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New concepts for lithium minerals processing

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Minerals Engineering, JUL, 2010, Vol. 23(8), pp. 659-661

A new concept for the enrichment of lithium minerals is offering higher purity and higher yield by applying new processing technologies addressing the specific properties of the pegmatitic host rock. Additional value is created from high quality by-products which will improve the sustainability of mining activity and the overall cost base. Within the new concept, flotation may even be avoided where wet separation techniques are not applicable. Two innovative processing technologies have been integrated in the new concept: electrodynamic fragmentation and optical sorting. Detailed results of lab-technical tests show that the new process design can achieve highly selective liberation and separation processes. Optical and mineralogical analyses of the test products indicate a high benefit for commercial applications.
10.1016/j.mineng.2010.03.021

Recovery of nickel and cobalt from laterite leach solutions using direct solvent extraction: Part 1-selection of a synergistic SX system

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Hydrometallurgy, JUL, 2010, Vol. 104, pp. 45-52

The separation of nickel and cobalt from impurities such as manganese, magnesium and calcium using solvent extraction with Versatic 10 was largely improved by the addition of a synergistic reagent LIX63 (an alpha-hydroxyoxime) or 4PC (a pyridine carboxylate ester). With the organic systems containing Versatic 10 alone, the separation factors of nickel and cobalt over manganese were 6 and 15 respectively. When 4PC was added to the system, these increased to 147 and 1870 respectively, and with LIX63, they were even higher at 534 and 7720 respectively. This indicates that the synergistic solvent extraction (SSX) system with Versatic 10 and LIX63 performed very well and better than that with Versatic 10 and 4PC. The SSX system consisting of 0.5 M Versatic 10, 0.45 M LIX63 and 1.0 M TBP in Shellsol D70

performed the best among the systems tested containing LIX63. After a single contact, the extraction of Ni and Co was 99.6% and 96.9%, respectively. Only 6 mg/L Mn, 8 mg/L Mg and 1 mg/L Ca were found in the loaded organic solution. The manganese scrub efficiency was 97.7% at pH 5.3, resulting in a scrubbed organic solution containing only 0.8 mg/L Mn. Over 99% nickel, cobalt and manganese were stripped at pH 2.0, indicating easy stripping of these metals. The SSX system consisting of 0.5 M Versatic 10 and 1.0 M 4PC in Shellsol D70 performed the best among the systems tested containing 4PC. After a single contact, the extraction of Ni and Co was 99.4% and 89.4%, respectively. Some 200 mg/L Mn, 10 mg/L Mg and 48 mg/L Ca were found in the loaded organic solution. The manganese could not be scrubbed at the tested pH range of 5.4-6.0. Very fast Ni and fast Co stripping kinetics were observed, however, the Mn stripping kinetics were very slow. After 2 min of stripping, only 1.22% Mn was stripped. It is concluded that the SSX system containing 0.5 M Versatic 10, 0.45 M LIX63 and 1.0 M TBP performed much better than the SSX system containing 0.5 M Versatic 10 and 1.0 M 4PC in terms of both manganese and calcium behaviour in extraction, scrubbing and stripping.
10.1016/j.hydromet.2010.04.009

Recovery of nickel and cobalt from laterite leach solutions using direct solvent extraction Part 2: Semi- and fully-continuous tests

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Hydrometallurgy, JUL, 2010, Vol. 104, pp. 53-60

In Part 1 of this paper, two synergistic solvent extraction systems consisting of Versatic 10/LIX63/TBP and Versatic 10/4PC were assessed in batch tests for the separation and purification of nickel and cobalt from synthetic laterite leach solution after iron removal. In Part 2, semi- and fully-continuous tests are reported for the Versatic 10/LIX63/TBP system, with conditions optimised for separating nickel and cobalt from manganese, magnesium and calcium. Semi-continuous extraction tests were conducted using the synergistic organic system consisting of 0.50 M Versatic 10, 0.45 M LIX63 and 1.0 M TBP in Shellsol D70. With a pH profile of 5.5/6.1/6.5 for the three stages EX1/EX2/EX3 at 40 degrees C, the nickel and cobalt extractions were 99.9% with only 5 mg/L nickel and <1 mg/L cobalt left in the raffinate. With two stages of scrubbing and a pH profile of 5.4/5.0 at 40 degrees C, about 2 mg/L manganese and less than 1 mg/L magnesium and calcium were left in the scrubbed organic solution. With two stripping stages and an O/A ratio of 10 at 40 degrees C using 50 g/L H(2)SO(4) as strip solution, the stripping efficiencies of nickel and cobalt were over 95%. A fully-continuous pilot plant was operated for 280 h. With an O/A ratio of about 2 and a pH profile of 5.5/ 5.8/6.0/6.3 for the four stages EX1/EX2/EX3/EX4 at 40 degrees C, both nickel and cobalt were almost completely extracted. The nickel and cobalt concentration in the raffinate was lower than

