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Beneficiation of Cassiterite and Iron Minerals From a Tin Tailing with Magnetizing Roasting-Magnetic Separation Process

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Separation Science And Technology, Apr, 2013, Vol. 48(9), pp. 1426-1432

The beneficiation of cassiterite and iron minerals from tin tailings with magnetizing roasting and low-intensity magnetic separation (MR-LMS) process was studied in this work. It showed that the process was effective in recovering the tin and iron values from the refractory ore, produced a high-quality iron concentrate assaying 64.68% Fe with the recovery of 87.47% and a tin-rich middling assaying 4.10% Sn with the tin recovery of 63.55%, from the tin tailing assaying 0.20% Sn and 14.56% Fe. It has been found that the key point of the process was the step of magnetizing roasting, which converted hematite and limonite into magnetite. The separation efficiency of the process closely correlated with roasting temperature, roasting time, lignite addition, and the liberation of cassiterite with the iron minerals.
10.1080/01496395.2012.726310

Observations on the separation of iron ore in a prototype batch jig

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International Journal Of Mineral Processing, Apr, 2013, Vol. 120, pp. 43-47.

The separation of iron ore in a prototype batch jig separator developed by Mintek in South Africa, referred to as the Mineral Density Separator (MDS), can separate ore samples into multiple bulk density fractions, provided that narrow feed size ranges are used. In this study, the performance of the equipment is considered by use of iron ore particles coloured according to density. This facilitated visualization of the density composition of the stratified ores. The highest density iron ore (>4000 kg/m(3)) could be separated efficiently from gangue material, but satisfactory stratification of lower density particles (<3600 kg/m(3)) could not be achieved.
10.1016/j.minpro.2013.01.007

Biomineralization One Promising Bridge between Inorganic Chemistry and Biomedicine

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PROGRESS IN CHEMISTRY, Apr, 2013, Vol. 25(4), pp. 633-641

Biomineralization refers to the processes by which organisms form minerals. The control exerted by many organisms over mineral formation distinguishes these processes from abiotic mineralization. In living organisms, nanoscale building blocks combine into self-assembled biominerals under the control of an organic matrix. Biomineralization, especially mineralization of unicellular organisms, physiologic and pathological mineralization, plays a vital role in biology and materials research and could offer a variety of inspirations for biomaterials design and biomedical engineering. As the basic building blocks of biological hard tissues such as bone, dentin, and enamel, hydroxyapatite (HAP) nanoparticles play an important role in the construction of biominerals. As analogues of biological units, nano-HAP can be used as ideal biomaterials due to their nice biocompatibility and bone/enamel integration. The construction of nanostructured calcium phosphates is highlighted in bone/tooth hard tissue engineering. Inspired by unicellular organisms, single cell and virus were entrapped in a biomimetic mineral shell and were endowed with enhanced resistance abilities in the hostile environment. Several ongoing works and related proceedings in this fields are highlighted in this article. The perspective from biomineralization to biomedical research including bone and teeth repair, cellular (virus) shell engineering are illustrated. As the bridge of inorganic chemistry and biomedicine, biomineralization is the well of knowledge for hard tissue repair, the guiding principle for preventing disease of pathological mineralization, the inspiration for cell interfacial engineering, and need to be exploited adequately.

A model for pulverised fuel production in an air-swept tube mill

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MINERALS ENGINEERING, Apr, 2013, Vol. 43-44, pp. 154-158

The grinding process of an air-swept tube mill can be modelled adequately using the selection and breakage functions approach to modelling comminution. However to model Pulverised Fuel (PF) production, all the other sub-processes that include: release of the ground product from the ball charge, internal air-classification within the mill and classification of an installed external classifier must be considered. Inefficiency in any one of these process steps can negate the overall mill capacity with little compensation from the other processes. Using industrial data from Kendal power station and data from a scaled down pilot mill at the University of Witwatersrand, a system of sub-process models have been defined and a simulator developed. We were able to simulate mill performance under different loading

conditions over the entire liner life. The model details and some of the results of industrial modelling are discussed.
10.1016/j.mineng.2012.11.005

Analysis and validation of a run-of-mine ore grinding mill circuit model for process control

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MINERALS ENGINEERING, Apr, 2013, Vol. 43-44, pp. 121-134

A simple and novel non-linear model of a run-of-mine ore grinding mill circuit, developed for process control and estimation purposes, is validated. The model makes use of the minimum number of states and parameters necessary to produce responses that are qualitatively accurate. It consists of separate feeder, mill, sump and hydrocyclone modules that can be connected to model different circuit configurations. The model uses five states: rocks, solids, fines, water and steel balls. Rocks are defined as too large to be discharged from the mill, whereas solids, defined as particles small enough to leave the mill, consist of out-of-specification coarse ore and in-specification fine ore fractions. The model incorporates a unique prediction of the rheology of the slurry within the mill. A new hydrocyclone model is also presented. The model parameters are fitted to an existing plant's sampling campaign data and a step-wise procedure is given to fit the model to steady-state data. Simulation test results of the model are compared to sampling campaign data of the same plant at different steady-state conditions. The model shows promise in estimating important process variables such as mill power and product particle size and is deemed suitable for process control studies. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2012.10.009

Beneficiated coals' char morphology

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INGENIERIA E INVESTIGACION, UNIV NAC COLOMBIA, FAC INGENIERIA, BOGOTA, Apr, 2013, Vol. 33(1), pp. 13-17

This work evaluated the char morphology of beneficiated and original coal (without beneficiation) from four Colombian coalmines: Cerrejon (La Guajira), La Jagua (Cesar), Guachinte (Valle del Cauca) and Nechi (Antioquia). Column flotation was used to obtain beneficiated coal, whereas a drop tube reactor at 1,000 degrees C, 104 degrees C/s heating rate and 100 ms residence time was used to obtain char. The chars were analysed by image analysis which determined their shape, size, porosity and wall thickness. It was found that char morphology depended on coal rank and maceral composition. Morphological characteristics like high porosity, thinner walls and network-like morphology which are beneficial in improving

combustion were present in vitrinite- and liptinite-rich lowest-ranking coals. Beneficiated coals showed that their chars had better performance regarding their morphological characteristics than their original coal chars.

Comprehensive study of process parameters affecting oil agglomeration using vegetable oils

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FUEL, Apr, 2013, Vol. 106, pp. 285-292

Spherical agglomeration is a size enlargement process in which the disperse medium is held together in aggregates by liquid bridges of an immiscible agglomerating agent in the dispersion medium in general, an aqueous environment. Extensive studies on the process have shown that the process is affected by a number of process parameters. In the present paper, a large number of process parameters such as agitation speed, oil dosage, agglomeration time, coal particle size, slurry pulp density, pH and temperature of the dispersion medium, oil type, surfactant (anionic) use, and sea water usage as pulping medium. affecting the oil agglomeration of Indian bituminous coal procured from North-Eastern region of the country were investigated. Initially, the process parameters were optimized for maximum coal recovery with significant ash rejections. Subsequent experiments to study the effect of surfactant, oil type and sea water usage as pulping medium were performed under the optimized conditions. All the experiments were performed under batch mode of operation. The coal-oil agglomerates were recovered by screening using a standard test sieve whose pore size was same as the maximum size of feed coal particle. The overall agglomeration performance was studied in terms of efficiency index which took into account both combustible recovery and ash rejection, the two important process estimates of the agglomeration process. The experimental results showed that the Indian bituminous coal used in the study was quite receptive to oil agglomeration process and significant recovery of coal fines with considerable ash rejections was possible through this clean coal technology.
 10.1016/j.fuel.2012.12.002

Designing liners for performance not life

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MINERALS ENGINEERING, Apr, 2013, Vol. 43-44, pp. 22-28

Scanalyse in collaboration with JKMRC and Newcrest Mining Limited conducted an extensive study of the effect of liner wear on mill performance of a 32 foot SAG mill at Newcrest's Cadia Valley Operations in Australia. The methodology of determining the optimum liner shape was previously presented at Metplant 2011, and expanded on at the SAG11. The results presented indicated that liners with a reduced mass and shorter life outperform their longer life counter parts in all key production parameters of throughput, energy consumption and product size. This paper

quantifies the benefit of having shorter liner life cycles for improved performance by calculating the increase in throughput and reduction in power based on historical data for an operational 32 foot mill. It also presents the total overall gain by accounting for the increase in required reline effort. This provides a holistic view of the net achievements when designing liners for performance and not life. 10.1016/j.mineng.2012.07.004

Effects of operating parameters on the efficiency of dry stirred milling

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MINERALS ENGINEERING, Apr, 2013, Vol. 43-44, pp. 58-66

Stirred media milling is an industrially accepted efficient grinding method for fine and coarse particles. The stirred mills can be operated both in vertical and horizontal configurations and the selection depending on the process variables. Successful operation of horizontal stirred milling (i.e. IsaMill) in wet applications encouraged the studies in dry applications. In this study, series of dry grinding tests were performed in a prototype horizontal stirred mill (42 L) to investigate the effects of operating parameters such as stirrer speed, feed rate, media filling and ball size on grinding considering the degree of size reduction and the energy consumption. The test results have shown that the stirrer speed, the media size and the media filling are directly proportional and the feed rate is inversely proportional with the specific energy consumption. Besides, energy savings up to 27% were achieved by adjusting the milling conditions properly (suitable media size) and the size reduction values (F-50/P-50) were between 1.05 and 2.42. 10.1016/j.mineng.2012.08.003

