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International Journal of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, Feb-19, 2010, Vol. 94, pp. 20-27.

The separation features of the floatex density separator (FDS) are investigated through experimental and computational approaches. It has been shown that the performance of the FDS can be predicted reasonably well using a slip velocity model and steady-state mass balance equations. The approach for the formulation of the slip velocity model makes a difference in the prediction of FDS performance. The computed data from four different slip velocity models have been compared and contrasted with the experimental observations. It has been shown that a slip velocity model based on the modified Richardson and Zaki equation. in which the dissipative pressure gradient is considered to be the primary driving force for separation, predicts the performance more accurately than the other three. A deslimed feed is recommended for better performance of the FDS. (C) 2009 Elsevier B.V. All rights reserved. 10.1016/j.minpro.2009.11.001

A Study of Rotary Tribo-Electrostatic Separation of South African Fine Coal

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International Journal Of Coal Preparation And Utilization, 2010, Vol. 30, pp. 154-172.

This article presents an experimental study of rotary tribo-electrostatic separation (RTS) as an alternative approach for beneficiating steam coal mainly used in South African power plants. An RTS with an octagonal charger developed at the University of Kentucky, USA has been used in beneficiating two types of South African coals containing nearly 37% and 32% ash, respectively. System parameters, such as applied charger potential, separation chamber voltage, rotation speed of the copper-plated rotor, and splitter distances were investigated for their effects on the separation performance. It was found that better separation was observed at 5000rpm rotation speed, no applied potential to the charger, and 25KV separation voltage. The RTS process reduced the ash content of the -177 mu m coal fraction by nearly 14.9% for the Klipfontein coal and 12.2% for the Liketh Townlands coal, with corresponding combustible recovery values of 10.7% and 8.9%, respectively. Total sulphur content was also reduced from 2.1% to 0.9% for the Klipfontein coal and from 2.8% to 0.4% for the Liketh Townlands coal at corresponding combustible recovery values of 5.7% and 8.9%, respectively. The x-ray diffraction analysis of the cleaned-coal samples confirmed a reduction in the mineral content with an improvement in the organic composition for both coal samples.
10.1080/19392699.2010.497100

Application of dielectrophoresis for the separation of minerals

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Minerals Engineering, MAR, 2010, Vol. 23(4), pp. 350-358.

Comminution is an energy intensive process, accounting for approximately 29% of total mining energy (Tromans, 2008). Better liberation at coarser size ranges (0.5-2 mm) has been identified by the minerals industry as an opportunity for energy conservation. In order to capitalise on future developments in comminution, an effective coarse particle separation method is required for liberated particles which are too coarse for flotation. This paper reviews the application of dielectrophoresis as a potential technique for the removal of coarse liberated gangue, thereby significantly reducing the volume of ore continuing onto fine grinding. Dielectrophoresis is the translational motion of neutral matter caused by polarisation effects in a non-uniform electric field. A simple apparatus has been constructed, in which the deflection of a particle in a non-uniform electrical field is used to quantitatively measure the dielectrophoretic force on quartz and galena particles of various sizes. The results show that the force increases as a function of voltage squared and particle radius cubed. This technique can potentially be used to measure the effective permittivity of single mineral particles and quantify the effect of particle composition on separation.
10.1016/j.mineng.2009.09.001

Application of the Palla (TM) vibrating mill in ultra fine grinding circuits

Andres, K; Haude, F
Journal Of The South African Institute Of Mining And Metallurgy, Mar, 2010, Vol. 110(3), pp. 125-131.

This paper presents the vibrating mill technology and summarizes the grinding principle of ultra fine grinding. In addition, a variety of operations is described and the benefits of these different operating modes' product size and efficiency are specified. A case study of an industrial application is presented to show the integration of vibrating mills into grinding circuits. The primary focus is the overall process scheme of this technology, the installation and operating costs, as well as the design parameters required for best performance. The vibrating mill can be used in a wide range of applications for process engineering duties. For a wide range of applications, from soft to extremely hard products, which require ultra fine grinding, surface activation or homogenization, the vibrating mill is well proven. Due to its easy operation, versatility and operation efficiency, the PALLA (TM) vibrating mill gains in importance in the mineral processing industry.

Calcination of low-grade laterite for concentration of Ni by magnetic separation

Kim, J; Dodbiba, G; Tanno, H; Okaya, K; Matsuo, S; Fujita, T
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Minerals Engineering, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, MAR, 2010, Vol. 23(4), pp. 282-288.

With the continuous depletion of high-grade nickel ores such as millerite and niccolite, nickeliferous laterites have become the major source for the production of nickel metal. However, only 42% of the world's production of nickel comes from laterites, since the concentration of Ni is relatively low (ca. 2 wt.%). In addition, other metals, such as magnesium, iron and silicon can be found in laterite, which make the concentration of nickel even more difficult. In this study, a low-grade nickeliferous laterite ore was first calcinated and then processed by using a wet magnetic separator in order to recover nickel. Since, the ore contains both Ni and Fe, the calcination of laterite is effective in altering the crystalline structure of Fe species and therefore its magnetic properties, which in turn enable the selective concentration of nickel by magnetic separation that is an easy and environmentally-friendly technique. The experimental results have indicated the importance of carefully controlling: (1) the calcination temperature; (2) the pulp density and (3) applied magnetic field strength. The main finding of this work was that magnetic separation is effective in recovering 48% of nickel from laterite, increasing the Ni grade in the recovered product from 1.5% to 2.9%, when prior to the separation the ore was calcinated at 500 degrees C for 1 h. 10.1016/j.mineng.2010.01.005