detection limit of 0.2 mg/L The manganese, magnesium and calcium concentrations in the loaded organic solution were 34, 8 and 1 mg/L, respectively. Using a pH profile of 5.4/5.0 for SC1/SC2 at an O/A ratio of 10 and 40 degrees C, the manganese scrubbing efficiency was over 96% and the concentrations of manganese and magnesium in the scrubbed organic solution were <5 mg/L and that of calcium 1 mg/L Using three strip stages and a strip solution containing 50 g/L H(2)SO(4) and 55 g/L Ni at an O/A ratio of 10 and 40 degrees C, over 98% Ni and 99% Co were stripped with only 64 mg/L Ni in the stripped organic solution. The nickel concentration in the loaded strip liquor was 86 g/L, giving a Delta Ni of 31 g/L. The loaded strip liquor contained less than 1 g/L acid. Crown Copyright. 10.1016/j.hydromet.2010.04.010

Performance characteristics of pilot plant dense media hydrocyclone for beneficiation of coal and 3-D CFD simulation

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Chemical Engineering Science, Aug, 2010, Vol. 65(16), pp. 4661-4671

Dense-medium separators have proven to be the most efficient processes for removing the undesirable material from run-of-mine coal. The application of high-pressure feed injection into dense-medium cyclones to provide an elevated centrifugal force has recently been found to allow efficient separation performances for the treatment of fine coal (i.e., < 1000 mu m). However, high-pressure injection requires specialized pumps and results in relatively high maintenance requirements. the Current study involves experimental investigation of separation performance characteristics of the dense media hydrocyclone (DMC). A pilot plant DMC has been designed and fabricated for performance characterization. Experiments have been conducted on 300 mm dense medium cyclone treating coal in the size range of -6 to +2 mm using magnetite as the medium under operating conditions. The operating variable was the specific gravity of the medium, feed inlet pressure and feed inlet flow rate. The ash contents of the feed coal reporting to the overflow and underflow have been analyzed qualitatively. The result indicates that the use of magnetite as dense medium in DMC resulted in the yield of clean coal, which is 5% more when the air core is suppressed as compared to the same conditions when the air core remains. A 3-D geometry is created in Gambit to support the experimental findings by using CFD simulation. It is interesting to observe that experimental findings agree well with the simulation results. 10.1016/j.ces.2010.05.006

Stabilized Dredged Material. III: Mineralogical Perspective

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Journal Of Geotechnical And Geoenvironmental Engineering, AUG, 2010, Vol. 136(8), pp. 1037-1050

The prior two papers in this series reported on the geoenvironmental and geomechanical properties of 20 stabilized dredged material (SDM) blends using dredged material (DM) from the U.S. Army Corps of Engineers Craney Island confined disposal facility. The pozzolans included lime, cement kiln dust (CKD), class F fly ash, and two cements (portland and slag cement). This paper reports on the mineralogical evolution of the SDM blends over a 6-month curing period using techniques new to mainstream geotechnical engineering: X-ray diffraction (XRD) with Rietveld quantification analysis which allows direct quantitative mineralogical comparisons between soil samples. Despite being classified as a high plasticity clay-organic clay (CH/OH soil), XRD showed that the DM contained no montmorillonite, illite or kaolinite, and was thus mineralogically unreactive. The quartz, feldspar, and mica contents were numerically tracked and were shown to remain stable 6 months after blending. The chlorite (in DM) content decreased over time and with the fly ash served as the sources of soluble silica and alumina for pozzolanic reactions especially in the lime-based SDM blends. Lime in the lime-based blends persisted in significant quantities (3%) as unreacted portlandite [Ca(OH)(2)] even at 6 months curing, indicating that the solubility of silica in the DM was the limiting factor for strength development. New (ettringite and hydrocalumite) mineral formation was quantified. CKD provided high early strength (7 and 28 days) when used in combination with small amounts of lime that provided prolonged pH buffering; CKD alone or in combination with fly ash did not maintain elevated pH (>10.8) over 6 months. Overall, the unconfined compressive strength, pH, and mineralogy results at 6 months were substantially different compared to the standard curing time of 28 days, confirming similar findings of previous long-term stabilization-solidification studies. 10.1061/(ASCE)GT.1943-5606.0000292

Flotation of diaspore and aluminosilicate minerals applying novel carboxyl hydroxamic acids as collector