Gasification of coal combustion ash for its reuse as adsorbent

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FUEL, Apr, 2013, Vol. 106, pp. 147-151

Beneficiation through gasification of coal combustion ash coming from an industrial power plant aimed at its reuse as adsorbent is dealt with. The raw ash was gasified in a tubular reactor at 850 degrees C for times ranging from 10 to 60 min, using either steam or CO2 as gasifying agent. The relationships among parent ash properties, gasification treatments and properties of the gasified ash deserve investigation. Therefore, ash characteristics (such as carbon content, porosimetric, diffractometric, chemical and granulometric properties) were correspondingly determined. In the light of a critical analysis of the obtained results, gasification conditions able to make the parent ash a potentially better adsorbent material were defined, with a particular emphasis on similarities and differences between steam and CO2 gasification. Preliminary results concerning cadmium adsorption onto gasified materials were also reported. 10.1016/j.fuel.2012.11.077

Implementation of optimized compressive crushing in full scale experiments

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MINERALS ENGINEERING, Apr, 2013, Vol. 43-44, pp. 135-147

Commonly used at the coarser end of the comminution process, cone crushers often operate as the final crushing stage in the aggregate industry, or as the supplier of feed material for HPGRs or ball mills in the mining industry. As such, the performance of cone crushers undoubtedly affects the performance and efficiency of the overall process. The aim of this study is therefore to implement theoretical optimizations of compressive crushing for two different applications. Three different prototypes of crushing chambers have been manufactured based on the conceptual designs obtained from theoretical optimizations. Tested in full scale experiments, the results for these prototypes (designed for aggregate production and mining operation) were subsequently compared to the measured data for the corresponding reference crushing chambers. The performed analysis suggests that the performance of cone crushers can be improved in terms of product yield as well as reduction ratio. (C) 2012 Published by Elsevier Ltd.
10.1016/j.mineng.2012.10.008

Investigation of particles with high crack density produced by HPGR and its effect on the redistribution of the particle size fraction in heaps

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The application of comminution technology such as the high-pressure grinding rolls (HPGRs), which is able to generate a high density of cracks in the ore particles, is favourable for leaching processes. Extraction of metallic values by the heap leach process, can take place on the particles with partial exposure of mineral grains, if it can provide sufficient surface front for chemical attack by leaching solution. The aim of this study was to assess the benefits of high crack density in the ore particles produced using the HPGR and how it could diminish due to inadequate percolation of the leaching agent. A zinc ore was comminuted using HPGR at three different pressure settings and with a cone crusher for the control experiment. Subsamples from the (+23/-25, +14/-16, +5.25/-6.75 mm) size fractions were characterized and packed into leach reactors. The reactors were stopped from time to time to investigate the progress of crack and micro-crack growth and its effect on metal extraction using the X-ray computed tomography (CT). The results are validated with those obtained using traditional techniques such as SEM and QEMSCAN. Investigation of the leach reactors residue indicated significant changes in the particle size distribution (PSD) of initial feed toward the fine size fraction. The residues from the reactors leaching the material prepared using the HPGR product contained more fine particles than the reactors, which were fed by cone crusher

product. These differences were up to 10.3%. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2012.08.010

Step change in the context of comminution

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Much has been written about innovation and the need for "game-changing" step change. There is no doubt that there are many challenges facing the mining and minerals industry and hence it is appropriate that the industry examines the level of response required. "Step Change" should not be regarded as a tightly defined, prescriptive descriptor, rather the industry needs to consider what it should mean in the context of the current and future challenges. In terms of comminution, the area bears much of the burden for the use of energy in the mining-processing system. Given this specific issue it is reasonable to consider that step change should be targeted at the reduction of the energy input per unit of final product. It is important to consider energy in terms of the final output, as without this, effort could be misdirected. To ensure the maximum effectiveness of innovation in this field, comminution must be regarded as a component of the wider system that encompasses the size reduction from the in situ rock mass to a saleable product. In regard to the total system, some of the key considerations are philosophical, not technological. Such points include the need to simplify circuits, increase flexibility, examine the impact of variability and consider the end-game. In essence the total system is not about breaking rocks to a size, it is about breaking only what requires size reduction, to the point at which a saleable product can be generated. With this in mind the context for step change is set and this forms the basis for the discussion.

10.1016/j.mineng.2012.06.010

The effect of feed moisture on the comminution efficiency of HPGR circuits

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The comminution efficiency of high-pressure-grinding-rolls (HPGRs) is a well described function of a number of feed parameters including grindability, abrasion index, granulometric composition, top size and particle size distribution. Far less studied is the effect of feed moisture. This paper investigates both the overall and the specific comminution efficiency of a circuit consisting of a pilot HPGR unit followed by a batch ball mill as a function of the moisture level in the HPGR feed. Forsterite olivine sand (-7 mm) supplied by Sibelco Nordic was used as feed material. The results showed that the relationship between moisture and crushing efficiency for both the HPGR and the circuit can be described successfully by means of a parabolic function. Dry material, as well as that with the highest moisture

content, showed the lowest particle size reduction ratios irrespective of the specific grinding force level. The paper also analyses the phenomenon of flake generation and shows that the feed moisture influences the flake content in the coarser size fractions of the HPGR product. (C) 2012 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2012.09.014

The lower and upper coal seams of the Candiota Coalfield, Brazil - Geological setting, petrological and chemical characterization, and studies on reactivity and beneficiation related to their combustion potential

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INTERNATIONAL JOURNAL OF COAL GEOLOGY, May, 2013, Vol. 111, pp. 53-66

In the Candiota Coalfield, RS, Brazil the Candiota Superior and Inferior coal seams are at current time being mined for power generation. The current study characterizes the other seams of the deposit, which include the upper (S2-S9) seams, the Banco Louco (BL) seam and the lower (I1-I5) seams, which up to date have not been considered for power generation. The analytical techniques applied in this study include: sequence stratigraphic analysis of the coal-bearing interval, petrographical and chemical analyses of the coal seams, reactivity tests based on thermobalance experiments and studies on beneficiation. Sequence stratigraphic analyses: Sedimentological analyses identified four depositional systems in the study area: alluvial fan, fluvial, lagoon-barrier and shallow marine, with coal seams developed in Transgressive Systems Tract, Highstand Systems Tract, and Lowstand Systems Tract. Petrographical and chemical analyses: The petrographical analyses showed that the most abundant maceral in the coals is vitrinite, followed by inertinite and liptinite. The average vitrinite reflectance is indicative of sub-bituminous rank (0.41 % Rr). The values for ash yield range from 29.0 to 74.2 wt.% (average 49.1 wt.%), and for volatile matter contents vary from 13.5 to 29.5 wt.% (average 19.9 wt.%). Sulfur contents range from 0.4 to 8.1 wt.% (average 1.9 wt.%). The gross calorific values, as received basis, range from 841 to 3727 cal/g (average 2632 cal/g). Based on X-ray diffraction analysis the most abundant minerals in the coal seams are quartz, kaolinite, illite and k-feldspar. Reactivity studies: Thermogravimetric analyses carried out on fourteen seam channel samples showed differences in the combustion behavior of the seams, in particular for the inertinite-rich seams S8 and Banco Louco. The I2 seam analyzed from four of the eight exploration wells indicated very similar combustion properties based on the thermogravimetric analyses. Beneficiation tests: From the sink-float tests and proximate and ultimate analyses, washability curves were prepared for all upper, lower and BL seams (>20 cm thick). These curves were plotted showing ash distribution and total sulfur content for a grain-size between 25.4 mm and 2.0 mm (Fraction A, -25.4 +2.0 mm) and for a grain-size between 2.0 mm and 0.1 mm (Fraction B, -2.0 +0.1 mm). These curves provided important information to a possible gravimetric beneficiation for both size fractions. However, the performance of such beneficiation mainly depends on both the Near Gravity Material (NGM)

value and separation density of each seam, which are the main parameters analyzed. In addition, these curves showed low values of total sulfur content in any separation density. However, the densest fractions were not taken into consideration. Conclusion: The results of the chemical and petrological analyses as well as the studies on combustion and beneficiation characteristics suggest that the seams investigated in this study (S1-S9, BL, I1-I5) do have the potential for being used in power generation.
10.1016/j.coal.2012.09.013

A non-invasive technique for sorting of alumina-rich iron ores

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MINERALS ENGINEERING, May, 2013, Vol. 45, pp. 55-58

