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Density-dependent separation of dry fine coal in a vibrated fluidized bed

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POWDER TECHNOLOGY, [ELSEVIER SCIENCE SA, LAUSANNE], Oct, 2008, Vol. 187(2), pp. 119-123.

The main purpose of coal separation is to reduce ash, sulfur, mercury and other mineral contaminants in the coal to increase the calorific value and benefit the environment. Dry coal beneficiation has obvious advantages over the wet process although the latter is currently the predominant method in use throughout the world. A vibrated fluidized bed was constructed for separating dry fine coal particles from unwanted gangue particles. An experimental investigation of vibrational energy transmission, and the interaction between vibration and gas flow, was performed. The motivation for these experiments was a theoretical development of the principles involved in forming a dense-media vibrated fluidized bed (DMVFB). The mechanism of bubble breaking by vibration is discussed. A formula for calculating the critical vibration frequency at which bubbles can be efficiently broken and bubble formation restrained is proposed. The experimental results demonstrate that the density of a dense-media vibrated fluidized bed is uniform, with a maximum relative error of 1.68% under optimal technological and operating conditions. The < 6 mm fine coal was efficiently separated with a probable error E value of 0.07 t/m(3). A lower limit of separation of 0.5 mm was achieved. The DMVFB separation efficiency is higher than wet jig with E value of 0.11 t/m(3) (C) 2008 Elsevier B.V. All rights reserved. DOI: 10.1016/j.powtec.2008.02.001

Discrete element method study of abrasion

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MINERALS ENGINEERING, 4th International Conference on DEM, AUG, 2007, Brisbane, AUSTRALIA
[PERGAMON-ELSEVIER SCIENCE LTD, OXFORD], OCT, 2008, Vol. 21(11), pp. 751-760.

Abrasion is a surface breakage event where irregular surfaces of particles are removed. In other words, in milling it is the process which produces sphere like particles by comminuting asperities. Extensive experimental work has been performed to study abrasion events and their process parameters. Very few studies have used the discrete element method (DEM) to study the abrasion behavior of particles. In this regard, this paper reports on using DEM simulation to study the abrasion in a small scale tumbling mill environment. DEM simulations have been carried out for different test mills ranging in diameter from 0.2 m to 1.1 m and all of the mills have 0.2 in length. Each mill has square shaped lifters of 30 mm cross-section. The outcome of the simulation are evaluated to investigate the abrasion and milling parameters, like, force, different energy losses, collision frequency, power consumption. The DEM results are compared with experimental results performed at the JKMRC laboratory.
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Carnallite froth flotation optimization and cell efficiency in the Arab Potash Company, Dead Sea, Jordan

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MINERAL PROCESSING AND EXTRACTIVE METALLURGY REVIEW, [TAYLOR & FRANCIS INC, PHILADELPHIA], 2008, Vol. 29(3), pp. 232-257.

Arab Potash Company (APC) was formed to develop minerals from the Dead Sea. Currently, APC is producing potash for agriculture and industrial potash for the chemical industry, industrial salt, bromine, and NPK (Nitrogen, Phosphorus, Potassium) fertilizers. The flotation unit at APC is a significant part of the overall processes, which end up separating halite from the carnallite in the mixture. The Dead Sea is the main and only source for the potash industry in the form of potassium chloride. The Dead Sea salts are converted into a final saleable product in the form of potassium chloride, which is commercially known as potash. The current study aims to provide plantoperators with a better understanding of flotation process. In this investigation, several laboratory experiments were conducted that covered several parameters and the best cell efficiency was achieved in terms of halite removal and carnallite recovery. Agitator speed, pulp density, reagent quantity, conditioning time, temperature effect, pH effect, additives effect, size distribution, and wet screening tests were performed. The conclusion is based on analyses of the obtained results incorporated with direct observation from APC flotation cells. The obtained results indicate that considering certain significant experimental parameters will reduce the loss and the overall cost and, consequently, will increase the overall production.
DOI: 10.1080/08827500801997894

Characteristics of Indian non-coking coals and iron ore reduction by their chars for directly reduced iron production

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MINERAL PROCESSING AND EXTRACTIVE METALLURGY REVIEW, [TAYLOR & FRANCIS INC, PHILADELPHIA], 2008, Vol. 29(3), pp. 258-273.