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Three novel carboxyl hydroxamic acids including ortho-carboxyl tetrachlorobenzohydroxamic acid (OCB), ortho-carboxyl hexahydrobenzohydroxamic acid (OHB) and ortho-carboxyl tetrahydrobenzohydroxamic acid (OTB), were synthesized and tested as collectors for flotation of diaspore, kaolinite and illite contained in diasporic bauxite from China. Subsequently, their flotation mechanism to diaspore and aluminosilicate minerals was investigated by zeta potential measurements and FT-IR spectrum checking. The results of flotation experiments show that by using carboxyl hydroxamic acid as collectors, the pulp pH value has significant influence on their collecting performance as the floatability of either diaspore or aluminosilicates varies sharply with their change, and the appropriate pH value for the flotation of diaspore gets close to neutral condition where diaspore presents good floatability

while kaolinite and illite exhibits poor performances. Additionally, the floatability of diaspore and aluminosilicates is in the descending order of diaspore, kaolinite, and illite in the presence of three collectors, and their collecting capacity to three minerals is in the ascending order of OTB, OHB and OCB. Of three synthesized carboxyl hydroxamic acids, OCB has the strongest collecting capability to diaspore while relatively weak to aluminoscilicate minerals, whose good selectivity for the flotation between diaspore and aluminosilicates is possibly suited for direct flotation desilication of diasporic bauxite. Moreover, the optimum pH value for diaspore flotation associated with FT-IR spectrum and zeta potentials indicate that the adsorption interaction between the synthesized collectors and diaspore is dominantly a kind of chemical bonding one in the form of three cycle chelate rings due to the coordination of carboxyl and hydroxamate to the metal aluminum atoms, where the oxygen atoms contained in carboxyl and hydroxamate of the polar group have the stereo conditions to form five to seven membered rings. By contrast, the adsorption interactions of the carboxyl hydroxamic acid on the surfaces of aluminosilicate minerals are mainly dominated by means of hydrogen bonds. 10.1016/j.hydromet.2010.05.006

Stage-wise flotation for the removal of colored minerals from feldspathic slimes using laboratory scale Jameson cell

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Separation And Purification Technology, Jul, 2010, Vol. 74(1), pp. 100-107

Fifteen percent of the total number of ores to be supplied to feldspar flotation facilities is generally comprised of fine particles under 38 mu m in size. Upgrading of these particles by current commercial beneficiation methods poses an environmental threat besides causing economic losses. In this study, an attempt was made to remove gang minerals containing Fe and Ti from a feldspathic slime sample (-38 mu m) using laboratory scale Jameson flotation cell in the presence of both anionic BD-15 and cationic G-TAP collectors. The finely sized ore was successfully upgraded to produce Na-feldspar suitable for ceramics industry. A Na-feldspar concentrate assaying 0.18% Fe(2)O(3) + TiO(2) from a slime sample containing 1.06% Fe(2)O(3) + TiO(2) at 50% recovery was obtained. 10.1016/j.seppur.2010.05.012

The development of dynamic models for a dense medium separation circuit in coal beneficiation

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Often the most difficult step in establishing a control system is the development of a suitable dynamic process model. As such a model is not available elsewhere, a first principle dynamic mathematical model was developed for a coal dense medium separation circuit. Each unit operation was modelled individually and then integrated together to form a complete non-linear state-space model for the circuit. This model was used to simulate the process and it was validated using real process data derived from a plant experiment. When developing models from first principles, it is necessary to estimate the model parameters. These parameters, specifically for non-linear state-space relationships, require a unique solution. A parameter identifiability method was used to show that the non-linear dynamic models developed have unique parameters for a specific set of input-output data. 10.1016/j.mineng.2010.05.020

The effect of an external magnetic field on cationic flotation of quartz from magnetite

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In this study, the effect of an external magnetic field on cationic flotation of quartz from magnetite was investigated by using a magnetic micro-flotation column. For this purpose, a micro-flotation column jacketed with three coils was fabricated to create a funnel-shaped magnetic field. Both the theoretical magnetic field strengths and the magnetic forces were calculated. The results from flotation experiments with 6 x 10(-5) M dodecylamine as collector using a binary mixture of quartz and magnetite as a feed material show that the separation efficiency increased from 0% without the magnetic field to 88% in the presence of the magnetic field. The significant enhancement in separation efficiency is evident. 10.1016/j.mineng.2010.06.001

Application of Flash Magnetizing Roasting Technique in Beneficiation of Siderite and Limonite

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Regulatory Regional Economic Challenge For Mining, Investment, Environment And Work Safety, International Symposium on Project Management, JUL, 2010, Jiangsu, PEOPLES R CHINA, AUSSINO ACAD PUBL HOUSE, MARRICKVILLE, 2010, pp. 13-17.