This paper describes an Infrared (IR) thermography based technique for sorting of iron ores consisting of alumina-rich particles of relatively low thermal absorptivity as compared to iron-rich particles in the ores. The technique primarily consists of selection of iron ores with Fe compositions ranging from 59 to 69 wt.% and alumina (Al2O3) from 0.35 to 8.85 wt.%, crushing the ores up to the particle size range around 10 mm. The iron ore fines are uniformly heated using heat source of wavelength ranging from 10(-2) to 10(-6) m for a period of time sufficient to create a difference in infrared emission between the ore particles. The thermal image of the heated ores is captured by IR thermography. The alumina-rich iron ore particles are heated up less as the thermal absorptivity of these ores is less than the ores with high iron content. Thus, the alumina-rich iron ore particles can be identified by observing the temperature profile and/or thermal image of these ores. This technique of ore recognition can be useful in improving the feed quality of iron ore to the blast furnace in iron and steel industries by rejecting the alumina-rich ores through modification in the presently existing processes. (c) 2013 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2012.12.004

MSL Chemistry and Mineralogy X-ray Diffraction X-ray Fluorescence (CheMin) Instrument

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2013 IEEE AEROSPACE CONFERENCE, MAR 02-09, 2013, Big Sky, MT, IEEE, NEW YORK, May, 2013

This paper provides an overview of the Mars Science Laboratory (MSL) Chemistry and Mineralogy X-ray Diffraction (XRD), X-ray Fluorescence (XRF) (CheMin) Instrument, an element of the landed Curiosity rover payload, which landed on Mars in August of 2012. The scientific goal of the MSL mission is to explore and

quantitatively assess regions in Gale Crater as a potential habitat for life - past or present. The CheMin instrument will receive Martian rock and soil samples from the MSL Sample Acquisition/Sample Processing and Handling (SA/SPaH) system, and process it utilizing X-Ray spectroscopy methods to determine mineral composition. The Chemin instrument will analyze Martian soil and rocks to enable scientists to investigate geophysical processes occurring on Mars. The CheMin science objectives and proposed surface operations are described along with the CheMin hardware with an emphasis on the system engineering challenges associated with developing such a complex instrument.

Adaptation of minerals processing operations for lithium-ion (LiBs) and nickel metal hydride (NiMH) batteries recycling: Critical review

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Production of LiBs and NiMH batteries is expected to increase rapidly due to the soaring price of oil and gas which increases interest in renewable energy as well as the introduction of hybrid vehicles (HVs), and electric vehicles (EVs) which used secondary batteries as an effective energy storage device. Development of an efficient recycling scheme to recover the valuable parts and safely dispose the harmful one at batteries end life is a necessity. The challenge, however, is how to recover all the valuable metals without sacrificing the economics of recycling process. Several LiBs and NiMH batteries recycling processes have been developed in recent years. A review of these processes and their development timeline was presented in this paper. It was found that the major drawback of these recycling processes is the losses of some of batteries valuable parts since these recycling processes are not originally developed for this type of batteries. Also, some of these processes are expensive and designed for specific types of batteries which ignore contamination of recycling stream with impurities and other type of batteries. Using minerals processing operations such as grinding, sieving, magnetic, electrostatic, and gravity separations to liberate batteries electrodal materials and concentrate valuable metals is critical step in any recycling process. This may be due to the simplicity, efficiency, flexibility, and high throughput of these separation processes. The literature showed that applying these processes reduces the volume of LiBs and NiMH scrap, liberates their valuables, reduces the need for leachate purification in hydrometallurgical process, and facilitates the decomposing of battery's electrolyte. Based on these results a flowsheet to recycle mixed stream LiBs, and NiMH battery scrap was proposed.
10.1016/j.mineng.2012.12.005

Effects of sodium carbonate on the carbothermic reduction of siderite ore with high phosphorus content

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MINERALS & METALLURGICAL PROCESSING, May, 2013, Vol. 30(2), pp. 100-107

Siderite ore with high phosphorus content was reduced isothermally at 1,050 degrees C with pulverized coal and different dosages of sodium carbonate. X-ray diffraction (XRD), scanning electron microscopy (S EM) and energy-dispersive analysis of X-rays (EDAX) were used to characterize the samples. The influence of sodium carbonate on the carbothermic reduction process was investigated. Sodium carbonate and its dosage played a considerable role in the carbothermic reduction. The iron particle size in the reduced ore was below 20 mu m, and fayalite was abundant without sodium carbonate additive. With a mass ratio of Na2CO3-to-ore of 5% additive, the iron particle size in the reduced ore was generally above 50 mu m, and the diffraction intensity associated with metallic iron in the XRD pattern increased. The effect of sodium carbonate on the phase transformation of fluorapatite during carbothermic reduction was also addressed via thermodynamic calculations and aqueous leaching experiments. The results showed that the fluorapatite was not reduced to P-2 at 1,050 degrees C, and a portion of the fluorapatite was converted to soluble phosphate. The reduction of siderite can be catalyzed by adding an appropriate amount of sodium carbonate. This catalytic activity was caused by an increase in the reducing reaction activity of FeO and the acceleration of the carbon gasification reactions. The decrease in phosphorous content in the iron concentrate was attributed to an improvement in the separation of the iron phase from the slag phase when sodium carbonate was added and with the formation of soluble phosphate.

Flotation of coal and sulphur from South African ultrafine colliery wastes

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JOURNAL OF THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY, May, 2013, Vol. 113(5), pp. 399-405

Flotation of coal and sulphur from a typical South African ultrafine colliery waste has been achieved in laboratory-scale batch flotation tests, using dodecane, kerosene, and oleic acid as coal collectors, and xanthates to float the sulphide minerals (with the aid of dextrin as a coal depressant). The use of oleic acid as collector, in conjunction with MIBC frother, produced a coal yield Of 56 per cent (much more than was obtained with dodecane or kerosene) at an ash content of 18 per cent, from a feed ash of 34.4 per cent; and a low-sulphur tailings. Sulphide flotation using potassium xanthate (PAX) recovered 26.3 per cent of the total sulphur in the concentrate. Staged addition of xanthate increased the total sulphur recovery to 42.1 per cent and reduced the sulphur content of the tailing further.

Preliminary studies on teeter bed separator for separation of manganese fines

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POWDER TECHNOLOGY, May, 2013, Vol. 239, pp. 284-289

Teeter bed separators are widely used in different mineral and coal industries for separation at different stages. The teeter bed separator works based on the principles of fluidization and hindered settling. However, the published literature on this separator doesn't demonstrate its use in the separation of mineral fines. In the present article, an attempt has been made to characterize the teeter bed separator (Floatex Density Separator) with respect to its performance at different conditions of operating variables, while treating manganese fines. Also regression models were developed based on statistical design of experiments to quantify the effect of key operating variables on the performance of the separator. The characterization of teeter bed inside the floatex density separator was also analyzed to identify the particle separation behavior while treating manganese fines.
10.1016/j.powtec.2013.02.015

Chemical Leaching of High-Ash Indian Coals for Production of Low-Ash Clean Coal

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MINERAL PROCESSING AND EXTRACTIVE METALLURGY REVIEW, Jun, 2013, Vol. 34(4), pp. 223-239

It is difficult to reduce the ash content in Indian coals below a certain level by conventional physical beneficiation techniques due to their poor washability characteristics. In the present work, the effect of aqueous alkali leaching at elevated temperature, followed by acid washing on the removal of mineral matter, was evaluated for different captive coals of Tata Steel. The research study revealed that the ash content of all these coals could be reduced by more than 50% using this method. The degree of demineralization improved by increasing the reaction time, alkali concentration, and temperature, and by reducing the coal particle size. No significant change was observed in the alkali content, whereas silica, alumina, and phosphorous content reduced significantly after the final acid treatment. The mechanism of demineralization was evaluated by analyzing the coal samples before and after the alkali and acid treatments using X-ray diffraction (XRD) techniques. Overall, this study provides an insight into possible alternative methods of beneficiation for removal of ash from physically beneficiated high-ash Indian coals.
10.1080/08827508.2012.656775

Copper ore density separations by float/sink in a dry sand fluidised bed dense medium

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INTERNATIONAL JOURNAL OF MINERAL PROCESSING, Jun, 2013, Vol. 121, pp. 12-20

Two types of copper ore have been separated based on density by float/sink in a dry sand fluidised bed dense medium. This is the first report of dry separation of lump copper ores using a dry sand fluidised bed dense medium. The separation point density and the separation efficiency, characterised by the probable error, can be controlled by changing the amount of different density sand particles in the medium mixture and the fluidisation air velocity. It has been shown that separation point densities between about 2200 and 3700 kg/m(3) with probable errors typically in the range of 0.01 to 0.06 can be obtained. Ores with particles in the size range of between about 10 and 25 mm can be treated. Depending on the ore mass-density distribution and copper-density distribution, between about 20 to more than 40% of the low density ore could potentially be rejected prior to wet grinding with little loss of valuable copper. This would significantly reduce the amount of energy and water required for wet grinding and down stream processing such as flotation. 10.1016/j.minpro.2013.02.008

Physical analysis and modeling of the Falcon concentrator for beneficiation of ultrafine particles