Studies on the chemical and physical properties (proximate analysis, sulphur content, reactivity, iron ore reduction potential, caking index, and ash fusion temperatures) of coals, procured from 16 different mines in Orissa, India, were undertaken for their judicial selection in Indian sponge iron plants. These coals were found to have low sulphur (range of 0.40-0.66%) and a moderate-to-high ash (range: 22-53%) contents. The results indicated that there were no caking characteristics in any of the coals except Basundhara. The majority of the studied coal ashes were found to have higher fusion temperatures (ST: 1349-1547 degrees C; HT: 1500-1663 degrees C; and FT: 1510-1701 degrees C). An increase in the fixed carbon content in the coal char, in general, led to a decrease in its reactivity toward CO2. The majority of the chars exhibited significantly higher reactivities (> 4.0 cc of CO/g center dot see). Further reduction studies in coal chars at 900 degrees C indicated an increase in the degree of reduction of fired hematite iron ore pellets with an increase of char reactivity and reduction time. The authors recommend using the majority of the studied coals as such and some of them (Lakhanpur, Samleshwari, Orient OC-4, and Dhera coals) after blending or beneficiation.
DOI: 10.1080/08827500801997902

Characterization and processing of low-grade iron ore slime from the Jilling area of India

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MINERAL PROCESSING AND EXTRACTIVE METALLURGY REVIEW, [TAYLOR & FRANCIS INC, PHILADELPHIA], 2008, Vol. 29(3), pp. 213-231.

Detailed characterization followed by beneficiation of low-grade iron ore slime from Jilling Langalota deposit, India, was studied. The work involved separating the gangue minerals viz. quartz and kaolinite to form iron-bearing minerals, mostly hematite and goethite, as identified using XRD analysis to produce a suitable concentrate for downstream processing. The feed slime sample assayed 37.86% total Fe, 19.08% silica, and 14.4% alumina. Detailed characterization data indicated that a substantial amount of the sample was below 20 mu m in size. The finer fraction contained larger amount of gangue while the coarser fraction was richer in iron. Considering the characterization data, two flowsheets were conceptualized for the beneficiation of the slime sample with two- and four-stage processing, respectively. In the two-stage operation, the grade of the slime could be improved to 60.26% Fe, 4.45% silica, and 3.98% alumina with an overall yield of about 20%. The results from

the four-stage operation showed that it is possible to upgrade the iron value to 66.97% with a yield of 14.4% while reducing the silica and alumina content down to 1.7% and 1.52%, respectively. A simple flowsheet has been suggested to improve the yield substantially for the production of sinter/pellet grade concentrate from this slime.
DOI: 10.1080/08827500801997886

Environmental impact of coal washery and Damodar River water on the morphometry and biochemical changes of maize (Zea mays L.) and soil health

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ENVIRONMENTAL MONITORING AND ASSESSMENT, [SPRINGER, DORDRECHT], OCT, 2008, Vol. 145, pp. 251-256.

Enormous quantity of water is used for coal beneficiation and accordingly huge amount of effluents are being generated. In this study an attempt was made to evaluate the potential of this effluent water for irrigation. Water samples were collected from three different points (a) feeding point, (b) thickening point, and (c) outlet point of coal washery, and from Damodar River for monitoring the water quality. The samples were analyzed for various parameters and compared with prescribed standard, which revealed that the total suspended solids of thickening point and Damodar River were higher. A pot experiment with maize was conducted to study the suitability of this coal washery water for irrigation. Pots were irrigated with water from the three points of washery and Damodar River in two concentrations (100% and 50% dilution with distilled water); pure distilled water was used for control. There was 100% germination in all the treatments. The plant growth, chlorophyll content and soil quality parameters were significantly better in washery and Damodar River water treated pots. The Damodar River water and washery water from feeding and outlet point could be successfully used for irrigation. In general mixing with good quality water has shown better results.
DOI: 10.1007/s10661-007-0034-3

A novel beneficiation scheme for a medium coking coal fines from India

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INTERNATIONAL JOURNAL OF COAL PREPARATION AND UTILIZATION, [TAYLOR & FRANCIS INC, PHILADELPHIA], 2008, Vol. 28(4), pp. 189-200.

Beneficiation strategy for a medium coking coal fines from India has been studied. These coal fines have good washability characteristics indicating about 60% yield at 14% ash in clean coal. But the release analysis results indicate poor flotability of these fines. Only about 30% yield was achievable at 14% ash in the clean coal. Various schemes for flotation including two-stage flotation, split flotation, spiral, and

a combination of spiral and flotation were studied using a 15-cm diameter Jameson Cell. Combination of spiral and Jameson Cell flotation achieved approximately 69% yield at 17.5% ash.
DOI: 10.1080/19392690802391155

Three-dimensional particle shape acquisition and use of shape library for DEM and FEM/DEM simulation

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MINERALS ENGINEERING, 4th International Conference on DEM, AUG, 2007, Brisbane, AUSTRALIA, [PERGAMON-ELSEVIER SCIENCE LTD, OXFORD], OCT, 2008, Vol. 21(11), pp. 797-805.