Gravity separation of coarse particles using the Reflux Classifier

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Minerals Engineering, MAR, 2010, Vol. 23(4), pp. 339-349

A comprehensive study examining the potential of the Reflux Classifier to be applied to the beneficiation of coarser coal up to 8 mm in size was undertaken. It was demonstrated that efficient combustible recovery and control of the separation density to target low ash products could be achieved. The major finding from the study was the critical importance of providing sufficient fluidization water, though beyond the critical level the process was largely insensitive to the fluidization rate. It was concluded the required fluidization velocity is nominally 10 m/h per mm of top-size, hence for a nominal 4 mm top size the required velocity is 40 m/h. In an extended campaign the control of the process was investigated by varying the set point density from high to low levels and then returning the process to the original settings, and demonstrating a return to the original separation. Further analysis was conducted to determine the partition curves and the shift in the separation density with particle size. The variation in the D(50) with particle size approaches a level that

is independent of the particle size. Previous data (Galvin et al., 2002, 2004) covering particles up to 2 mm in size are consistent with the results from this study, involving feeds with top sizes of 4 mm and 8 mm. Beyond a particle size of 2 mm the Ep is typically less than 0.05 and approaches about 0.03 as the particle size increases to 8 mm. 10.1016/j.mineng.2009.09.014

Hierarchical porosity of bentonite-based buffer and its modification due to increased temperature and hydration

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Applied Clay Science, JAN, 2010, Vol. 47, pp. 163-170

The use of the hierarchical pore structure in a bentonite-based mixture as a part of a nuclear waste repository's engineering barrier is proposed. The pore structure was observed in an experimental mixture composed of milled Ca-bentonite (85 vol.%), quartz sand (10 vol.%), and graphite (5 vol.%), which had been subjected to long-term (44 months) combined effects of increased temperature (up to 90 degrees C) and hydration during the Mock-Up-CZ experiment. Although there were negligible changes in the mineralogical composition (a slight increase of illite content, and minor conversion of montmorillonite to beidellite), the studied material underwent significant changes in the hierarchical pore structure. The parameters of the pore space were examined by adsorption techniques (CO(2) and N(2) as well as by the intrusion technique (mercury porosimetry). Detectable pore radii ranged from about 0.4 nm to 58 mu m (micro-, meso-, macropores, and coarse pores). The observed pore categories were attributed to the presence of solid particles and their arrangement. The smallest pores exhibited a typical radius of 0.65 nm (a range from 0.4 to 1.6 nm), a total specific surface area of 50 m(2)/g for the initial material. Mesopores showing radii 10-20 times higher were found within aggregates of clay mineral particles. Their specific surface area was roughly similar to that of micropores. Simultaneous heating and hydration decreased the specific surface area of the micropores close to the source of heat (i.e. in the direction of increasing temperature). There was a slight increase of their volume in moderately heated areas (50-70 degrees C) and a decrease in both the less heated (30-40 degrees C) and highly heated areas (over 70 degrees C). The same process increased the specific surface area of mesopores by 1-18%. The maximum increase of this parameter was observed in the samples exposed to a lower temperature (3040 degrees C). The volume and specific surface area of macropores and coarse pores significantly decreased (by 20 and 40% respectively) when compared to the pre-experimental material but the typical radius of macropores was increased by a factor of about 2 or 3 in the zone of maximum temperature. This fact contributed to increased hydraulic conductivity observed by Pusch et al. (2007). (C) 2009 Elsevier B.V. All rights reserved. 10.1016/j.clay.2009.10.005

Measurement of particle loading on bubbles in the flotation process

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Methods for estimation or measurement of particle loading on bubbles in the flotation process are reviewed. The paper focuses on direct measurement methods developed under the direction of Moys at the University of the Witwatersrand and by Seaman and co-workers at the JKMRC, Brisbane, Australia. Deficiencies in both designs are identified and a new design which deals with all these deficiencies is proposed. A hydrodynamic model for this version is developed and tested in a water-only environment, then tested on the copper flotation plant at El Teniente. It was found that the new design had successfully dealt with prior method deficiencies and provided a very precise (relative standard deviation equal to 0.72%) measurement of the loading on the bubbles in five tests. (C) 2009 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2009.11.004

Microbially Induced Mineral Beneficiation

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Mineral Processing And Extractive Metallurgy Review, 2010, Vol. 31(1), pp. 1-29

The divergent role of microbes in the field of mineral processing starting from mining and beneficiation to efficient waste disposal has been well recognized now. The roles of various microorganisms and bioreagents in the beneficiation of minerals are illustrated in this paper. Various types of microorganisms useful in bringing about selective flotation and flocculation of various oxide and sulfide minerals are illustrated. Interfacial phenomena governing microbe-mineral interactions are discussed with reference to bacterial cell wall architecture, cell surface hydrophobicity, electrokinetic data, and adsorption behavior on various minerals. Applications of microbially induced mineral beneficiation are demonstrated with respect to beneficiation of iron ores, bauxite, limestone, and complex multimetal sulfides. 10.1080/08827500903404682