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A predictive model of the Falcon enhanced gravity separator has been derived from a physical analysis of its separation principle, and validated against experimental data. After summarizing the previous works that led to this model and the hypotheses on which they rely, the model is extended to cover a wide range of operating conditions and particle properties. The most significant development presented here is the extension of the analytical law to concentrated suspensions, which makes it applicable to actual plant operating conditions. Two examples of industrial use cases are described and studied by interrogation of the model: dredged sediment waste reduction and coal recovery from fine tailings. Comparisons with empirical studies available in the literature show a good agreement between model predictions and industrial data. The model is then used to identify separation efficiency limitations as well as possible solutions to overcome them. These two examples serve to show how this predictive model can be used to obtain valuable information to improve physical separation processes using a Falcon concentrator, or to evaluate Falcon separator's abilities for new applications.
10.1016/j.minpro.2013.02.009

Pre-concentration of vanadium from stone coal by gravity separation

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INTERNATIONAL JOURNAL OF MINERAL PROCESSING, Jun, 2013, Vol. 121, pp. 1-5

In China, more than 87% of vanadium is discovered from stone coal. However, because the vanadium grade in stone coal is generally low, current vanadium extraction technology faces challenges in terms of large ore tonnage and high energy consumption, acid consumption and cost. A new process for pre-concentration of vanadium from stone coal by gravity separation was investigated based on mineralogical study. It was confirmed that the vanadium occurred in muscovite and illite, and the acid consuming minerals were pyrite and calcite. The process comprised three key steps: decarburization, selective grinding and gravity separation. In the decarburization stage, the thermal energy of carbon in the stone coal can be used and the V2O5 grade increased to some extent. The differences of V2O5 grade among different size fractions increased through the selective grinding stage. In the gravity separation stage, 28.9% of the feed ore were rejected as final tailings, while the V2O5 loss was 9.7%. The pre-concentration of vanadium from stone coal can improve the V2O5 grade and decrease the content of high acid consuming minerals. The benefits of the pre-concentration process in terms of cost savings and solving processing problems were discussed. 10.1016/j.minpro.2013.02.014

Dry stacking of wastewater treatment sludges

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WATER RESEARCH, Jun, 2013, Vol. 47(10), pp. 3534-3542

Drying pans are used during wastewater treatment (WWT) to store, stabilise and dry residual solids. The pans are filled with sludge that dries via exposure to sunshine and wind. We propose that drying pans be operated based on dry stacking principles, a technique with proven success in the mineral processing industry. The implementation of the dry stacking technique requires very little in the way of additional engineering beyond a conventional drying pan. By applying the sludge in thin layers, the sludge naturally forms its own stack with an angle that is dependent on the consistency of the material. The benefits of dry stacking are that the slope allows instantaneous run-off of rainfall and supernatant, allowing operation throughout the year rather than seasonally. The layering approach also maximises the evaporation achieved in the available deposition area compared to filling the pans sequentially. A series of laboratory tests were carried out on samples from Melbourne Water's Western Treatment Plant in Werribee, Australia, to provide validation of the dry stacking concept for WWT sludges. Rheological tests showed that samples had appropriate flow properties to form stacks. Drying and re-wetting tests on the samples indicated that a sloped, partially dry sludge sheds rainfall, depending on the slope, cake dryness and amount of rainfall. Local rainfall data was used to estimate a potential increase in pan throughput of 65%-140% due to dry stacking. The greatest improvements were predicted to occur during wetter years. In combination, the results indicated that dry stacking has the potential to dramatically improve the performance of WWT sludge drying pans. 10.1016/j.watres.2013.04.002

A method to predict shape and trajectory of charge in industrial mills

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Charge motion is of prime importance in the efficiency of comminution in tumbling mills. Since direct observation of charge shape and its motion in industrial mills are not possible, a combination of analytical and physical studies was used to determine charge trajectory. Software packages, which predict charge motion such as the GMT (Grinding Media Trajectory) only consider the outermost layer of charge (single ball) and ignore the charge and the interactions of grinding elements. In this research, the charge trajectory measured in a laboratory mill (model mill) with the diameter of 100 cm and length of 21.5 cm with the transparent end was compared with that of the GMT. Three types of polyurethane rings were accurately machined to scale down the liners arrangements at two industrial mills. To explore various charge shapes and trajectories, the model mills were operated at 55%, 70% and 85% of critical speed for five levels of mill filling (10%, 15%, 20%, 25% and 30% by volume). The special design of the model mill which enabled gradual increase of the mill length so as to minimize the impact of the end-wall effect. The experiments indicated that the ends wall effect was negligible for the model mill with the length of 10.8 cm and beyond. The proposed relationships to correct the trajectory and charge shape obtained by the GMT were validated by using the new liner of the Gol-E-Gohar iron ore company AG mill. The average relative error of prediction was found to be 1%. The results indicated that when the lifter face angle increased from 7 degrees to 30, the distance between the charge impact point and the toe decreased from 40.1 degrees to 11.2 degrees for 30% filling. This meant increasing the probability of charge impacting the toe not the liner which favoured more efficient comminution practice. After converting AG mills to SAG mills on the account of liner profile change, 31% increase in throughput (from 419 to 548 t/h) in addition to 4% decrease in the product size (from 516 to 496 pm) were realized which was a significant contribution to the plant performance improvement. 10.1016/j.mineng.2013.04.013

Amenability for processing of oolitic iron ore concentrate for phosphorus removal

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Beneficiation routes aimed at dephosphorisation of oolitic gravity magnetic concentrate and involving a combination of roasting, re-grinding, magnetic separation and water and acid leaching are investigated. Roasting was carried out at 900 degrees C for 1 h without or with lime or sodium hydroxide as roasting additives. When additives were used, cement phases of Si-Al-Na-Ca-O type were

detected as well as the mineral giuseppettite. During the thermal process sodium silicate is liquefied and the newly formed phases coat the oolites and penetrate inside the cracks. Energy Dispersive Spectroscopy analysis has indicated that the zone surrounding the oolites consists of Na, Al and Si phases with part of phosphorus being captured there. As a result of the alkaline roasting, goethite is partly transformed to magnetite and this reduction is reinforced with an increase in sodium hydroxide dosage. Investigation of redistribution of phosphorous shows that it could be only partly separated if leaching is not accompanied by re-grinding and physical separation. The recommended dosage of the reductive agent for the final flowsheet is 8 mass% ratio to concentrate. Grinding to a mean size of 0.040 mm, with water and acid leaching and double magnetic separation creates conditions to obtain a high-quality iron concentrate with 65.97% Fe and recovery of 92.43%, with simultaneous decrease in the phosphorus content from 0.71% to 0.05%. 10.1016/j.mineng.2013.03.028

Biological degradation and solubilisation of coal

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BIODEGRADATION, Jun, 2013, Vol. 24(3), pp. 305-318

This review focuses on ligninolytic fungi, soil bacteria, plants and root exudates in the degradation and solubilisation of low grade and waste coal and the interaction between these mutualistic biocatalysts. Coal represents a considerable portion of the total global fossil fuel reserve and continued demand for, and supply of this resource generates vast quantities of spoil and low grade waste. Large scale bioremediation technologies for the beneficiation of waste coal have unfortunately not yet been realised despite the many discoveries of microorganisms capable of lignite, lignin, and humic acid breakdown. Even so, solubilisation and depolymerization of low grade coal appears to involve either ligninolytic enzyme action or the production of alkaline substances or both. While the precise mechanism of coal biosolubilisation is unclear, a model for the phyto-biodegradation of low rank coal by mutualistic interaction between ligninolytic microorganisms and higher plants is proposed. Based on accumulated evidence this model suggests that solubilisation and degradation of lignite and waste coals commences upon plant root exudate and ligninolytic microorganism interaction, which is mutualistic, and includes soil bacteria and both mycorrhizal and non-mycorrhizal fungi. It is envisaged that this model and its further elaboration will aid in the development of functional technologies for commercial bioremediation of coal mine spoils, contribute to soil formation, and the overall biogeochemistry of organic carbon in the global ecosystem. 10.1007/s10532-012-9594-1

DEM validation of media shape effects on the load behaviour and power in a dry pilot mill

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Simulations were carried out in Metso's DEM simulator so as to draw tip an understanding of the effects the various ways of defining media shapes within the simulator have on the load behaviour and mill power draw. Wits University made available the load behaviour and mill power draw experimental results for the spherical balls, worn balls and cylpebs so as to validate the DEM simulations. The spherical media were defined by a regular spherical shape model and a multi-faceted polyhedron model. Worn balls were defined by super quadric models. A comparison was made between spherical media shapes, non-spherical single media shapes and a distribution of non-spherical media shapes and sizes in representing a load comprised of worn balls. The effect of increasing angularity of non-spherical media shapes on mill power was investigated. The cylpebs were modelled using a regular cylindrical shape model and the effects of friction on the power drawn were determined.
10.1016/j.mineng.2013.03.025