Numerical simulation that will capture the complex behaviour of rock fragment systems, e.g., in mining and civil engineering, requires both the computational mechanics capability to model particle interactions between complex shapes and an associated means to represent the kind of arbitrary or angular geometry relevant to problems involving rock fragments. This paper is concerned less with the modelling and more with the representation. Here, we focus on representation geared to 'soft contact' modelling using either combined finite-discrete element (FEM/DEM) methods, or non-spherical DEM methods such as multi-sphere approximations of irregular geometry. 3D laser ranging (LADAR) is used to capture astonishingly realistic rock aggregate geometries. We report on the work flow procedures to generate computationally meshed virtual particles for modelling. The design of a shape library and a suggested procedure for selecting virtual particles for input to FEM/DEM or DEM models is discussed together with the use of inertia moments for shape descriptors. Use of the shape library for shape descriptor analysis is also illustrated. DEM simulations of packing using irregular particles from the shape library are presented. (C) 2008 Elsevier Ltd. All rights reserved.
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Adsorption Mechanism of Mixed Long-chain Amines and Alcohols on Silicate Minerals

Vidyadhar, A and Das, Avimanyu and Bhattacharyya, K K and Rao, Hanumantha K (2008). In: 11th International Mineral Processing Symposium, 21-23 October 2008, Belek-Antalya, Turkey.

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The mechanism of adsorption of long chain alkyl primary amines and co-adsorption of amines and alcohols on silicate minerals (quartz and feldspar) were studied using FTIR (DRIFT and IRRAS) and XPS spectroscopy methods at neutral pH 6-7. The spectroscopic data were correlated with zeta-potential and Hallimond flotation

results. The influence of long chain alcohols on the adsorption of amines in mixed amine-alcohol is also examined. The infrared studies revealed that the amine cation form strong hydrogen bonds with the surface silanol groups. The XPS spectra revealed the presence of molecular amine together with the protonated amine on silicate surface. Based on these observations, a model of successive two-dimensional and three-dimensional precipitation was suggested to explain amine adsorption on a silicate surface. The co-adsorption of long chain alcohols with amine cations leads to formation of a closer packed surface layer with synergistic enhancement of amine adsorption. The enhanced adsorption and hence higher flotation recoveries is discussed in the light of our experimental results.

Towards a virtual comminution machine

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MINERALS ENGINEERING, 4th International Conference on DEM, AUG, 2007, Brisbane, AUSTRALIA, [PERGAMON-ELSEVIER SCIENCE LTD, OXFORD], OCT, 2008, Vol. 21(11), pp. 770-781.

Towards the end of the 1990s readily available personal Computers became sufficiently powerful - when combined with an efficient numerical code - to use discrete element modelling (DEM) in two dimensions for models involving a few hundred to a few thousand particles in commercially available packages. Some proprietary codes reported up to 200,000 particles [Herbst, J.A., Nordell, L., 2001. Optimization of the design of sag mill internals using high fidelity simulation. In: Vancouver, B.C., Barratt, D.J., Allan, M.J., Mular, A.L. (Eds.), Proceedings of the SAG Conference, University of British Columbia, IV, 150-164; Cleary, P.W., 2001 a. Charge behaviour and power consumption in ball mills: Sensitivity to mill operating conditions, liner geometry and charge composition. Int. J. Min. Process. 63, 79-114 and Cleary, P.W., 2001b. Recent advances in DEM modelling of tumbling mills. Minerals Eng. 14, 1295-1319]. In early 2000, JKMRC and CSIRO-MIS agreed to an informal collaboration with the objective of testing various DEM approaches against detailed process measurements. The initial collaboration demonstrated that 3D-DEM using spheres was sufficiently realistic for flow patterns and power estimation within tumbling mills. The results were reported in papers which were presented at SAG 2001 and in the technical literature [Morrison, R.D., Cleary, P.W., Valery. W., 2001. Comparing power and performance trends from DEM and JK modelling. SAG 2001, Department of Mining and Minerals Process Engineering. University of British Columbia, Vancouver, 284-300: Cleary. P.W., Morrison, R., Morrell, S., 2003. Comparison of DEM and experiment for a scale model SAG mill. Int. J. Min. Process. 68, 129-165]. The commencement of the CRC for Sustainable Resource Processing in 2003 provided an opportunity to formalize the collaboration and bring increased resources to bear. The objective of this collaboration is to develop a virtual comminution machine (VCM). The VCM will allow a comminution machine design which exists as a Suitably detailed design in a 3D Computer aided design file (CAD)

to simulate processing an ore (which has been characterised by suitable test work) to predict progeny, power consumption, wear and even machine component loadings. This paper reports on the substantial progress made to date towards a practical Virtual Comminution Machine. (C) 2008 Published by Elsevier Ltd.
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A coupled THMC model of FEBEX mock-up test

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PHYSICS AND CHEMISTRY OF THE EARTH
3rd International Meeting on Clays in Natural and Engineered Barriers for Radioactive Waste Confinement, SEP 17-20, 2005, Lille, FRANCE, [PERGAMON-ELSEVIER SCIENCE LTD, OXFORD], 2008, Vol. 33, pp. S486-S498.