Siderite and limonite are well known refractory ores featuring low theoretical grade and complicated association with gangue minerals which usually differ little from siderite and limonite in specific gravity, specific susceptibility, surface hydrophobicity and specific conductivity. Therefore, satisfactory beneficiation results for them can be hardly obtained by physical means. Even if iron concentrates

almost having a theoretical grade are obtained at the cost of loss of iron recovery, they can not be used in sintering process in large quantity due to the structure of the ores. In view of the problem, a technique of flash magnetizing roasting is developed to transform siderite and limonite into artificial magnetite so as to enlarge the difference between siderite/limonite and gangue minerals and realize effective separation of the ores. Through comparing the results of separation after Magnetizing roasting of siderite and limonite with those by physical means, it is found that the grade of iron concentrates is increased by 6-15%, the recovery of iron by 15-20%. The technique of flash magnetizing roasting, characterized by fast mass and heat transfer and short reaction time, has advantages such as low roasting cost and high feasibility.

Biomass to Fuels: Impact of Reaction Medium and Heating Rate

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We have recently reported on the impact of CO(2) on biomass gasification and its ability to more effectively gasify biomass than steam. Continuing this investigation has led to understanding the impact of heating rates and different reaction environments. This article presents the results from the gasification of various biomass feedstocks. Heating rates were varied from 1 to 100 degrees C min(-1) to ballistic rates (similar to 500 degrees C min(-1)). Gasification media investigated include H(2)O/N(2), CO(2), CO(2)/N(2)/H(2)O, and O(2)/N(2). Global activation energies for pyrolysis were found to be significantly higher than for gasification, whereas those for the grasses were significantly lower than the woods, possibly indicating a catalytic effect during pyrolysis of the high mineral content herbaceous feed-stocks. CO(2) pyrolysis (110-450 degrees C) activation energy values for lignin, cellulose, and biomass were 22-49, 202-230, and 28-72 kJ mol(-1), respectively, and CO(2) gasification (500-700 degrees C) values for lignin and biomass were 12-38 and 9-57 kJ mol(-1), although cellulose did not exhibit significant mass loss in the gasification interval 500-700 degrees C. Using a least squares fit on the rate of mass loss fraction, the global decomposition reaction during pyrolysis for lignin in either medium was found to be third order, whereas that for cellulose was first order and for the various biomass samples either first or second order. The most significant difference in biomass processing in CO(2), when compared with steam gasification, occurred above 750 degrees C where nearly all of the biomass was converted to volatiles with less than 2% ash remaining after CO(2) gasification. Only when pure CO(2) was used as the gasification medium under a slow heating rate did complete processing of the components to volatile products occur. Gas chromatography analysis has shown the effect of CO(2) on product distribution. Data are presented focusing on the relation between gasification medium, feedstock selection, and major chemical species evolution.
10.1089/ees.2009.0372

Fly ash based geopolymer thin coatings on metal substrates and its thermal evaluation

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Journal of Hazardous Materials, Vol 180(1–3), 15 August 2010, Pages 748-752, http://dx.doi.org/10.1016/j.jhazmat.2010.04.121.

Class F fly ash based Na-geopolymer formulations have been applied as fire resistant coatings on steel. The main variables for the coating formulations were Si: Al molar and water: cement weight ratios. We have determined that the adhesive strength of the coatings strongly depend on geopolymer composition. The ease with which geopolymer can be applied onto metal surfaces and the resultant thickness depend on the water content of the formulation. Adhesive strengths of greater than 3.5 MPa have been achieved on mild steel surfaces for compositions with Si:Al of 3.5. Microstructure evolution and thermal properties of the optimised coating formulations show that they have very promising fire resistant characteristics.

Experimental analysis of wet mill load based on vibration signals of laboratory-scale ball mill shell

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Real-time measurement of the mill load is the key to improve the production capacity and energy efficiency for the grinding process. In this paper, experimental analysis of the wet mill load based on the vibration signals of the laboratory-scale ball mill shell is presented. A series of experiments are conducted to investigate the vibration characteristics corresponding to different grinding conditions such as dry grinding, wet grinding and water grinding. The power spectral density of the vibration signals is systematically interpreted. Experimental results show that the rheological properties of the pulp affect the amplitude and frequency of the vibration signal. The most important conclusion is that the frequency range of the shell vibration of the laboratory wet mill can be divided into three parts, namely natural frequency band, main impact frequency band and secondary impact frequency band.

Finally, soft-sensor models between vibration signal and mill operating parameters of mill load are established using genetic algorithm-partial least square (GA-PLS) technology. After more work on industry scale ball mill is done, the soft-sensor modeling based on the mill shell vibration for operating parameters of mill load will improve the performance of the ball mill in the grinding process. (C) 2010 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2010.05.001

Flowsheet considerations for optimal use of high pressure grinding rolls

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Minerals Engineering, AUG, 2010, Vol. 23(9), pp. 663-669