Modelling iron-bentonite interactions

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Applied Clay Science, JAN, 2010, Vol. 47, pp. 91-98

The presence of both iron canisters and bentonitic clay in some engineered barrier system (EBS) designs for the geological disposal of high-level radioactive waste (HLW) creates the potential for chemical interactions which may impact upon the long-term performance of the clay as a barrier to radionuclide migration. Natural

systems evidence suggests that the sequence of alteration of clay by Fe-rich fluids may proceed via an Ostwald step sequence. The computer code QPAC has been modified to incorporate processes of nucleation, growth, precursor cannibalisation, and Ostwald ripening to address the issues of the slow growth of bentonite alteration products. This, together with inclusion of processes of iron corrosion and diffusion, has enabled investigation of a representative model of the alteration of bentonite in a typical EBS environment. Simulations with fixed mineral surface areas show that berthierine dominates the solid product assemblage, with siderite replacing it at simulation times greater than 10,000 years. Simulations with time-dependent mineral surface areas show a sequence of solid alteration products, described by: magnetite -> cronstedtite -> berthierine -> chlorite. Using plausible estimates of mineral-fluid interfacial free energies, chlorite growth is not achieved until 5000 years of simulation time. The results of this modelling work suggest that greater effort should be placed upon providing key data for iron silicates (e.g. kinetic data, solubilities, and mineral-fluid interfacial free energies), through a dedicated programme of laboratory experimental and natural analogue research. 10.1016/j.clay.2008.03.011

Optimization Studies of Hydrocyclone for Beneficiation of Iron Ore Slimes

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Mineral Processing And Extractive Metallurgy Review, 2010, Vol. 31(2), pp. 86-96

Hydrocyclone is a key unit operation in mineral-processing industry for beneficiation of mineral values that uses centrifugal force to separate materials by density or size. The optimization of different operating parameters of hydrocyclone is gaining importance to achieve the best performance. In the present investigation, an attempt has been made to develop statistical models using design of experiment technique and optimize the model parameters using the Nelder-Mead multidimensional pattern search technique to obtain a product of desired grade and recovery. Hydrocyclone parameters such as spigot diameter (mm), vortex finder diameter (mm), solids consistency (%), pressure (psi), and dispersant (gms/kg) are optimized to recover iron values from iron ore slime generated at iron ore washing plant. Addition of dispersant significantly improved the separation efficiency. The maximum iron grade and recovery predicted by the model is 65.0% and 60%, respectively, for a iron ore slime sample containing 57.84Fe, 6.0% Al2O3, and 6.7% of SiO2. 10.1080/08827500903397142

Predicting the specific energy required for size reduction of relatively coarse feeds in conventional crushers and high pressure grinding rolls

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Minerals Engineering, JAN, 2010, Vol. 23(2), pp. 151-153

In a previous paper (Morrell, 2009. Predicting the overall specific energy requirement of crushing. high pressure grinding roll and tumbling mill circuits. Minerals Engineering 22 (6), 544-549), an approach was described to predict the specific energy of a range of tumbling mill and crushing/high pressure grinding rolls (HPGR) circuits. In the case of crushing and HPGR circuits, recently acquired data have enabled this approach to be extended to coarser particle size reduction situations. This is achieved through the use of a size-dependent hardness parameter. Crushing and HPGR conditions are described where the use of this parameter should improve the accuracy of specific energy predictions. A worked example is also given.
10.1016/j.mineng.2009.10.003

Reduction roasting and Fe-Al separation of high iron content gibbsite-type bauxite ores

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Light Metals 2010, Technical Session on Light Metals 2010 held at the 139th TMS Annual Meeting, FEB 14-18, 2010, Seattle, WA, MINERALS, METALS & MATERIALS SOC, WARRENDALE, 2010, pp. 133-137

Large reserves of high iron content gibbsite-type bauxite ores have been found in China, which are characterized as relatively high iron oxides content, but low alumina content and A/S ratio. Aluminiferous minerals and ferrous minerals are fine or superfine in size, and conjoint and substituted with each other; therefore, physical beneficiation is not feasible due to extremely difficult liberation. In this study, reduction roasting and separation of iron and alumina had been investigated. The influences of reduction time, roasting temperature and magnetic separation were involved. The results indicate that a metallic iron concentrate with 93.3% total iron grade and non-magnetic product with 40% alumina content were obtained when a sample with 31.22% total iron grade and 26.35% alumina was processed. Metallic iron concentrate can be used as steelmaking burden, and alumina can be extracted from the non-magnetic product further.