FEBEX (Full-scale Engineered Barrier EXperiment) is a demonstration and research project for the engineered barrier system (EBS) of a radioactive waste repository in granite. It includes two full-scale heating and hydration tests: the in situ test performed at Grimsel (Switzerland) and a mock-up test operating at CIEMAT facilities in Madrid (Spain). The mock-up test provides valuable insight on thermal, hydrodynamic, mechanical and chemical (THMC) behavior of EBS because its hydration is controlled better than that of in situ test in which the buffer is saturated with water from the surrounding granitic rock. Here we present a coupled THMC model of the mock-up test which accounts for thermal and chemical osmosis and bentonite swelling with a state-surface approach. The THMC model reproduces measured temperature and cumulative water inflow data. It fits also relative humidity data at the outer part of the buffer. but underestimates relative humidities near the heater. Dilution due to hydration and evaporation near the heater are the main processes controlling the concentration of conservative species while surface complexation, mineral dissolution/precipitation and cation exchanges affect significantly reactive species as well. Results of sensitivity analyses to chemical processes show that pH is mostly controlled by surface complexation while dissolved cations concentrations are controlled by cation exchange reactions.
DOI: 10.1016/j.pce.2008.10.023

Applying DEM outputs to the unified comminution model

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MINERALS ENGINEERING, 4th International Conference on DEM, AUG, 2007, Brisbane, AUSTRALIA, [PERGAMON-ELSEVIER SCIENCE LTD, OXFORD], OCT, 2008, Vol. 21(11), pp. 744-750.

The concept of a unified comminution model (UCM) was formulated with the vision of bringing all comminution models onto a common base. The structure of the model relies on knowledge of the mechanical environment in the comminution devices - the discrete element method (DEM) has been used as the tool to simulate this. The model structure tackles the fundamental causes of rock breakage, considering them to be independent of the comminution equipment. The equipment is considered to be the mechanism that applies a given comminution environment to the ore particles. Thus, once an understanding of the processes of ore breakage is gained, the mechanical environment from any type of equipment can be overlaid to provide a model that predicts the production of broken material.
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Erosion of a mud from the Loire estuary by a flow

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BULLETIN OF ENGINEERING GEOLOGY AND THE ENVIRONMENT, [SPRINGER HEIDELBERG
HEIDELBERG], NOV, 2008, Vol. 67(4), pp. 597-605.

This research work deals with an experimental study on the erosion phenomenon of a mud under the action of a water current. It is observed from research works carried out by Partheniades (J Hydraul Div ASCE 91(HY1): 105-139, 1965), Migniot (La Houille Blanche 1&2: 11-29, 95-111, 1989), Ockenden and Delo (GeoMar Lett 11: 138-142, 1991), Aberle et al. (Mar Geol 207: 83-93,2004), among others, that mud erosion process by an hydrodynamic action depends mainly on sediment properties. Based on a literature study, this critical stress is assumed to be proportional either to the effective cohesion (Eq. 2) or to the yield stress (Eq. 4) of the sediment bed. Six erosion test series have been performed at six different concentrations of a mud from the Loire estuary. Some properties of the tested sediments are: a solid particles density rho(s)= 2,550 kg m(-3), a liquidity and plasticity limit at 140 and 70% of the water content, respectively, a mean size of the dispersed mineral fraction determined by laser techniques of 10 mu m, and a volatile matters content of 11.86% by total dry weight burned at 550 degrees C. As the rheological behaviour is difficult to describe, the sediment strength is characterized by only a parameter, namely, the yield stress tau(y). It is measured with a coaxial cylinder Brookfield LVT viscosimeter following a defined procedure (Hosseini in Liaison entre la rigidite initiale et la cohesion non drainee dans les vases molles-Relation avec la dynamique sedimentaire. These, Universite de Nantes, 167 p, 1999). For each studied concentration, three successive erosion tests are carried out, and for every erosion test, 15 successive measurements of tau(y) are made. The mean values and the standard deviations of tau(y) are shown in Table 1 as a function of the bed sediment concentration C. A confined flume has been conceived and built to characterize the erosion rates. With this device, a current-induced shear stress is