High pressure grinding roll ("HPGR") technology is very rapidly gaining a wide acceptance within the mineral processing industry. Benefits, including a superior energy efficiency and a lower overall operating cost of an HPGR based circuit compared to alternative technologies have been demonstrated at a number of operations throughout the world. Increasing numbers of units are presently being installed in the minerals industry world-wide. This trend is an excellent reflection of the confidence now placed in the technology by new and existing users. This paper summarizes basic principles of the equipment and of various options how to include an HPRG in the grinding circuit for most efficient use. Case studies demonstrate the application of HPGR's in different grinding circuit set-ups and for the comminution of different ore types. Benefits of the options of open circuit grinding, closed circuit grinding incorporating wet and dry screening as well as the option of achieving a finer grind by recirculating part of the HPGR product using a mechanical splitter are discussed. From a processing point of view the effects of partial product recycle are detailed and some guidance for selection of cut size between HPGR and ball mill is provided. 10.1016/j.mineng.2009.09.012

Mechanism and support measures of floor heave mainly caused by horizontal extrusion stress in soft rock roadway

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Rock Stress And Earthquakes, 5th International Symposium on In-Situ Rock Stress
AUG 25-27, 2010, Beijing, PEOPLES R CHINA, CRC PRESS-TAYLOR & FRANCIS GROUP, BOCA RATON, 2010, pp. 387-394

Floor heave is one of the most difficult problems of soft rock roadway supporting in coal mines. A serious floor heave have occurred when the west wing track roadway of Tingnan coal mine was being constructed, the maximum value reached to 50 cm, which impacted the normal application of roadway severely. The article involved engineering geology, soft rock engineering mechanics and clay mineralogy etc, employed the ways of study on engineering geomechanics, laboratory testing on properties of rock mass, and combined with FDM 3D numerical simulation, and deeply researched the deformation mechanism and generating process of floor heave, it indicated clearly that the major influencing factor that led to floor heave was the horizontal extrusion stress, and the secondary ones were floor surrounding rock with high content of swelling clay minerals and soaking effect on floor rock. Thus the deformation mechanism was compound type of floor heave caused by the combined action of plastic extrusion and swelling. Aimed at the above-mentioned mechanism, a new support measures would be provided with inverted arch and floor bolt to control the floor heave. Project protice has shown good results of new

supporting have been obtained with expected effects, and controlled the floor heave effectively.

Modeling of the thermohydrodynamic and reactive behavior of compacted clay for high-level radionuclide waste-management systems

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Clays And Clay Minerals, AUG, 2010, Vol. 58(4), pp. 486-500

Bentonite is often proposed as an engineered-buffer material in high-level radionuclide waste-management systems. For effective design of the barrier that will provide protection over the long time periods required, the physical/thermal/chemical processes taking place in the barrier material must be understood thoroughly. These processes, which interact, include the flow of water and gas, the flow of heat, and the transport and reaction of chemical constituents. The purpose of this study was to better understand the processes that occurred in a small-scale experiment within a confined bentonite space. A conceptual and mathematical model (FADES-CHEM) was built in order to simulate the results of an experiment conducted in 2000, and thereby to gain a better understanding of the controlling processes. In that experiment, a block of compacted bentonite was placed in an air-tight cell and subjected, for 6 months, to simultaneous heating and hydration from opposite sides. The bentonite block was then sliced into five sections each of which was then analyzed in order to obtain a series of physicochemical parameters illustrating the changes that had occurred. Before modeling, the chemical composition of the bentonite pore waters was restored in order to account for different processes such as gas outgassing and cell cooling. Modeling indicated that gas-pressure build up was a relevant process when computing the saturation of bentonite, and the computations in the present study suggested that evaporation/condensation processes played a crucial role in the final distribution of the water content. Gas pressure and evaporation/condensation also affected the geochemical system, and the numerical model developed gives results that were consistent with the experimental values and trends observed. The model reproduced the results obtained and enable use at the repository scale and over longer time frames, provided that adequate data are available.
10.1346/CCMN.2010.0580404

Failure of Layered Sandstone under Brazilian Test Conditions: Effect of Micro-Scale Parameters on Macro-Scale Behaviour

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Rock Mechanics And Rock Engineering, SEP, 2010, Vol. 43(5), pp. 641-653.

The experimental research in this paper focuses on the effect of micro-scale parameters on macro-scale behaviour of samples tested under Brazilian test conditions for one particular layered sandstone, i.e. sandstone from Modave in the South of Belgium. Five (visually) similar blocks are studied; however, they are different at micro-scale. Their differences on microscopic level (such as grain size, mineral contents and number of layer boundaries) affect the failure process. Fracture length parallel to the layers increases if more layer boundaries (e.g. per cm) are present and more weak minerals. The Brazilian tensile strength of studied layered Modave sandstone is larger for larger quartz grains, while fracture length parallel to the layers is smaller. Quartz grains in the studied layered sandstone are classified as fine sand. 10.1007/s00603-010-0084-7

Leaching characteristics of fly ash from fluidized bed combustion thermal power plant: Case study: Çan (Çanakkale-Turkey)

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Fuel Processing Technology, Volume 91, Issue 9, September 2010, Pages 1073-1080, ISSN 0378-3820, http://dx.doi.org/10.1016/j.fuproc.2010.03.015.