Selective Classification of Mineral Sand Slimes in an Air Fluidized Bed

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Mineral Processing And Extractive Metallurgy Review, 2010, Vol. 31(2), pp. 59-72

Studies were carried out for selective classification of mineral sands to remove unwanted slimes (particles of 0.63 mu m in size). Vertical and arched fluidized bed setups were tested to retain the coarser heavy mineral particles from fluidized mineral sand beds. Theoretically calculated process parameters were used to develop the experimental setups. The mathematical model given by Nguyentranlam

and Galvin (oParticle classification in the reflux classifier.o Minerals Engineering, 14(9), 2001, pp. 1081-1091) was used to develop an arched fluidized bed setup. Experiments were carried out at six different superficial air velocities (0.21, 0.25, 0.34, 0.41, 0.64, and 0.82m/s) in the vertical and arched fluidized bed setups. An acceptable agreement was found in the experimental and theoretical results. The overall process capability of the vertical fluidized bed to selectively remove the slimes was 44.8% with the loss of 3.93% of heavy minerals. The overall process capability was improved up to 52% with the loss of 4.08% of heavy minerals by the proposed arched fluidized bed setup. The developed arched fluidized bed setup showed improved performance for selective elutriation of mineral sand slime particles with compromising heavy mineral losses. 10.1080/08827500903397076

Electrochemical behavior of gold cyanidation in the presence of a sulfide-rich industrial ore versus its major constitutive sulfide minerals

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A detailed study on the relative importance of passivation phenomena and galvanic interactions during gold cyanidation was carried out. Mineral disc electrodes consisting of a sulfide-rich industrial ore and major sulfide components were prepared along with an Au electrode (gold/silver alloy) in use for gold leaching rate tests. These leaching tests that were conducted by hyphenating gold and mineral disc electrodes conjointly in one electrochemical cell or in two separate electrochemical cells objectified both passivation-induced setbacks as well as boosts by Au/mineral galvanic interactions on gold dissolution. To decipher the role of sulfide ores on gold cyanidation, a systematic study was performed by monitoring the leaching behavior of an Au disc electrode successively immersed in slurries of industrial ore and its major sulfide constituents, i.e., pyrite, sphalerite and chalcopyrite. The tested mineral constituents and ore exhibited an inhibiting effect on gold leaching, decreasing in the following order: chalcopyrite> sphalerite> industrial ore> pyrite. Pre-oxidation of the industrial sulfide ore prior to cyanidation improved the gold leaching rate. However, in spite of noticeable reductions in cyanide consumption, no beneficial effect of pre-oxidation on gold leaching was observed for the major sulfide (ore) constituents when tested separately. Although cooperating permanent galvanic interactions between gold and main constitutive minerals in the industrial ore prompted higher gold leaching rates, predictability of the latter from lab-controlled leach tests of the nearly pure constitutive sulfide minerals still remain premature.
10.1016/j.hydromet.2009.12.004

Assessment of minerals and iron-bearing phases present in hydrometallurgical residues from a nickel sulfide concentrate and availability of residue associated metals

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Hydrometallurgical facilities refining nickel sulfide ores produce waste residues in the form of sludges which contain concentrations of metals as well as iron and sulfur-bearing minerals and phases. The geochemical and mineralogical character of hydrometallurgical residues is important for the management of this type of industrial waste. Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD) analysis indicate that the minerals produced in the process are principally gypsum and the iron oxides, hematite and magnetite, iron hydroxides and residual sulfur and sulfides in the form of FeS, chalcopyrite, pyrrhotite and pentlandite. The iron oxide particles in the leach residue exhibit an atypical framboidal structure that is relevant to its metal leaching properties. The mineralogy and microstructure of mini plant residue is compared to that of the demonstration plant residue through the SEM and XRD. Sequential extractions are used to determine the association between different phases/minerals and select metals in each residue. 10.1016/j.hydromet.2009.12.006

Column bioleaching of metals from electronic scrap

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The present work was aimed at studying the column bioleaching feasibility of metals from electronic scrap by the selected moderately thermophilic strains of mixed adapted consortium of acidophilic chemolothotrophic and acidophilic heterotrophic bacteria. These included Sulfobacilllus thermosulfidooxidans and Thermoplasma acidophilum. The tolerance of bacterial cultures to mixed metal ions (Ag(+), Al(3+), Cu(2+), Fe(3+), Ni(2+), Pb(2+), Sn(2+) and Zn(2+)) could be improved markedly after nearly two year adaptation from 12 g/L to 20 g/L. During whole leaching process included acid pre-leaching operation of 27 days and bioleaching operation of 280 days about 80% Zn, 64% Al, 86% Cu and 74% Ni was leached out. 10.1016/j.hydromet.2009.12.007

Kinetics on leaching rare earth from the weathered crust elution-deposited rare earth ores with ammonium sulfate solution

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Hydrometallurgy, MAR, 2010, Vol. 101, pp. 166-170

In this paper, the kinetic of leaching rare earth from the weathered crust elution-deposited rare earth ores with ammonium sulfate solution was investigated. The effects of the main leaching parameters such as temperature and ore particle size on leaching process were examined and discussed in order to elucidate the kinetics and mechanism of leaching rare earth. It was found that the higher the leaching temperature or the smaller the ore particle size, the faster the leaching progress. The leaching mechanism was analyzed with different kinetics models. The results show that the leaching process can be described by the shrinking-core model, the leaching rate was controlled by the inner diffusion of reactants and leaching products through mineral porous layer, the leaching process follows the kinetic model 1-2/3 alpha-(1-alpha)(2/3) = kt, the apparent activation energy was 9.24 kJ/mol obtained from calculating the experimental data and the order of the ore particle size found to be approximately 2. An empirical equation relating the rare earth leached rate constant with ore particle size and leaching temperature was established as 1-2/3 alpha-(1-alpha)(2/3) = 1.50. r(0)(-2).e(924/RT). t. 10.1016/j.hydromet.2010.01.001