generated above an homogeneous deposited sediment (Fig. 1). The bed shear stress so is calculated from the measured mean velocity V by Eq. 5. The friction coefficient c(f) involved in Eq. 5 has been evaluated from measurements of the hydraulic pressure loss. Finally, the validity of Eq. 5 has been confirmed by five calibration tests on the incipient of the movement of sands for which results are compared with Shields diagram in Fig. 2. The observed erosion mechanisms affecting cohesive sediments depend mainly on the value of the yield stress. For a fluid mud (tau(y) less than 3 N m(-2)), the bed shear stress produces at first a wavy motion on the bed surface with a progressive undulation. When the shear stress increases, resuspension produces a diluted sediment cloud which is entrained and dispersed by the flow. For a plastic mud (tau(y) greater than 3 N m-2), erosion occurs by a wrenching of aggregates which are transported near the bottom. Initially, the eroded aggregates measure several millimetres in size; but, once transported, aggregates break into very rigid and compact aggregates of maximum size close to 1 mm in all the cases. During erosion tests, erosion volumetric rates E(v) have been evaluated under steady-state bed shear stress so from the observed variation in time of suspended sediment concentration. A generalized erosion is assumed for E(v) >= E(vo)= 3 x 10(-7) m s(-1) (that is the equivalent of 1 mm sediment layer eroded per hour). The generalized erosion occursabove a critical bed shear stress tau(oe) which is linked to tau(y) and mud density through Eq. 7. A phenomenological law defined by Eq. 8 is proposed to calculate the erosion rate as a function of yield stress and hydrodynamic shear stress at the bottom. For tau(o) < tau(oe), a small erosion is observed, which is described by a formulation given by Cerco et al. (Water quality model of Florida Bay. U. S. Army Engineer Research and Development Center, ERDC/EL TR-00-10, Vicksburg, USA, 260 p, 2000). Above tau(oe), a small increase in so produces an important erosion rate rise which is described by a formulation suggested by Mehta and Partheniades (Resuspension of deposited cohesive sediment beds. In: Proceedings of the 18th coastal engineering conference, Cape Town, South Africa, 2: 1569-1588, 1982). Figure 3 shows as a function of so the observed values of Ev (discrete symbols) as well as the proposed model (in solid lines) for the six concentrations. For the theoretically maximum value of Ev, the hydrodynamic shear stress is very high with regard to the sediment cohesion; and then, the water flux produces an entrainment of underlying fluid mud layers. The asymptotic law obtained from the model of Kranenburg and Winterwerp (1997) plotted in dashed lines in Fig. 3, is expressed by E(v)= 0.3 u*. A sediment trap inserted in the experimental system allows a sample of eroded mud aggregates to be obtained. It is observed that the maximum value of the diameter D(M) of the eroded aggregates depends on the density and yield stress of the initially deposited mud according to Eq. 10. In the same way, the density of the aggregates issued from plastic mud erosion is measured following an original experimental method and procedure (Table 3). The erosion of plasticmuds with a concentration from 310 to 420 kg m(-3) produces aggregates with a concentration close to 400 kg m(-3) and yield stress a little greater than 100 N m(-2).

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Experimental compaction of clays: relationship between permeability and petrophysical properties in mudstones

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PETROLEUM GEOSCIENCE, [GEOLOGICAL SOC PUBL HOUSE, BATH], NOV, 2008, Vol. 14(4), pp. 319-337.

This study determines the relationship between permeability and other petrophysical properties in synthetic mudstones as a function of vertical effective stress. Six brine-saturated clay slurries consisting of smectite and kaolinite were compacted in the laboratory under both controlled pore pressure and proper drained conditions. Porosity, permeability, bulk density, velocity (both V(p), and V(s)) and rock mechanical properties were measured constantly under increasing vertical effective stress up to 50 MPa. The results show that smectite-rich clays compact significantly less and have lower bulk density, velocity, permeability, bulk and shear modulus but higher Poisson's ratio compared to kaolinite-rich clays at the same effective stress. Kaolinite aggregates compacted to about 26% porosity at 10 MPa effective stress corresponding to about 1 km burial depth in a normally compacted basin, whereas a pure smectite aggregate has a porosity of about 46% at the same stress. The permeability of kaolinite aggregates varies between 0.1 mD and 0.001 mD, while that of smectite aggregates varies from 0.004 mD to 0.00006 mD (60 nD) at stresses between 1 MPa and 50 MPa. Permeabilities in clays show a logarithmic decrease with increasing effective stress, bulk density, velocity or decreasing porosity. At the same porosity or bulk density, permeabilities differ up to five orders of magnitude within the smectite kaolinite mixtures. Applications of the Kozeny-Carman equation for calculating permeability based on porosity in mudstones will therefore produce highly erroneous results. The relationships between V(p), V(s), bulk and shear modulus to permeability also vary by up to four orders of magnitude depending on the clay compositions. Velocities or rock mechanical properties will therefore not be suitable to estimate permeability in mudstones unless the mineralogy and textural relationships are known. These experimental results demonstrate that smectite content may be critical for building up pore pressure in mudstones compared to kaolinite. The results help to constrain compaction and fluid flow in mudstones in shallower parts of the basins (<80-100 degrees C) where mechanical compaction is the dominant process. These results may also have implications for waste disposal and engineering practice, including structural design and slope stability analysis.

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SELECTIVE ABSTRACTS

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

Coal Mining in Meghalaya - a boon or bane?