It is known that the concentration of elements of fly ash varies due to the used-coal and the used-lime qualities varying in different periods. In the Çan Thermal Power Plant (CTPP) located at northwestern Turkey, Çan (Çanakkale) basin coals, which are classified as lignite to sub-bituminous C coal with high total sulphur (0.4–12.22%) and a broad range of ash contents (3.2–44.6%) are mainly used. Performed studies reveal that some toxic elements exit in the coal, including As, U and V. Also, while the As, Cu, Co and Hg contents in coal increases, the sulphur contents in coal also increase. Additionally, trace elements that have inorganic compounds in coal are mobilized into air during the combustion process. This poses a big risk for human health and keeping the environment when Çan Basins low quality lignite is burned, it's the fly ash that contains several toxic elements which can leach out and contaminate the water resources. In this study, toxicity tests were conducted on the fly ash samples that were obtained from the fluidized bed combustion of Çan Thermal Power Plant. The results showed that water temperature, pH and the quality of the limestone used were the most important factors affecting the leaching properties. Concentration of some toxic elements found in the fly ash, such as; As, Cd, Cr, Pb, Se and Zn were analyzed. Concentration richness of some heavy metals were attributed to the increase of water temperature, especially when pH is lower than 5. At pH = 5 value, there is no clear explanation of each heavy metal presence in the fly ash from fluidized bed combustion thermal power plant.

Bonded-particle modelling of microwave-induced damage in ore particles

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Minerals Engineering, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, SEP, 2010, Vol. 23(10), pp. 780-790.

Microwave heating of mineral ores offers a mechanism to induce fractures around grain boundaries due to the different rates of microwave power dissipation and the differences in thermal expansion coefficient among various minerals in the ore particles. As a consequence, this has the potential to reduce the energy required in subsequent grinding and to enhance liberation of valuable minerals. In this paper, numerical simulation using a bonded-particle model was undertaken to provide a better understanding of the mechanism of microwave-induced micro-fracture and to predict the effect of microwave power delivery and ore texture on microwave treatment of ores. Computational simulations of microwave heating and thermal damage have been carried out on two-phase conceptual ores. It was shown that the extent of damage and the crack pattern in an ore sample for the same microwave energy input depend strongly on the applied power density and the microwave absorbent phase grain size. It is possible both to reduce the energy input and to localize the microwave-induced damage around the grain boundaries by operating at high power density. It was also shown that high power pulsed equipment would be more efficient than continuous wave equipment for treating fine-grained ores. 10.1016/j.mineng.2010.05.019

Coal preparation research in South Africa

de Korte, GJ

Journal Of The South African Institute Of Mining And Metallurgy, SOUTH AFRICAN INST MINING METALLURGY, MARSHALLTOWN, JUL, 2010, Vol. 110(7), pp. 361-364.

South Africa is reliant on coal for the generation of almost all the electricity used in the country, and several large industrial concerns such as Sasol are also coal based. Research relating to the mining, beneficiation and utilization of coal is important in order to ensure the optimal exploitation and use of coal within the country. The Fuel Research Institute (FRI) of South Africa was established in 1930 to investigate all aspects of coal beneficiation and utilization in South Africa. The FRI went on to conduct world-class research, and in 1957 a pilot coal preparation plant was constructed in Pretoria to enable large-scale practical experimentation. The pilot plant played a pivotal role in the establishment of South Africa's low ash coal export project. Political and economic factors contributed to the eventual closure of the FRI and South Africa experienced a period of about 10 years between 1990 and 1999 during which very little public coal preparation research was done. This changed for the better towards the end of 1999 when Coaltech 2020, a collaborative research program was established. Participants included the CSIR, universities, the government and the major coal producers. Coal preparation research conducted under Coaltech thus far include dewatering and drying of fine coal, size classification of ultra-fine coal and dense-medium fine coal beneficiation. Currently, the Coaltech focus is on the beneficiation of low-grade coal reserves and is investigating existing as well as new techniques that can be utilized to provide cost-effective beneficiation of low-grade raw coals and reject coals.

Development of protective coatings using fly ash premixed with metal powder on aluminium substrates

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Waste Management & Research, SAGE PUBLICATIONS LTD, LONDON, JUL, 2010, Vol. 28(7), pp. 660-666.