Selective Flotation Technique for Separation of PET and HDPE Used in Drinking Water Bottles

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Mineral Processing And Extractive Metallurgy Review, 2010, Vol. 31(4), pp. 214-223

Plastics have become the widely used materials because of their advantages, such as cheapness, endurance, lightness, and hygiene. However, they occur as solid waste masses within a short time when used in package industry. This causes waste and soil pollution, because they do not decompose. Polyethylene terephthalate (PET) and high-density polyethylene (HDPE) are the most important varieties of plastics that are usually used in the manufacturing drinking water bottles. Depending on their surface characteristics, these plastics can be separated from each other by flotation method. But, all plastics are naturally hydrophobic. In order to employ flotation for the separation process, one of these plastics is made hydrophilic, while the other remains hydrophobic. Plasticizer reagents are used to change the plastics' surface character and make them hydrophilic. The aim of this investigation is to research selective flotation of used PET and HDPE by utilizing Triton XL-100N and Diethylene Glycol Dibenzoate-type plasticizers at optimum temperature, pH, and conditioning time. As a result of this investigation, PET-HDPE concentrates having about 100% purities were obtained with 100% recovery, when the mixture of PET-HDPE was conditioned for 30min with 40kg/t NaOH at pH 10 and 1000g/t Dietilen Glycol Dibenzoate at 50 degrees C.
10.1080/08827508.2010.483362

Strategies for Washing Australian Coals

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 69-82

This article represents a distillation of QCC's experience over the last 20 years in developing coal-washing circuits to optimize coal recoveries for a wide range of Australian coals. The article will look at typical washabilities and product types to capture the general washing requirements. The major processing equipment will be reviewed as to their typical usage in the Australian context. From this background the processing circuits and strategies commonly used will be discussed for the relevant coal types, including hard coking coal, semi-hard coking coal, PCI, export thermal, and domestic thermal coal from the major producing regions in NSW and Queensland. 10.1080/19392699.2010.497080

Predictive Control of Screen Process Efficiency

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 83-99

The durability of critical wear components, the ability to predict their remaining life, and their improved operating efficiency was identified by the Australian coal industry to be a long-term strategic objective. Polymer screen panels used in high-capacity multisloped screens (banana screens) are a critical wear component that can affect both availability of the plant and plant performance. As a screen panel wears more oversize material is presented to downstream processing unit operations such as spirals and flotation plants, this oversize material has detrimental affects on the operating efficiency of these unit operations and can result in considerable yield losses. In addition, the maintenance of the screen panels is often done on a reactive basis or carried out at times when it is not needed resulting in unnecessary stoppages to the plant. If the plant operators can predict when the screen apertures/misplaced material reaches a point where yield loss is excessive and screen maintenance is required then reactive screen maintenance can be eliminated. This article describes the plant work undertaken during the course of the project, the results of the plant work, and the next steps towards developing a model describing the wear and the effect this wear has on downstream processing. Two plants were chosen for the test work; the first a plant with desliming banana screens cutting at nominally 1.8mm with the oversize (30mmx1.8mm) reporting to a primary 1m DMC and the undersize to classifying cyclones and spirals. The second plant was desliming the 50mm top-size feed again using banana screens at a cut-point of nominally 0.4mm; the 50mmx0.4mm was cleaned using a primary 1m dense medium cyclone and the desliming screen undersize nominally 0.4mmx0mm was treated using column flotation. Both these circuits incorporated secondary processing of the primary DMC rejects using secondary DMCs to produce a thermal coal. Screen

apertures were measured over a period of 10 to 12 weeks using an optical-image analysis technique and samples taken of the screen products either just prior to the aperture measurement or immediately after. 10.1080/19392699.2010.497081

Development and Evaluation of the CAVEX Dense Medium Cyclone

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 100-112

The CAVEX dense medium cyclone (DMC) was developed in the later part of the 1990s as a result of the expertise developed by Weir engineers in slurry pumping. The inlet area of the cyclone is designed to minimize turbulence and to reduce wear at the feed entry point, which provides more energy for particle separation at a given feed pressure. A parametric study was performed on a 150mm diameter unit to quantify separation efficiency as a function of feed pressure, apex diameter, medium density, and cone angle. The added energy in the cyclone was confirmed by comparing the stability of the medium in the CAVEX unit with that provided by a common commercial unit having the same dimensions. A 500mm unit was installed in parallel with an identically sized industrial unit in an operating preparation plant treating 12x1mm coal. The separation efficiency values achieved by the CAVEX DMC were found to be higher than those obtained by the standard industrial unit and the amount of improvement increased with a decrease in particle size. The data from the pilot-scale and in-plant tests are presented and discussed in this article. 10.1080/19392699.2010.497086

CFD Modeling of Dense Medium Cyclone

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 113-129

A number of empirical models are in existence for the dense medium cyclone (DMC) and in recent years this subject has been broached with computational fluid dynamics (CFD). The dense medium presents a centrifugal field within the cyclone body. The coal particles separate in this field due to various forces acting on them. Hence, CFD is ideally suited for the modeling of the DMC. The Large Eddy Simulation (LES) method for resolving the turbulence was used in the CFD simulation of a 76mm dense medium cyclone. In particular, the magnetite was modeled as three granular fluids. In the simulation the diameter of the vortex finder and spigot are varied to compare with the experimental data of P. A. Verghese and T. C. Rao. The results obtained using LES turbulence model is found to be accurate in terms of the cut density and the slope of the distribution curves. Thus, the three granular fluid modeling of the magnetite stream is a computationally simpler method for the analysis of DMC. 10.1080/19392699.2010.497089