Energy recovery potential in comminution processes

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Comminution processes are cited as having an efficiency of less than 1%. Even if the efficiency of these processes could be increased to 5% as is suggested to be possible, the conclusion would remain that cornminution processes are very inefficient with some 95% of the input energy lost to the environment as heat. This is an interesting observation as one could suggest that, although comminution systems are very inefficient in producing new surface energy, they should be very efficient in producing heat. On the other hand, high efficiency in generating heat might be off-set by a limit on the energy that can be recovered. In this paper, four issues will be addressed: heat generated in comminution, potential energy recovery, different means to increase energy recovery in comminution processes and avenues to possible implementation. It will close with a discussion of a number of issues surrounding energy recovery in comminution processes. 10.1016/j.mineng.2012.12.002

Image based modeling of rock fragmentation

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In the mineral extraction industry, comminution modeling is not only interested in maximum rock strength, but also, or much more, in the energy required to induce rock fracture and, most significantly, into the effect of energy application on the produced rock fragments size distribution. An additional aspect of rock breakage,

specific to the mineral extraction industry, is the modeling of liberation of particular mineral grains from the host rock matrix. These aspects of rock behavior make comminution modeling a unique field of rock mechanics. From a traditional engineering point of view (mining and civil), rock samples are considered to be homogenous. Although the mechanical properties of individual minerals can vary significantly, the properties of the minerals and of the mineral boundaries interact randomly enough to assume that in the size of rock samples mechanical properties can be considered homogenous. However, from a comminution point of view, heterogeneity caused by a difference in the properties of minerals are crucial and therefore rock material, even in the scale of a few centimeters, should be considered as heterogeneous. The comminution response of such rock will be influenced by the textural parameters of the rock as well as mechanical properties of constitutive mineral grains. Image based numerical modeling is a useful tool for investigation of the pattern and dynamics of the rock breakage process. Its usefulness rests on the fact that a difficult step of building a faithful model of rock texture and composition, as a pre-requisite for modeling of rock breakage, is removed. Numerical modeling based on the use of classified digital image of the rock surface, could be particularly effective in the mineral extraction industry, where one of the key objectives is liberation of specific minerals, by providing inside view of mechanisms that are responsible for liberation of valuable minerals embedded into specific ore matrix. 10.1016/j.mineng.2013.03.002

Mineralization induction effects of osteopontin, bone sialoprotein, and dentin phosphoprotein on a biomimetic collagen substrate

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JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A, Jun, 2013, Vol. 101A(6), pp. 1571-1581

Native bone tissue is composed of a matrix of collagen, noncollagenous proteins, and calcium phosphate minerals, which are primarily hydroxyapatite. The SIBLING (small integrin-binding ligand, N-linked glycoprotein) family of proteins is the primary noncollagenous protein group found in mineralized tissues. In this work, the mineralization induction capabilities of three of the SIBLING members, bone sialoprotein (BSP), osteopontin (OPN), and the calcium-binding subdomain of dentin sialophosphoprotein, dentin phosphoprotein (DPP), are directly compared on a biomimetic collagen substrate. A self-assembled, loosely aligned collagen fibril substrate was prepared, and then 125I-radiolabeled adsorption isotherms were developed for BSP, OPN, and DPP. The results showed that BSP exhibited the highest binding capacity for collagen at lower concentrations, followed by DPP and OPN. However, at the highest concentrations, all three proteins had similar adsorption levels. The adsorption isotherms were then used to identify conditions that resulted in identical amounts of adsorbed protein. These substrates were prepared and placed in simulated body fluid for 5, 10, and 24 h at 37 degrees C. The resulting mineral morphology was assessed by atomic force microscopy, and the composition

was determined using photochemical assays. Mineralization was seen in the presence of all the proteins. However, DPP was seen to be the only protein that formed individual mineral nodules similar to those seen in developing bone. This suggests that DPP plays a significant role in the biomineralization process and that the incorporation of DPP into tissue engineering constructs may facilitate the induction of biomimetic mineral formation. (c) 2012 Wiley Periodicals, Inc. J Biomed Mater Res Part A, 2013. 10.1002/jbm.a.34462

The influence of equipment settings and rock properties on high voltage breakage

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High voltage breakage is a novel comminution method that relies on highly energetic electrical pulses to weaken or fully fragment rocks. The potential of this technology to improve liberation and increase the grindability of ores has been demonstrated previously, but the fragmentation process is not fully understood. In this study a total of 20 rock types were treated in a SELFRAG Lab device to determine the influence of equipment parameters on breakage. Rock mass properties and Bond Work Index were determined for each rock type to identify their relation to breakage behaviour. Results show how, by influencing total applied energy, the number of discharges and voltage are the two major influences on the resultant product size. It has also been shown that coarser feed sizes are more amenable to high voltage breakage. Acoustic impedance, porosity and quartz content were found to relate to breakage but Bond Work Index only correlates loosely. (C) 2013 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2013.02.008

From Science Direct

Yang Qu, Bin Lian, Binbin Mo, Congqiang Liu, Bioleaching of heavy metals from red mud using Aspergillus niger, Hydrometallurgy, Volume 136, April 2013, Pages 71-77, http://dx.doi.org/10.1016/j.hydromet.2013.03.006.

(http://www.sciencedirect.com/science/article/pii/S0304386X1300073X)

Abstract: Red mud (bauxite residue) is the main waste product of the alkaline extraction of alumina from bauxite with high amounts of metals. In this study, bioleaching of heavy metals from red mud by using the fungus Aspergillus niger was investigated. Bioleaching experiments were examined in batch cultures with the red mud at various pulp densities (1–5%, w/v) under various bioleaching conditions (one-step, two-step and spent medium bioleaching). It was shown that the main lixiviant excreted by A. niger was citric acid. The highest leaching ratios of most

various heavy metals were achieved under spent medium leaching at 1% pulp density. The increase in red mud pulp densities resulted in a general decrease in leaching ratios under all bioleaching conditions. However, in the case of the spent medium leaching the decrease in leaching ratios was lowest. The Toxicity Characteristic Leaching Procedure (TCLP) tests showed that the leaching toxicity of the bioleaching residue was far below the levels of relevant regulations. The micromorphology of the red mud particles were changed by the fungal activity during bioleaching process.

Keywords: Red mud; Bioleaching; Heavy metals; Aspergillus niger

Daniel Saramak, Rolf Arne Kleiv, The effect of feed moisture on the comminution efficiency of HPGR circuits, Minerals Engineering, Volumes 43–44, April 2013, Pages 105-111, http://dx.doi.org/10.1016/j.mineng.2012.09.014.

(http://www.sciencedirect.com/science/article/pii/S0892687512003226)

Abstract: The comminution efficiency of high-pressure-grinding-rolls (HPGRs) is a well described function of a number of feed parameters including grindability, abrasion index, granulometric composition, top size and particle size distribution. Far less studied is the effect of feed moisture. This paper investigates both the overall and the specific comminution efficiency of a circuit consisting of a pilot HPGR unit followed by a batch ball mill as a function of the moisture level in the HPGR feed. Forsterite olivine sand (−7 mm) supplied by Sibelco Nordic was used as feed material. The results showed that the relationship between moisture and crushing efficiency for both the HPGR and the circuit can be described successfully by means of a parabolic function. Dry material, as well as that with the highest moisture content, showed the lowest particle size reduction ratios irrespective of the specific grinding force level. The paper also analyses the phenomenon of flake generation and shows that the feed moisture influences the flake content in the coarser size fractions of the HPGR product.

Keywords: Comminution; Industrial minerals; HPGR

T.S. Sverak, C.G.J. Baker, O. Kozdas, Efficiency of grinding stabilizers in cement clinker processing, Minerals Engineering, Volumes 43–44, April 2013, Pages 52-57, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.08.012.

(http://www.sciencedirect.com/science/article/pii/S0892687512002828)

Abstract: Stabilizers are commonly used in the production of very finely ground particulate materials. Doping with such additives is an absolutely essential process step in the production of ultra-fine and nano-fine solids; in all cases, the additives work as inhibitors that prevent the re-agglomeration of fine particles. Such additives, which are well known in both dry grinding and wet grinding processes, help to decrease the enormous energy consumption of cement production. This paper describes the essential features of stabilizers used in Portland clinker grinding

processes. The results of milling experiments employing twelve commercially used and experimental additives are described. Their effectiveness in producing ultrafine (0–30 μm) particles varied widely. Novel acrylate-based grinding stabilizers showed considerable promise for the production of very fine cement clinkers.

Keywords: Grinding stabilizers; Very fine grinding; Ball mill; Grinding aids; Cement clinker grinding

Gauti Asbjörnsson, Erik Hulthén, Magnus Evertsson, Modelling and simulation of dynamic crushing plant behavior with MATLAB/Simulink, Minerals Engineering, Volumes 43–44, April 2013, Pages 112-120, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.09.006.

(http://www.sciencedirect.com/science/article/pii/S0892687512003044)

Abstract: Every process is subjected to changes in performance and efficiency over time. These dynamics can originate upstream and be inherent through the process or occur anywhere in the downstream process. Traditional plant simulations are performed with steady-state simulation, which are limited to give the performance in an ideal situation. However, plant performance usually tends to deviate away from the predicted plant performance. These dynamics are usually consequences of an altered state of the plant due to factors such as natural variation, unmatched, inappropriate or degrading equipment performance and/or stochastic events. This paper presents a novel approach for simulating dynamic plant behavior and evaluating effects from process modification through dynamic simulations with MATLAB/Simulink. An example of an existing crushing circuit is used to illustrate the functionality and the advantage of using a dynamic simulator. The results and knowledge gained from the simulation can provide a base for optimizing a robust production output in the form optimal utilization, energy efficiency or higher product quality.