Fly ash is a solid waste generated in huge quantities from coal-fired thermal power stations during the combustion of coal. Rich in metal oxides, it has tremendous potential as a coating material on structural and engineering components. This work aims at developing and characterizing a new class of such coatings made of fly ash by a novel technique - plasma spraying. Plasma spray technology has the advantage of being able to process various low-grade ore minerals to obtain value-added products and also to deposit ceramics, metals and a combination of these, generating near-homogeneous coatings with the desired microstructure on a range of substrates. In the present investigation, coatings are developed on aluminium substrates using fly ash premixed with aluminium powder in different weight proportions at various plasma torch input power levels ranging from 918 kW DC. The coatings are characterized in terms of interface adhesion strength and deposition efficiency. Maximum adhesion strength of about 35 MPa is recorded with coatings deposited at 12 kW power level. It was noticed that the quality and properties are significantly affected by the operating power level of the plasma sprayer. This work identifies fly ash as a potential coating material, suitable for possible tribological applications. 10.1177/0734242X09348016

Dry dense medium separation of iron ore using a gas-solid fluidized bed

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The dry dense medium separation of iron ore based on floating and sinking of ore particles in a gas-solid fluidized bed was investigated using zircon sand as the fluidized medium. The float-sink of ore particles with mean size D(ave) = 23.6 mm was investigated as the fluidizing air velocity and the float-sink time were varied. It was found that gangue with density less than 2850 kg/m(3) which float is able to be separated from valuable ore with density greater than 2850 km/m(3) which sink. The set point (density where half the particles float and half the particles sink) decreases with increasing the air velocity, and that the float-sink separation is completed within 2 min. The influence of different sized ore particles in the float-sink experiments was also investigated. As a result, the iron ore with D(ave) >= 17.6 mm are successfully separated. As D(ave) decreases below 17.6 mm, the ore particles with density near the set point tend to scatter in the fluidized bed without floating or sinking, resulting in separation efficiency which decreases with decreasing D(ave). This indicates that

the size of the ore particles is one of the major factors, to achieve high separation efficiency.
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An enhanced-gravity method to recover ultra-fine coal from tailings: Falcon concentrator

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The Falcon concentrator is an enhanced-gravity separator used for the concentration of fine and ultra-fine minerals. This study was conducted to evaluate the effects of different process variables on the performance of the Falcon SB-40 concentrator for beneficiation of tailings to recover ultra-fine coal. Various operating and design conditions such as bowl speed (G force), water pressure, pulp solid ratio and pulp feed rate were investigated. A hydrocyclone was used for pre-enrichment with the Falcon concentrator. Operation parameters of the hydrocyclone, namely feed solids, inlet pressure, vortex finder and apex diameters were investigated. In order to produce fine coal concentrates, regression equations were derived by applying the least squares method using Minitab 15 software. Response functions were produced for the ash content and the recovery of the clean coal concentrates for the performance of the hydrocyclone and Falcon concentrator under different operating conditions. Predicted values were found with the experimental values giving R(2) values of between 0.73 and 0.58 for ash content and between 0.65 and 0.39 for recovery of the clean coal. It was shown that under optimized conditions the Falcon concentrator can produce a clean coal with an ash value of 36% from a feed coal of about 66% ash. 10.1016/j.fuel.2010.04.009

Fine Coal Filtration as Revealed by 3D Lattice-Boltzmann Simulations

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The multiphase flow and dewatering that occurs during fine coal filtration can be described by the results from Lattice-Boltzmann (LB) simulations. As is known, important factors that influence the efficiency of filtration include: particle size distribution (pore network structure is determined by x-ray microcomputed tomography), pressure drop (flow rate), and wetting characteristics of the coal (water contact angle). Results from permeability experiments are used to validate preliminary simulations. Research is in progress to simulate coal filtration and to identify conditions that will lead to improved water removal and minimum cake moisture content. 10.1080/19392699.2010.497114

Enhanced Process Control - Maximizing Coal Handling Preparation Plant Productivity

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The benefits of various enhanced methodologies in process control are well documented and include safer operation, reduced environmental impact, and improved efficiencies, qualities, and throughputs [1, 2]. Numerous applications of these techniques exist in the fields of petrochemical, oil and gas, pulp and paper, and mineral processing. However, the application of these has been slow to filter through into coal preparation [3]. Variability associated with plant feed rates and the coal seam(s) often results in problems in achieving plant throughput and the desired quality. Since plants are generally designed to average feed specifications and as the feed material qualities change (more or less ash, fines, etc.), the plant operators and control system must compensate accordingly. This article will present two different case studies demonstrating the benefits achievable through improvements in process control techniques. The performance of industrial plants is significantly affected by control loop configuration and the effectiveness of the operator and the interface in use. The first case study will highlight the benefits of prototyping and simulating enhanced control schemes before implementation on the actual plant. The second case study demonstrates how to improve operator situation awareness through enhanced graphics techniques and process alarm rationalization.