Gravity Separation of Coal in the Reflux Classifier - New Mechanisms for Suppressing the Effects of Particle Size

Galvin, K. P.; Callen, A.; Spear, S.; Walton, K.; Zhou, J.
International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 130-144

The Reflux Classifier was applied to the separation of coal and mineral matter over different size bands, -8+0.5mm, -2+0.25mm, and -2+0.075mm. The technology consists of a fluidized bed, with a system of parallel inclined channels above. Significant improvement in separation efficiency was achieved by exploiting new separation mechanisms that apply to particles of a given size within the inclined channels. For the coarsest size range, the use of a sufficiently large channel aspect ratio, defined by the channel length to gap ratio, leads to separation densities that are independent of the particle size, and in turn strong control of the cut point. For the finer particles, a new and powerful separation mechanism was exploited, leading to a major reduction in the variation of the particle separation density with particle size, and to a significant reduction in the Ep. The new separation mechanism, achieved through the use of appropriate, closely spaced, inclined channels leads to significant suppression of the effects of particle size in the particle size range -2+0.075mm, even at low solids concentration. For example, over the size range 0.25 to 2.0mm Ep values of 0.06 to 0.08 were obtained.
10.1080/19392699.2010.497094

Evaluation of a Novel Fine Coal Dry Cleaning Process at Greenfields Coal Company

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 145-153

Coal mining and processing operations have in the past and continue to create large tonnages of fine coal and waste particles. While technological advances in wet processing has made it possible to efficiently recover coal fines, difficulties associated with dewatering make these fine particles unattractive economically for most coal markets. A novel system has been developed for cleaning fine raw coal utilizing a multistage dry classification process that removes the clay particles that are typically much smaller than the majority of the clean coal particles and that reduces the product surface moisture to as low as 1%. In this article, the novel dry coal-cleaning process under license to Greenfields Coal Company was evaluated. The classification process offers a viable alternative to traditional wet processing and dewatering of the fine particles, especially for operations recovering abandoned impoundments where a sufficient water source and/or a waste slurry disposal site are unavailable. This article presents the separation performance and operating results obtained from field testing with a 2t/hr pilot-scale unit located at an abandoned impoundment in southern West Virginia. 10.1080/19392699.2010.497098

A Study of Rotary Tribo-Electrostatic Separation of South African Fine Coal

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 154-172

This article presents an experimental study of rotary tribo-electrostatic separation (RTS) as an alternative approach for beneficiating steam coal mainly used in South African power plants. An RTS with an octagonal charger developed at the University of Kentucky, USA has been used in beneficiating two types of South African coals containing nearly 37% and 32% ash, respectively. System parameters, such as applied charger potential, separation chamber voltage, rotation speed of the copper-plated rotor, and splitter distances were investigated for their effects on the separation performance. It was found that better separation was observed at 5000rpm rotation speed, no applied potential to the charger, and 25KV separation voltage. The RTS process reduced the ash content of the -177 mu m coal fraction by nearly 14.9% for the Klipfontein coal and 12.2% for the Liketh Townlands coal, with corresponding combustible recovery values of 10.7% and 8.9%, respectively. Total sulphur content was also reduced from 2.1% to 0.9% for the Klipfontein coal and from 2.8% to 0.4% for the Liketh Townlands coal at corresponding combustible recovery values of 5.7% and 8.9%, respectively. The x-ray diffraction analysis of the cleaned-coal samples confirmed a reduction in the mineral content with an improvement in the organic composition for both coal samples.

10.1080/19392699.2010.497100

A Novel Approach for Improving Column Flotation of Fine and Coarse Coal

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International Journal Of Coal Preparation And Utilization, Vol. 30(2-5), Mar-Oct, 2010, pp. 173-188

Froth flotation, applied to the separation of solid particulates, has been practiced commercially for a long time in the coal and mineral industries. The potential benefits of establishing a deep froth, especially in column flotation have been shown by a number of researchers and that includes demonstrating that the froth phase is much more efficient at mineral upgrading than is the pulp phase. This approach could be useful in where the particles have difficulty in reporting from pulp phase to froth phase. Hence, it is expected that introduction of particles into the froth phase will significantly improve the grade and recovery of particles. In this article, a novel way of operating a flotation column was implemented, and the results were compared to those when operating the same column in the conventional fashion. Tests were conducted with both fine and coarse coals. Feeding into the froth zone enhances bubble-particle contact as observed by a higher product yield of 79.4% compared to a conventional column flotation yield of 73.4%, both at about 9% product ash. It was also observed that the novel froth feed improved the recovery of coarse (+1mm) coal particles from 0.9wt% to 2.2wt% compared to the conventional

way of feeding slurry to pulp. Similarly, recovery of 1x0.6mm particles improved from 4.6wt% to 8.3wt% at the same ash level. Positive results were also obtained by external reflux of a portion of the concentrate back into the top of the column. The potential to simultaneously achieve improvement in both recovery and grade can be explained by application of conventional mass transfer concepts, analogous to developments in two-phase foam fractionation. 10.1080/19392699.2010.497106