Keywords: Modelling; Simulation; Ore handling; Crushing; Screening

Sudarshan Martins, Wei Li, Peter Radziszewski, Arnaud Faucher, Sami Makni, Experimental and simulated instrumented ball in a tumbling mill—A comparison, Minerals Engineering, Volumes 43–44, April 2013, Pages 79-84, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.09.002.

(http://www.sciencedirect.com/science/article/pii/S0892687512003007)

Abstract: Tumbling mills play an essential role in modern mineral processing. Because of the nature of the mill, the internal forces make instrumentation of the mill interior difficult. One solution to this problem is the use of an instrumented ball. An instrumented ball, equipped with an accelerometer, rotation rate sensors and a temperature sensor has been built. The instrumented ball and a camera system are used to measure the state of the charge within a laboratory mill. In parallel, a discrete element model (DEM) of the laboratory mill is developed. Using the

distributions and moments of the energy terms of the charge, the simulation and experimental results are analyzed and compared. The moments are used to tune the DEM, such that the simulation results are in agreement with the experimental results. The comparison also identifies which aspects require further improvement.

Y. Ghorbani, A.N. Mainza, J. Petersen, M. Becker, J-P. Franzidis, J.T. Kalala, Investigation of particles with high crack density produced by HPGR and its effect on the redistribution of the particle size fraction in heaps, Minerals Engineering, Volumes 43–44, April 2013, Pages 44-51, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.08.010.

(http://www.sciencedirect.com/science/article/pii/S0892687512002804)

Abstract: The application of comminution technology such as the high-pressure grinding rolls (HPGRs), which is able to generate a high density of cracks in the ore particles, is favourable for leaching processes. Extraction of metallic values by the heap leach process, can take place on the particles with partial exposure of mineral grains, if it can provide sufficient surface front for chemical attack by leaching solution. The aim of this study was to assess the benefits of high crack density in the ore particles produced using the HPGR and how it could diminish due to inadequate percolation of the leaching agent. A zinc ore was comminuted using HPGR at three different pressure settings and with a cone crusher for the control experiment. Subsamples from the (+23/−25, +14/−16, +5.25/−6.75 mm) size fractions were characterized and packed into leach reactors. The reactors were stopped from time to time to investigate the progress of crack and micro-crack growth and its effect on metal extraction using the X-ray computed tomography (CT). The results are validated with those obtained using traditional techniques such as SEM and QEMSCAN. Investigation of the leach reactors residue indicated significant changes in the particle size distribution (PSD) of initial feed toward the fine size fraction. The residues from the reactors leaching the material prepared using the HPGR product contained more fine particles than the reactors, which were fed by cone crusher product. These differences were up to 10.3%.

Keywords: Heap leaching; High-pressure grinding rolls (HPGRs); Crack density; X-ray computed tomography (CT)

Liwen Ma, Zuoren Nie, Xiaoli Xi, Xin'gang Han, Cobalt recovery from cobalt-bearing waste in sulphuric and citric acid systems, Hydrometallurgy, Volume 136, April 2013, Pages 1-7, http://dx.doi.org/10.1016/j.hydromet.2013.01.016.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000194)

Abstract: Sulphuric and citric acid systems were used to recover Co from cobalt-bearing waste in this paper. The cobalt-bearing waste was leached sufficiently with the Co leaching efficiency over 99% in both systems, but the leaching efficiency of other metals Fe, Mn and Cu was lower in citric acid (H3Cit) system. The

thermodynamic simulation showed that the complexing effect of citric acid changes the precipitation property of different metal ions, which makes them more difficult to be separated by precipitation in H3Cit system than in H2SO4 system. Thus, the impurities in H2SO4 system were removed by pre-precipitation of Fe at pH 3.5 followed by solvent extraction; while the impurities in H3Cit system were removed by direct extraction. In H2SO4 system, 96.2% Mn, 95.4% Fe and 93.2% Cu were removed by D2EHPA extraction at pH 3 with the cobalt loss over 30%; while in H3Cit system, 92.0% Mn, 73.7% Fe and 25.4% Cu were extracted at lower pH of 1.5 with the cobalt loss of 18.8%. Finally Co(OH)2 and crude CoFe2O4 were obtained from H2SO4 system and H3Cit system, respectively.

Keywords: Cobalt-bearing waste; Metal separation; Cobalt recovery

Jianming Lu, David Dreisinger, Solvent extraction of copper from chloride solution I: Extraction isotherms, Hydrometallurgy, Volume 137, May 2013, Pages 13-17, http://dx.doi.org/10.1016/j.hydromet.2013.04.001.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000819)

Abstract: This study was conducted as part of the development of a novel process for copper recovery from chalcopyrite by chloride leaching, simultaneous cuprous oxidation and cupric solvent extraction to transfer copper to a conventional sulfate electrowinning circuit, and hematite precipitation to reject iron. Copper solvent extraction from chloride solution has been studied using four LIX® extractants (LIX84-I, LIX612N-LV, XI-04003 and LIX984N) from BASF with respect to copper extraction as a function of pH and A/O ratio, and behavior of the impurities. At a pH below 0.5, the copper extraction increased quickly with increasing pH while at a pH above 0.5, it increased only slightly with pH. The copper extraction in organic solution was virtually not affected by the impurities. The iron extraction in organic solution increased with decreasing A/O ratio from 2:1 to 1:8 as the copper extraction decreased. Conversely, the Cu/Fe ratio in organic solution increased as copper extraction increased. The extractions of silver and lead were 1 mg/L or lower under all conditions tested. The other impurities (Zn, Ni, Cd, Cr, Hg, As and Sb) were virtually not loaded into the organic solution. The optimum copper solvent extraction conditions in chloride solution were proposed.

Keywords: Copper; Chloride solution; Solvent extraction; Extraction isotherm

Jinping Liu, Weihua Gui, Zhaohui Tang, Chunhua Yang, Jianyong Zhu, Jianqi Li, Recognition of the operational statuses of reagent addition using dynamic bubble size distribution in copper flotation process, Minerals Engineering, Vol. 45, May 2013, Pages 128-141, http://dx.doi.org/10.1016/j.mineng.2013.02.003.

(http://www.sciencedirect.com/science/article/pii/S0892687513000460)

Abstract: The output PDF (probability density function) shape of surface bubble size in froth flotation is believed to be closely related to the operational statuses of

reagent additions. An online operational status recognition method for quality evaluation of reagent addition is presented based on adaptive learning of the dynamic distribution features of the surface bubble size. We avoid the bubble over-segmentation problem by exploring an improved image segmentation algorithm to get the accurate bubble size statistics taking account of the local regional distribution of the image brightness value. By utilizing the kernel density estimation, we obtain the PDF and CDF (cumulative distribution function) of the bubble size statistics effectively. The distribution features of the bubble size statistics under the PDROS (pre-defined reagent operation statuses) are learned by FNC (furthest neighbor clustering), successively, the current health status of the reagent addition in the test time period is inferred by Bayesian inference according to the dynamic change of the bubble size PDFs; what is more, the statistical distribution features under PDROS are updated online according to the disturbance of the process operation conditions. This status recognition method is tested and practically applied in a copper ore beneficiation plant. The experimental results on the real production data demonstrate that this method outperforms other quasi machine vision based production condition recognition methods with much lower error recognition rate. It paves the way for the realization of an optimal control and fault diagnosis for reagent addition in the flotation process operation.

Keywords: Froth image; Dynamic statistical distribution of bubble size; Kernel density estimation; Furthest neighbor clustering

Janusz S. Laskowski, From amine molecules adsorption to amine precipitate transport by bubbles: A potash ore flotation mechanism, Minerals Engineering, Volume 45, May 2013, Pages 170-179, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.02.010.

(http://www.sciencedirect.com/science/article/pii/S0892687513000678)

Abstract: Recent investigations summarized in this review have been conveniently grouped into (i) those dealing with the mechanism of action of the reagents applied in the flotation of potash ores, and (ii) those focused on the flotation properties of salt-type minerals and explanation of the remarkable selectivity between floatable sylvite, and non-floatable halite. This paper is confined to the first group. It is argued that in discussing the mode of action of long-chain primary amines in the flotation of potash ores account must be taken of the way in which these amines are applied by industry. Because they are water insoluble they are melted by heating up to 70–90 °C and then they are dispersed in acidified aqueous solution. Once added to the flotation pulp, the hot amine dispersion rapidly cools down to a temperature far below the Krafft point. The rapid conversion from a hot emulsion to a cold precipitate is a very severe transformation. Since nothing is known about the kinetics of these changes and phase instability only the lab tests in which the adopted reagent preparation procedures closely follow the industrial practice have been considered in this review.

Keywords: Sylvite; Potash ore; Flotation; Potash ore flotation; Amines; Precipitation

Seher Ata, Graeme J. Jameson, Recovery of coarse particles in the froth phase – A case study, Minerals Engineering, Volume 45, May 2013, Pages 121-127, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.02.006.