10.1080/19392699.2010.497116

Fine Coal Measurement Needs for Improved Control

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The monitoring and management of fine coal circuits in coal preparation plants is limited in current practice. As part of the Australian Coal Association Research Program (ACARP) oIntelligent Plant Projecto (C11069), the relationships between the main operational and control factors for the unit operations and the circuit and the performance indicators have been identified. The unit operations examined included desliming (hydrocyclones and sieve bends), small coal cleaning (spirals and hydraulic separators), flotation, and dewatering (vacuum filters, centrifuges, and thickeners). These relationships were then used to assist in the identification of the important parameters to be measured and the preferred level of accuracy required to be useful. An important issue was the interconnection between the various unit operations and the potential impact of an upstream problem on the subsequent performance of downstream units. Analysis with the relationships showed that the flow rate of respective feed slurries and the solids content were

found to be significant variables. This article will discuss this analysis and provide some case studies. 10.1080/19392699.2010.497118

Natural Gamma Comes of Age for the Quick Measurement of the Ash Content of Coal in Piles, Wagons, and TrucksSome Case Histories

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The last ten years have seen a significant increase in the production and use of coal around the world. Associated with this increase in production has been a growing requirement for quick and accurate ash measurement, be this for coal on conveyors, laboratory samples, or for coal in trucks, wagons, or piles. On-line ash monitors have been on the market for several decades but the availability of a portable hand instrument for measuring the ash content of coal in trucks, wagons, or piles is more recent. For safety reasons Natural Gamma is the only practical technology to use for this application. The early part of this article provides a brief description of the Ash Probe but the main part provides a number of detailed case studies where this instrument has been used to significantly improve customer operations. These studies show how the sites functioned prior to the use of the Ash Probe and then how they operate using the instrument. Details of their performance along with the benefits they provide to their users are described. These case studies show applications from several different countries around the world.
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Attrition of limestones by impact loading in fluidized beds: The influence of reaction conditions

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Abstract: The extent of attrition associated with impact loading was studied for five different limestones pre-processed in fluidized bed under different reaction conditions. The experimental procedure was based on the measurement of the amount and the particle size distribution of the debris generated upon impact of sorbent samples against a target at velocities between 10 and 45 m/s. The effect of calcination, sulfation and calcination/re-carbonation on impact damage was assessed. Fragmentation by impact loading of the limestones was significant and increased with the impact velocity. Lime samples displayed the largest propensity to undergo impact damage, followed by sulfated, re-carbonated and raw limestones. Fragmentation of the sulfated samples followed a pattern typical of the failure of brittle materials. On the other hand, the behaviour of lime samples better conformed to a disintegration failure mode, with extensive generation of very fine fragments. Raw limestone and re-carbonated lime samples followed either of the two patterns

depending on the sorbent nature. The extent of particle fragmentation increased after multiple impacts, but the incremental amount of fragments generated upon one impact decreased with the number of successive impacts.

Removal of arsenic in coal fly ash by acid washing process using dilute H2SO4 solvent

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Coal fly ash emitted from coal thermal power plants generally contains tens ppm of arsenic, one of the hazardous elements in coal, during combustion and their elution to soil or water has become a public concern. In this study, the acid washing process developed by the authors was applied to the removal of arsenic from coal fly ash. Laboratory- and bench-scale investigations on the dissolution behavior of arsenic from various coal fly ash samples into dilute H2SO4 were conducted. Arsenic in the coal fly ash samples were dissolved into H2SO4 solutions rapidly. However, its concentrations decreased with an increase in the pH of H2SO4 solution in some cases. The species of arsenic in the dilute H2SO4 was estimated as H3AsO4, and its anionic species was considered to adsorb with the elevation of pH under the presence of ash particle. Such adsorption behavior was enhanced under the presence of Fe ion in the solution. The sufficient removal of arsenic was achieved by controlling pH and avoiding the adsorption of arsenic on the surface of coal fly ash particles, and the elution of arsenic from coal fly ash sample was successfully below the regulation limit.

Fly ash from a Mexican mineral coal I: Mineralogical and chemical characterization

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The properties of coal fly ash are strongly dependent on the geological origin and the combustion process of the coal. It is important to characterize regional fly ash in detail to ascertain its potential uses as raw material in the production of high value products. The physicochemical properties of fly ash coming from the "Jose Lopez Portillo" coal-fired power plant, Coahuila, Mexico (MFA), are presented in this work. A detailed study of trace elements, the chemical composition of the amorphous phase, thermal stability and the leaching of contaminant elements under different conditions are included. MFA is composed of mullite, quartz, calcite, magnetite and an amorphous phase. This material contains mainly silica (59.6%), alumina (22.8%)

and magnetite (5.6%). Its amorphous phase (78.3%) has a high silica (49.4%) and alumina (14.4%) content. According to its mineralogical and chemical composition, MFA is potentially useful as a raw material for making cement, silica, and alumina, as well as low silica/alumina ratio zeolites. Deleterious elements could be removed during the zeolitization process or with an additional acid treatment. Because of its morphological properties and structural and thermal stability, MFA can be used in thermal isolation and refractory materials and as a support for heterogeneous catalysts.