Nayak, B and Bhattacharyya, K K

In: Proceedings of National Seminar on Environmental Management in Mining and Allied Industries (EMMA-2008), November 7-8, 2008, BHU, Varanasi.

Thin seams of coal occur assiciated with the Lakadong sandstones of Eocene age in the Jaintia Hills of Megha-laya. These Tertiary coals are low-ash coking coals but due to their high sulfur content they do not find proper market in the iron and steel industries. However, they are being mined rampantly for use as a fuel for other small and medium-scale industries such as power, cement, tea, fertilizer and bricks etc. Due to unscientific mining methods the environment is seriously affected destroying the land, soil, forest, water and the natural heritages. The law of the land is also a major bottleneck for persuading large-scale integrated mechanized mining by public and private sectors. Government efforts are yet to deliver a clear cut mineral and mining policy or any significant results towards protecting the environment. This is a serious issue which needs attention of the policy makers, planners, administrators, mining engineers, geo-enVironmentalists, scientists, technocrats, entrepreneurs and academicians to discuss, deliberate and suggest some solution for the benefit of the people of Meghalaya as well as for the protection of the environment.

DOI: http://eprints.nmlindia.org/5778/

Beneficiation of Guachinte (Cauca) and Golondrinas (Valle Del Cauca) Coals Using a Cyclone Test Rig with two Separation Stages

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DYNA-COLOMBIA, [UNIV NAC COLOMBIA, FAC NAC MINAS, MEDELLIN], NOV, 2008, 75, 156, pp. 165-176.

Two Colombian coals from South-West, Guachinte (Cauca) and Golondrinas (Valle del Cauca)), were beneficiated using a dense medium cyclone with two separation stages in series. It was obtained a concentrated fraction in organic matter (beneficiated fraction) for each separation stage. Yield of beneficiated fractions obtained in the first separation stage were in the range 28 to 58%. Using the second separation stage, the maximum yield obtained for Guachinte coal was 71%. Ash content of beneficiated coal fractions was between 6.84 and 24.68% which was lower than feed fractions 23.39 y 43.29%. A reduction in sulphur content was also found in

beneficiated fractions of Guachinte coal in comparison to feed fractions, however, a contrary behavior was obtained for Golondrinas coal.

Can Bacteriophage be Used to Separate Minerals?

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FIRST INTERNATIONAL FUTURE MINING CONFERENCE AND EXHIBITION 2008, PROCEEDINGS
1st International Future Mining Conference and Exhibition, NOV 19-21, 2008, Sydney, AUSTRALIA, [AUSTRALASIAN INST MINING & METALLURGY, PARKVILLE VICTORIA], 2008, 10, pp. 113-117

Bacteriophage (phage) are viruses that infect bacteria. Protein coatings on the surface of the phage particle can be genetically engineered so that they bind to inorganic molecules. The filamentous phage particle is about 930 nanometres in length and 6.5 nanometres in diameter and consists of a single-stranded molecule of DNA surrounded by live different coat protein molecules denoted P3, 136, P7, P8 and P9. Peptide sequences in the P3 coat protein that bind to sphalerite and chalcopyrite have been identified. The binding is selective; phage with specific P3 peptide sequences bind to minerals but do not bind to silica or to pyrite. Two peptide sequences in the P8 coat protein that bind selectively to chalcopyrite and pyrite have also been identified, The amino acids in the P8 binding sequences are hydrophilic and thus a coating of a mineral particle with phage having these peptide sequences may render the particle hydrophilic. Experiments arc underway to confirm this. Phage are relatively easy to grow and are not living organisms requiring an energy source to maintain life. Phage can also tolerate a range of pH and temperatures. Given this, and the ability to indentify phage coat proteins that bind selectively to a variety of inorganic molecules, phage have the potential to be useful tools in mineral processing and waste treatment.

Approaches to modelling coupled flow and reaction in a 2D cementation experiment

Cochepin, B; Trotignon, L; Bildstein, O; Steefel, CI; Lagneau, V; Van der Lee, J
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ADVANCES IN WATER RESOURCES, [ELSEVIER SCI LTD, OXFORD], DEC, 2008, Vol. 31(12), pp. 1540-1551.

Porosity evolution at reactive interfaces is a key process that governs the evolution and performances of many engineered systems that have important applications in earth and environmental sciences. This is the case, for example, at the interface between cement structures and clays in deep geological nuclear waste disposals. Although in a different transport regime, similar questions arise for permeable reactive barriers used for biogeochemical remediation in surface environments. The