(http://www.sciencedirect.com/science/article/pii/S0892687513000630)

Abstract: This study explores the role of the froth phase in the collection of particles that are introduced into the froth layer in a flotation cell. A bench-scale flotation cell was tested at an operating concentrator, using a feed taken directly from the plant. The equipment was constructed so that dropback from the froth phase was separated from the pulp phase. A stream taken from the plant cleaner feed was floated in the apparatus, thus creating a stable froth layer. A separate sample was taken from the feed to the plant rougher cells, and added directly into the froth layer in the experimental apparatus. The performance of the test cell was evaluated, in terms of the copper grade and recovery on a size-by-size basis. The experimental variables were the superficial gas velocity, the froth depth and the location of the feed distributor relative to the overflow lip of the test cell. The results show that the froth is an effective medium for the recovery of coarse particles that are poorly recovered in conventional flotation cells. This was especially evident when the particles were just introduced below the froth surface.

Keywords: Froth flotation; Froth; Coarse particle; Particle processing

Wenbo Zhou, Josue Moreno, Roberto Torres, Hector Valle, Shaoxian Song, Flotation of fluorite from ores by using acidized water glass as depressant, Minerals Engineering, Volume 45, May 2013, Pages 142-145, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.02.017.

(http://www.sciencedirect.com/science/article/pii/S0892687513000745)

Abstract: The flotation of fluorite from ores by using acidized water glass (AWG) as depressant has been studied for the substitution of the commonly used depressant (soda ash plus sodium lignosulfonate). The experimental results have shown that the flotation with AWG could considerably improve the sedimentation rate of fine particles in tailing slurry and thus produce cleaner recycled water, compared with the actual depressant. Also, it improved fluorite recovery and flotation rate. In addition, it has been found that AWG could achieve higher selectivity between fluorite and gangue minerals (carbonate and silicate minerals) in fluorite flotation.

Keywords: Froth flotation; Nonmetallic ores; Flotation depressants

Arpita Ghosh, B. Nayak, T.K. Das, S. Palit Sagar, A non-invasive technique for sorting of alumina-rich iron ores, Minerals Engineering, Volume 45, May 2013, Pages 55-58, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.12.004.

(http://www.sciencedirect.com/science/article/pii/S0892687512003986)

Abstract: This paper describes an Infrared (IR) thermography based technique for sorting of iron ores consisting of alumina-rich particles of relatively low thermal absorptivity as compared to iron-rich particles in the ores. The technique primarily consists of selection of iron ores with Fe compositions ranging from 59 to 69 wt.% and alumina (Al_2O_3) from 0.35 to 8.85 wt.%, crushing the ores up to the particle size range around 10 mm. The iron ore fines are uniformly heated using heat source of wavelength ranging from 10^{-2} to 10^{-6} m for a period of time sufficient to create a difference in infrared emission between the ore particles. The thermal image of the heated ores is captured by IR thermography. The alumina-rich iron ore particles are heated up less as the thermal absorptivity of these ores is less than the ores with high iron content. Thus, the alumina-rich iron ore particles can be identified by observing the temperature profile and/or thermal image of these ores. This technique of ore recognition can be useful in improving the feed quality of iron ore to the blast furnace in iron and steel industries by rejecting the alumina-rich ores through modification in the presently existing processes.

Keywords: IR thermography; Iron ore; Beneficiation; Ore sorting; Thermal absorptivity

Wenqing Qin, Kai Liu, Mengxue Diao, Jun Wang, Yansheng Zhang, Congren Yang, Fen Jiao, Oxidation of arsenite (As(III)) by ferric iron in the presence of pyrite and a mixed moderately thermophilic culture, Hydrometallurgy, Vol. 137, May 2013, PP. 53-59, http://dx.doi.org/10.1016/j.hydromet.2013.05.011.

(http://www.sciencedirect.com/science/article/pii/S0304386X13001023)

Abstract: The oxidation of As(III) by Fe^{3+} in the presence of pyrite and a mixed moderately thermophilic culture with high As(III)-resistance was investigated under various conditions. The oxidation of As(III) took place on the pyrite surface, and in the presence of excessive Fe^{3+} the reaction could be classified as a zero-order reaction or a first-order reaction, which depended on whether or not the catalytic sites on the pyrite surface were saturated by As(III). The rate constant of the first-order reaction, 0.0214 h^{-1}, was calculated from the experimental data, and the rate constant of zero-order reaction was correlated to the pulp density of pyrite. A simple model was built to model the change of As(III) concentration during the biooxidation of arsenic bearing gold concentrates. The model showed that when the content of As in the concentrate was less than 11.4% (w/v) and that of pyrite was more than 60%, the As(III) level in the solution did not significantly increase over time.

Keywords: Arsenite; Biooxidation; Pyrite; Arsenic-bearing gold concentrate; Moderate thermophiles

Jared L. Deutsch, David B. Dreisinger, Silver sulfide leaching with thiosulfate in the presence of additives Part II: Ferric complexes and the application to

silver sulfide ore, Hydrometallurgy, Volume 137, May 2013, Pages 165-172, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.03.013.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000807)

Abstract: Ferric complex alternatives to the cupric–ammonia catalyzed thiosulfate system including ferric–EDTA, ferric–oxalate and ferric–citrate were studied with a silver sulfide rotating disk. Of these complexes, ferric–EDTA and ferric–oxalate were the most promising alternatives. All ferric complexes tested were unreactive towards thiosulfate, but are reduced by sulfides present in the ore. When leaching a silver sulfide ore, the most effective lixiviants were ferric–EDTA and the cupric–ammonia thiosulfate systems. None of the thiosulfate alternatives were able to recover as much silver as cyanide leaching, likely due to the presence of other silver minerals which may not be amenable to thiosulfate leaching. Although less silver was recovered, less than 1% of mercury in the ore was leached by thiosulfate complexes compared to 50% mercury recovery by cyanide.

Keywords: Thiosulfate; Silver sulfide; Leaching; Ferric complexes; Cupric–ammonia

Siska L.A. Valcke, Angelo J. Sarabèr, Penny Pipilikaki, Hartmut R. Fischer, Henk W. Nugteren, Screening coal combustion fly ashes for application in geopolymers, Fuel, Volume 106, April 2013, Pages 490-497, ISSN 0016-2361, http://dx.doi.org/10.1016/j.fuel.2012.12.070.

(http://www.sciencedirect.com/science/article/pii/S0016236112010940)

Abstract: Driven by cost and sustainability, secondary resource materials such as fly ash, blast furnace slag, and bottom ash are increasingly used for alternative types of concrete binders, such as geopolymers. Because secondary resources may be highly variable from the perspective of geopolymers, it is often a challenge to upscale these binder types to an industrial scale. This paper describes the testing of a screening method – feature sizing and chemical typing (FS&CT) using an electron microscope – in order to capture the heterogeneity of secondary resources in a quantitative manner. This automated technique is able to simultaneously measure inter particle variations in chemistry (energy dispersive X-ray spectra) and size (shape). Two key variables for application in geopolymers, Si:Al ratio and size, are measured using FS&CT for coal combustion fly ash and its fraction of potentially reactive aluminium-silicate particles. These measurements have been preliminary related to the reactivity of the fly ash in NaOH-solutions with high liquid/solid ratios as well as low liquid/solid ratios (geopolymers). As such the FS&CT method is found to be a useful alternative to commonly used bulk methods such as X-ray fluorescence (XRF) or manually operated electron microscopy that gives just an indication of local heterogeneity.

Keywords: Fly ash; Reactivity; Binder; Geopolymer; Feature sizing and chemical typing

R.F. van Schalkwyk, J.J. Eksteen, G. Akdogan, Leaching of Ni–Cu–Fe–S converter matte at varying iron endpoints; mineralogical changes and behaviour of Ir, Rh and Ru, Hydrometallurgy, Volume 136, April 2013, Pages 36-45, http://dx.doi.org/10.1016/j.hydromet.2013.02.008.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000455)

Abstract: The Bushveld Igneous Complex in South Africa is a rich source of platinum group elements (PGEs), as well as base metal sulphides. Typical beneficiation routes entail milling and flotation, smelting, matte converting and hydrometallurgical processing of converter matte to selectively recover metal values. The primary focus is on PGE recovery, with the secondary objective of base metals recovery. At the Western Platinum Pty. Ltd. Base Metals Refinery, converter matte typically contains 48% Ni, 29% Cu, 21% S and 0.6–5% Fe by weight, and the major mineral phases have compositions approaching heazlewoodite (Ni3S2), chalcocite (Cu2S) and a Ni–Cu alloy. It has been observed that the iron content of converter matte can have a significant impact on performance of the first stage atmospheric leach, in which the primary goal is to precipitate copper and PGEs from spent electrolyte (via metathesis and cementation reactions) and the secondary goal is the dissolution of nickel. In this work, laboratory scale batch leach tests were carried out with samples of converter matte with varying Fe-endpoints (0.53%, 0.83% and 5.72%), under oxygenated and non-oxygenated conditions, to improve understanding of the effect of the Fe-endpoint. X-ray diffraction and scanning electron microscopy techniques were employed to understand mineralogical changes that take place during leaching. Matte with a higher iron content was characterised by a lower Ni–Cu alloy content than matte with a lower iron content, and the presence of relatively inert pentlandite (NiFe)9S8. Under oxygenated conditions, nickel was leached more readily from low iron matte and copper and PGEs were precipitated more readily onto low iron matte than high iron matte. Under non-oxygenated conditions, copper was precipitated more readily onto the low iron matte and more nickel was leached from a low-iron matte than high iron matte, this can probably be attributed to the presence of the alloy phase in the low iron matte, which galvanically inhibits the metathesis reaction.