Evaluation of the StackCell Technology for Coal Applications

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The StackCell flotation technology offers significant metallurgical and design benefits that are a result of a superior rate of flotation when compared to conventional, mechanical cells. This improvement in flotation rate is the combined result of pre-aeration techniques, high-shear contacting, and a quiescent phase separation. In addition, high-grade products similar to that achieved in column flotation applications are also possible due to the addition of wash water that is distributed over a deep froth. Design considerations for this new technology are discussed relative to both lab- and pilot-scale test data.
10.1080/19392699.2010.497108

Development of the Centribaric Dewatering Technology

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The solid-solid separation processes employed by modern coal preparation plants require large amounts of process water. After cleaning, the unwanted water must be removed from the surfaces of the particles using mechanical dewatering equipment such as filters or centrifuges. Unfortunately, the existing processes that are used to dewater fine particles are inefficient in terms of moisture reduction and/or solids recovery. In light of these problems, a new ultrafine dewatering process called the Centribaric technology has been developed. This novel device combines centrifugation and pressure filtration within one process to substantially reduce moistures over what can be achieved using conventional dewatering systems. This article discusses the evolution of the Centribaric technology from early research through commercial development and presents data from recent laboratory, pilot-plant, and in-plant test programs. 10.1080/19392699.2010.497113

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Jha, Manis K and Shivendra, and Kumar, Vinay and Pandey, B D and Kumar, Rakesh and Lee, Jae-chun (2010) *Leaching studies for the recovery of metals from the waste printed circuit boards (PCBs).* In: Proceedings of TMS-2010, Feb 2010.

Leaching studies were carried out for the recovery/ recycling of metals from PCBs containing 17.05% Cu, 0.74% Ni, 1.74% Fe, 4.35% Pb and 8.32% Sn using various acids such as H2SO4,HCl and HNO3. While sulfuric acid was not a suitable leachant for the dissolution of metals from PCBs, hydrochloric acid selectively dissolved tin. The nitric acid was found to be effective lixiviant with the recovery of 99.99% Cu, Fe, Ni and 36.7% Pb in 6M HNO3 at S/L ratio of 100 g/L and 90oC. The kinetic studies carried out with 2M and 4M HNO3 at 90oC showed "Ash diffusion control dense constant size-spherical particles" model. http://eprints.nmlindia.org/2975/

Mehta, K D and Das, Chitrangada and Pandey, B D (2010) *Leaching of copper, nickel and cobalt from Indian Ocean manganese nodules by Aspergillus niger.* Hydrometallurgy, 105 (1-2). pp. 89-95.

The leaching of copper, nickel and cobalt from polymetallic manganese nodules from the Indian Ocean was investigated using a fungus Aspergillus niger. Parameters such as initial pH, pulp density, particle size and duration of leaching were optimized for the bio-recovery of metals. At an initial pH of 4.5, 35 degrees C temperature and 5% (w/v) pulp density, about 97% Cu, 98% Ni, 86% Co, 91% Mn and 36% Fe were dissolved in 30 days time using adapted fungus as against only 4.9% Cu, 8.2% Ni, 27% Co, 6.3% Mn and 7.1% Fe solubilized in control experiment. The results indicate that A. niger released organic acids such as oxalic and citric acids which in turn reduced the host metal oxides/hydroxides to their lower valence states, and thus dissolving the base metals following the indirect mechanism. A comparison of results obtained with chemical leaching of sea nodules using citric and oxalic acids and bio-leaching using A. niger show that the leaching of metals was more effective in presence of the fungus. The appearance of some lower oxide phases of manganese and iron in the leach residue identified by XRD phase analyses may account for unlocking of the host lattice leading to release and dissolution of metals during leaching. (C) 2010 Elsevier B.V. All rights reserved. http://eprints.nmlindia.org/3276/

Nayak, B and Vaish, A K and Singh, S D and Bhattacharyya, K K (2010) *Petrography, Chemistry and Economic Potential of the Magnetite Ores of Pokphur Area, Nagaland.* Memoir Geological Society Of India, 75 . pp. 341-348.

Unlike other magnetite ores of India, the magnetite ore deposit of Pokphur area, Nagaland is unique because of its ophiolitic association, igneous origin and