COMEDIE project aims at investigating the coupling between transport, hydrodynamics and chemistry when significant variations of porosity occur. The present work focuses on a numerical benchmark used as a design exercise for the future COMEDIE-2D experiment. The use of reactive transport simulation tools like Hytec and Crunch provides predictions of the physico-chemical evolutions that are expected during the future experiments in laboratory. Focus is given in this paper on the evolution during the simulated experiment of precipitate, permeability and porosity fields. A first case is considered in which the porosity is constant. Results obtained with Crunch and Hytec are in relatively good agreement. Differences are attributable to the models of reactive surface area taken into account for dissolution/precipitation processes. Crunch and Hytec simulations taking into account porosity variations are then presented and compared. Results given by the two codes are in qualitative agreement, with differences attributable in part to the models of reactive surface area for dissolution/precipitation processes. As a consequence, the localization of secondary precipitates predicted by Crunch leads to lower local porosities than for predictions obtained by Hytec and thus to a stronger coupling between flow and chemistry. This benchmark highlights the importance of the surface area model employed to describe systems in which strong porosity variations occur as a result of dissolution/precipitation. The simulation of highly non-linear reactive transport systems is also shown to be partly dependent on specific numerical approaches. (c) 2008 Published by Elsevier Ltd.
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An experimental study of the recovery of hydrophilic silica fines in column flotation

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This paper presents results of tests performed to investigate the effect of gas rate (1.2-2.5 cm/s), hydrophilic fines content (5-20% w/w silica) and froth depth (10-30 cm) on fines recovery in a laboratory-scale flotation column operating without wash-water addition and absence of floatable particles. A model was developed based on the entrainment coefficients presented by [Trahar, W.J., 1981. A rational interpretation of the role of particle size in flotation. International Journal of Mineral Processing 8, 289-327], which describes the mass contribution of the different size classes to the solids recovered in the concentrate. The entrainment model of [Zheng, X., Johnson, N.W., Franzidis, J.P., 2006. Modelling of entrainment in industrial flotation cells: water recovery and degree of entrainment. Minerals Engineering 19, 1191-1203] was also tested. The results show both models described well the dependence of the mass flow rate of hydrophilic solids in the concentrate.
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Simulation of multi-stage gravity separation circuits by size-density bivariate partition function

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The size-density bivariate partition function is an operator that maps the distributed feed to a gravity separator into distributions of sink and float products. Because separator efficiency is primarily determined by size and density, bivariate partition function provides a more meaningful and quantitative assessment of the steady state performance of both stand-alone and multi-stage separators than the more commonly invoked partition functions in a single particle attribute, namely, size or density. Based on the nodal mass balance, we derive generic expressions for the overall bivariate partition function of a multi-stage separator in terms of the bivariate partition functions of its constituent equipment, their statistical expectations and circuit configuration. A recently proposed stochastic model of size-density partition function for the stand-alone separator is embedded in the circuit equations in order to simulate the published coal cleaner data for an air table, which has clean coal, middlings, and refuse product streams. The air table is modeled as single pass, two-stage separators in series in which the coal feed is split into clean coal and bulk refuse in the first stage, and the latter is separated into middlings and reject in the second stage. General expressions for the overall bivariate partition function and bypass of a two-stage separator configured in four different ways are derived. The partition functions of individual units are converted into equivalent overall stochastic partition functions. Simulation results and their analyses indicate that compared to the constituent equipment operating alone, all two-stage separators give, as expected, sharper performance in terms of ecart probable; depending on the configuration, the overall bypass increases, decreases or remains more or less unchanged; and the cut density can be manipulated over a broad range by changing the circuit configuration. In general. the performance of a multi-stage separator is strongly dependent on the manner in which its individual equipment is linked. Our model could provide a convenient tool for identifying the optimal circuit for a given separation/cleaning task.
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Recovery of heavy metals from MSW molten fly ash by carrier-in-pulp method: Fe powder as carrier

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Municipal solid waste (MSW) molten fly ash is classified as a hazardous waste because it contains considerable amount of heavy metals, which pose environmental concern due to their leaching potential in landfill environment. This study proposes carrier-in-pulp (CIP) method as a new hydrometallurgical route to extract and recover Pb, Zn, Cu, and Cd from molten fly ash before landfilling. In this method, a carrier material, which recovers the extracted metals, is added simultaneously with fly ash to a leaching solution and is harvested from the pulp by physical separation method, such as magnetic separation or sieving. To demonstrate the effect of the CIP method, shaking flask experiments were conducted under various conditions using NaCl solution, iron powder as carrier, and molten fly ash. More than 99 wt% Pb, Zn, and Cd, and 97 wt% Cu were extracted from the ash. However, only Pb and Cu were recovered (96.3 wt% Pb and 94.3 wt% Cu) by the iron powder through cementation, leaving behind Zn and Cd ions in the solution phase. The leaching test conducted on the treated fly ash residue revealed that the CIP method suppressed the solubilization of Pb to a value below the landfill disposal guideline.
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Recovery of silver and zinc by acid pressure oxidative leaching of silver-bearing low-grade complex sulfide ores

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Rich silver-bearing low-grade complex sulfide ores can be found in great supply in China's Yunnan Province. The beneficiation experiment showed that it would be very difficult to separate Ag (Zn or Pb) minerals with traditional ore beneficiation methods. In the present work. acid pressure oxidative leaching of such complex sulfide ores in sulfate medium added sodium iodine and at the temperature ranging from 90 to 170 degrees C was studied to search for silver recovery alternatives. The Lab-scale experiments were conducted in a 2-L autoclave to investigate the influences of temperature, acidity, sodium iodide addition, oxygen pressure, oxygen flow rate on recovery of silver and zinc. The experimental results obtained show that under optimum conditions, recovery yield of silver and zinc reaches 71.5% and 41.29%, respectively.
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Non-coking coal preparation by novel tribo-electrostatic method

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A new laboratory fluidised bed tribo-electrostatic separator has been assembled and the beneficiation potential of thermal non-coking coal from Hingula block of Talcher coal field, India, is examined on this separator. The uniqueness of the separator originates from the efficient tribo-electrification of coal material in the cylindrical fluidised bed with internal baffle system. The collecting bins of the material underneath the copper plate electrodes are designed to function as Faraday cups such that the charge polarity and magnitude of particles in each bin can be measured directly. The liberation attributes of coal material is assessed by sink and float analysis of various size fractions. The mineral and maceral composition is determined by XRD and petrographic analysis. The separation tests were conducted at different tribo-charging and applied voltage conditions. The material collected in bins close to positive and negative electrodes show an ash content of 61% and 8% respectively, illustrating differential charge acquisition of mineral rich and coal rich particles during tribo-electrification. The charge results are in good agreement with the ash content of the coal material collected in the bins. The results showed that a clean coal of about 15% ash can be obtained from a coal containing 30% ash with about 70% yield. A better separation results can be achieved by recycling the material. The ash content in the clean coal is however limited by the liberation characteristics of the coal, which is evidenced by the SEM analysis of the particles in different bins. Thus, the tribo-electrostatic method observed to be a promising dry coal preparation technique.
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Integrated waste and water management in mining and metallurgical industries

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AMSTERDAM], DEC, 2008, Vol. 18(6), pp. 1497-1505.

Extractive operations usually co-produce large quantities of unmarketable materials (mineral wastes), most of which are conventionally discarded to clumps (coarse material) and tailings ponds (fines). Escalating cost and regulation worldwide highlight an increasing need for reduction and re-use of such wastes. The present paper introduces a new integrated waste management scheme for solids and water. The scheme was exemplified by novel treatment of synthetic waste and process water linked to the biohydrotmetallurgical processing of metal sulphide notation concentrates. Bioleaching of sulphide concentrate leads to two types of solid waste: a ferrihydrite/gypsum precipitate from neutralisation of the bioleach liquor and un-leached gangue. The paper indicates that, depending upon the minor components involved, the solid phases in admixture might be usefully distributed among three

types of product: conventional underground backfill, cemented civil engineering backfill (particularly controlled low strength material or CLSM) and manufactured soil. It emphasizes CLSM containing simulated mineral waste, showing that such material can exhibit the required characteristics of strength, porosity and permeability. When toxic components, e.g., arsenic from refractory gold ore, are present, encapsulation will be required. Process water is typically recycled as far as possible, although any excess should be treated before re-use or discharge. The paper also highlights treatment by reverse osmosis (one of the few methods able to generally remove dissolved components), particularly showing that arsenic in oxidation state +6 can be readily removed for discharge (<50 X 10(-12) As), although additional ion exchange is needed for potable water (< 10 X 10(-12) As).

Level set simulation of coupled advection-diffusion and pore structure evolution due to mineral precipitation in porous media

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A pore-scale simulation technique based on level set interface tracking has been developed for modeling coupled reactive flow and structure evolution in porous media and fracture apertures. Advection, diffusion, and mineral precipitation resulting in changes in pore geometries are treated simultaneously by solving fully coupled fluid flow and reactive solute transport equations. The reaction-induced evolution of solid grain surfaces is captured using a level set method, and a subgrid representation of the interface based on the level set approach is used instead of a pixel representation of the interface often used in cellular automata and lattice-Boltzmann simulations. Precipitation processes within a 2-D porous medium represented by non overlapping discs were simulated under various flow conditions and reaction rates, and the resulting changes of pore geometry are discussed. The simulation results indicate that under reaction-limited conditions, precipitation is nearly uniform over the grain surfaces. However, this is no longer true when reaction is relatively fast and diffusion is the dominant transport process. In such cases, precipitation occurs mostly near the throat inlet and results in rapid permeability reduction with only a small reduction of porosity. In the case of fast reaction with transport dominated by advection (which is mostly likely in engineered remediation applications), solute can be delivered deep into fracture apertures and precipitation occurs mostly along preferential flow paths. Quantitative relationships between permeability and porosity under various flow conditions and reaction rates are also reported.
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