economic potentiality. The magnetite ores occur as sheet like bodies over the ultramafic to mafic cumulate sequence. These ores have been characterized with respect to their petrography and bulk chemistry in order to evaluate their economic potentiality. Ore petrographic studies on five bulk samples collected from different locations in the Pokphur magnetite body reveal that magnetite is the dominating ore-mineral constituting about 40 to 50 modal percent. The matrix materials are altered silicates of chloritic composition. Other iron minerals recorded are martite, hematite, maghemite, lepidocrocite and goethite. The magnetite crystals vary widely in their grain size (<10μm to >2mm) and are dispersed in the silicate matrix. Magnetite grains have suffered partial 'martitization' in grain boundaries and in fracture planes. Coexistence of chromite and magnetite is recorded where magnetite occurs in the inter-granular spaces of chromite. The replacement of chromite by magnetite is notable and this replacement also starts from grain boundaries and along fine cracks within chromite grains. Occasional presence of ilmenite and trace specks of sulphides is also noticed. Apart from the supergene oxides (e.g. goethite, martite, lepidocrocite etc), two generations of primary (igneous) crystallization of iron oxide minerals are observed in the magnetite ores: an earlier generation represented by isolated crystals of magnetite and a subsequent (second) generation of maghemite that follows the flow pattern of the lava. Bulk chemistry of the ores have a composition of Fe (t) = 43-53%, Cr = 2.3-3.8%, Ni = 0.3-0.7%, and Co = 0.03-0.04%. TiO2 exceeding one percent is also recorded in one sample. The silica and alumina content together are quite high (19-28 wt. %). The compositions of the ore clearly indicate that these ores cannot be used to extract iron metal by conventional blast furnace route. However, the magnetite ore of this region is of strategic importance as it contains significant quantity of nickel, chromium and cobalt. The National Metallurgical Laboratory, Jamshedpur is exploring various smelting processes and the possibilities of preparing Ni-hard steel from these magnetite ores http://eprints.nmlindia.org/3559/

Sarkar, B and Das, Avimanyu (2010) *A comparative study of slip velocity models for the prediction of performance of floatex density separator.* International Journal of Mineral Processing, 94 (1-2). pp. 20-27.

The separation features of the floatex density separator (FDS) are investigated through experimental and computational approaches. It has been shown that the performance of the FDS can be predicted reasonably well using a slip velocity model and steady-state mass balance equations. The approach for the formulation of the slip velocity model makes a difference in the prediction of FDS performance. The computed data from four different slip velocity models have been compared and contrasted with the experimental observations. It has been shown that a slip velocity model based on the modified Richardson and Zaki equation, in which the dissipative pressure gradient is considered to be the primary driving force for separation, predicts the performance more accurately than the other three. A deslimed feed is recommended for better performance of the FDS. http://eprints.nmlindia.org/484/

Singh, Ratnakar and Sinha, N (2010) *Floatation studies on a low grade graphite sample from Palamu.* Journal of Chemtracks, 12 (1). pp. 71-74.

Characterisation and flotation studies were carried out on a finely disseminated low grade graphite sample from palamu district, Jharkhand. The sample showed the presence of graphite of crystalline nature, represented by its flaky habit with silica, clay, mica and iron oxides as the impurities. Froth flotation under varying particle size conditions resulted in graphite rougher float with a yield of 30.6% with ash content of 62.23%. Multi-stage cleaning of rougher product produced final graphite concentrate with 96.2%, fixed carbon . The final concentrate showed an overall enrichment of Ilakv graphite with little tines. http://eprints.nmlindia.org/3791/

Srinivasa Rao, D and Rajalaxmi, M and Vasumathi, N and Bhima Rao, R (2010) *Beneficiation studies on beach placer sample for steel making industries.* Journal of Mining and Metallurgy Section A: Mining, 46 A . pp. 11-21.

Beneficiation studies were carried out on the Talashil beach placer sample of South Maharastra Coast, India. The sample contains magnetite, ilmenite, rutile, hematite, goethite and chromite as opaque minerals in the sample. The total heavy minerals fraction reaches 53.8 % by weight whereas the total magnetic minerals are 56.9%. It is observed that the 2nd stage DHIMS magnetic fraction contains 65.2 % Fe2O3 with an over all yield of 37.8 % and a 86 % recovery from a containing 26.8 % Fe2O3 feed. This product can be used in the pellet feed for steel making after suitable blending with high-grade iron ore fines. http://eprints.nmlindia.org/6569/

Upadhyay, Rajendra Kumar and Venkatesh, Akella Satya and Roy, Subrata (2010) *Mineralogical Characteristics of Iron Ores in Joda and Khondbond Areas in Eastern India with Implications on Beneficiation.* Resource Geology, 60 (2). pp. 203-211.

Precambrian iron ores of the Singhbhum-North Orissa region occur in eastern India as part of the Iron Ore Group (IOG) within the broad horse-shoe shaped synclinorium. More than 50% of Indian iron ore reserves occur in this region. Massive-hard, flaky-friable, blue dust and lateritic varieties of iron ores are the major ore types, associated with banded hematite, jasper and shales. These ores could have formed as a result of supergene enrichment through gradual but extensive removal of silica, alumina and phosphorus from banded iron formations and ferruginous shale. Attempts for optimal utilization of these resources led to various ore characterization studies using chemical analysis, ore and mineral petrography, XRD analysis, SEM and electron probe micro analysis (EPMA). The ore chemistry indicates that the massive hard ores and blue dust have high iron, low alumina and phosphorus contents. Because of high quality, these ores do not require any specialized beneficiation technique for up-gradation. However, flaky-friable, lateritised and goethitic ores are low in iron, high in alumina and phosphorus

contents, requiring specific beneficiation techniques for up-gradation in quality. XRD, SEM and ore microscopic studies of massive hard ores indicate the presence of hematite and goethite, while flaky and lateritic ores show a higher concentration of goethite, kaolinite, gibbsite and hematite. EPMA studies show the presence of adsorbed phosphorous as fine dust in the hard ores. Sink and float studies reveal that most of the gangue minerals are not completely liberated in the case of goethitic and lateritic ores, even at finer fractions. http://eprints.nmlindia.org/2054/