Keywords: Matte leaching; Mineralogy; Platinum group elements; Nickel sulphide

Antoni Muszer, Jerzy Wódka, Tomasz Chmielewski, Sabina Matuska, Covellinisation of copper sulphide minerals under pressure leaching conditions, Hydrometallurgy, Volume 137, May 2013, Pages 1-7, http://dx.doi.org/10.1016/j.hydromet.2013.03.010.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000777)

Abstract: A series of laboratory experiments have been performed on pressure leaching in oxygenated sulphuric acid solutions of commercial copper flotation concentrate produced by Lubin Concentrator (KGHM, Poland). Major copper

sulphides: chalcopyrite, bornite and chalcocite were reported to undergo phase conversion to covellite (CuS), which was found to be the most stable sulphidic form of copper. The formation of copper sulphide (covellite) appeared to be a significant step in the examined pressure leaching process. Copper present in the flotation concentrate was observed to be solubilised in the leaching solution only after the conversion of all copper sulphide minerals into the covellite phase. Permeable, openwork texture of covellite formed during the copper sulphide conversion facilitates easy leaching and transport of the leaching medium to the leaching surface, effecting leaching of the remaining minerals in the solid feed.

Keywords: Copper concentrate; Pressure leaching; Covellinisation

Yimin Zhang, Xiaobo Zhu, Tao Liu, Jing Huang, Shaoxian Song, Effect of colloidal potassium alum formation on vanadium recovery from acid leach solutions of stone coal, Hydrometallurgy, Volume 138, June 2013, Pages 54-58, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.06.014.

(http://www.sciencedirect.com/science/article/pii/S0304386X13001217)

Abstract: The nattier-blue colloidal particles precipitated out from the sulfuric acid leach solution of stone coal were identified to be potassium alum ($KAl(SO_4)_2 \cdot 12H_2O$). The particles were characterized through X-ray diffraction (XRD), scanning electron microscopy (SEM) and theoretical analysis with thermodynamics of ion crystallization. The results show that the particles belonged to potassium alum with micro-scale granular surfaces. The colloidal potassium alum formed with the temperature of the leaching solution cooling to 45 °C. This observation could lead to 27.6% vanadium loss in the vanadium extraction process, which might be attributed to the chemical adsorption of vanadium in the form of the species of VO^{2+} on the potassium alum surfaces.

Keywords: Potassium alum; Vanadium recovery; Thermodynamics; Acid leaching; Stone coal

Joana Ribeiro, Silvio R. Taffarel, Carlos H. Sampaio, Deolinda Flores, Luis F.O. Silva, Mineral speciation and fate of some hazardous contaminants in coal waste pile from anthracite mining in Portugal, International Journal of Coal Geology, Volumes 109–110, 1 April 2013, Pages 15-23, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2013.01.007.

(http://www.sciencedirect.com/science/article/pii/S0166516213000104)

Abstract: The coal (anthracite A) in Douro Coalfield (NW of Portugal) has been exploited for many years and has been mainly used as fuel supply by a thermal power plant. The mining activities inevitably impacted the environment, which includes a large number of coal waste piles emplaced over the old mine sites and adjacent areas of the Douro Coalfield. The disposal of coal mining residues represents significant environmental concerns due to their potential influence on

soils and sediments, as well as on the surface and groundwater of the surrounding areas. In the present study, the development of sequential extraction combined with various advanced analytical techniques was performed to provide an improved understanding of the complex processes related with sulfide-rich coal waste oxidation, sequences of mineral formation, and the transport mechanisms of hazardous elements by specific neoformed soluble minerals. The results showed the presence of amorphous iron (oxy-) hydroxides and goethite with various degrees of crystallinity, containing hazardous elements, such as As, Cr, Hg, Mo, Se, Pb, U, and others. Some of the neoformed minerals found in the coal waste material are the same as those commonly associated with coal acid drainage, in which oxidation of sulfides plays an important role. The precipitated neoformed minerals include pickeringite, blödite, and a mixture of epsomite, pickeringite, and hexahydrite. As these sulfates may dissolve after the first rain, they may release above-mentioned elements into surrounding water bodies.

Keywords: Coal mining residues; Sequential extraction; Sulfide oxidation; Sulfate potential environment effects

Shifeng Dai, Weiguo Zhang, Vladimir V. Seredin, Colin R. Ward, James C. Hower, Weijiao Song, Xibo Wang, Xiao Li, Lixin Zhao, Huan Kang, Licai Zheng, Peipei Wang, Dao Zhou, Factors controlling geochemical and mineralogical compositions of coals preserved within marine carbonate successions: A case study from the Heshan Coalfield, southern China, International Journal of Coal Geology, Volumes 109–110, 1 April 2013, Pages 77-100, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2013.02.003.

(http://www.sciencedirect.com/science/article/pii/S0166516213000438)

Abstract: The Late Permian coals in the Heshan Coalfield of southern China are preserved within marine carbonate successions and characterized by super-high organic sulfur (5.13–10.82%). Minerals identified in the coals include quartz, kaolinite, illite, mixed layer illite/smectite, albite, pyrite, marcasite, calcite, and dolomite, along with trace amounts of smectite, fluorite, strontianite, REY-bearing carbonate minerals, jarosite, and water-bearing Fe-oxysulfate. The coals are very rich in trace elements including F (up to 3362 μg/g), V (up to 270 μg/g), Se (up to 24.4 μg/g), Mo (up to 142 μg/g), U (up to 111 μg/g), and, to a lesser extent, Sr, Y, Zr, Nb, Cd, Cs, heavy rare earth elements, Hf, Ta, W, Hg, and Th. Previous studies attributed the high organic sulfur and elevated trace elements to the seawater influence or the formation of soil horizons before the accumulation of peat in the basin. However, mineralogical and geochemical data presented in this study have shown that the sediment-source region and multi-stage hydrothermal fluids are the dominant influences on the mineralogical composition and elevated trace elements in the coal, although seawater influence also contributed to the composition of the mineral matter. For example, a large proportion of the quartz and clay minerals, as well as almost all the albite, in both the coal benches and the parting mudstones were derived from detrital materials of

terrigenous origin in the Yunkai Upland. High concentrations of lithophile trace elements were also derived from the sediment source region. Minerals including fluorite, calcite, dolomite, strontianite, and REY-bearing carbonate minerals were derived from multi-stage hydrothermal activities. High concentrations of V, Mo, and U that occur through the coal seam sections were probably derived from hydrothermal solutions during peat accumulation or at the early diagenetic stages. The hydrothermal fluids also corroded the syngenetically-formed minerals (quartz, albite, and pyrite) and caused re-distribution of lithophile elements from partings to the underlying coal benches, resulting in higher key element ratios (Yb/La, Nb/Ta, and Zr/Hf) and more abundant heavy rare earth elements in the coal benches than in the immediately overlying partings.

Keywords: Minerals in coal; Trace elements in coal; Late Permian coal; Hydrothermal fluids; Heshan of southern China

Mark A. Engle, Ricardo A. Olea, Jennifer M.K. O'Keefe, James C. Hower, Nicholas J. Geboy, Direct estimation of diffuse gaseous emissions from coal fires: Current methods and future directions, International Journal of Coal Geology, Volume 112, 1 June 2013, Pages 164-172, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.10.005.

(http://www.sciencedirect.com/science/article/pii/S0166516212002467)

Abstract: Coal fires occur in nature spontaneously, contribute to increases in greenhouse gases, and emit atmospheric toxicants. Increasing interest in quantifying coal fire emissions has resulted in the adaptation and development of specialized approaches and adoption of numerical modeling techniques. Overview of these methods for direct estimation of diffuse gas emissions from coal fires is presented in this paper. Here we take advantage of stochastic Gaussian simulation to interpolate CO2 fluxes measured using a dynamic closed chamber at the Ruth Mullins coal fire in Perry County, Kentucky. This approach allows for preparing a map of diffuse gas emissions, one of the two primary ways that gases emanate from coal fires, and establishing the reliability of the study both locally and for the entire fire. Future research directions include continuous and automated sampling to improve quantification of gaseous coal fire emissions.

Keywords: Coal fires; Emissions; Greenhouse gases; Geostatistics; Sequential Gaussian simulation

Jörg Benndorf, Application of efficient methods of conditional simulation for optimising coal blending strategies in large continuous open pit mining operations, International Journal of Coal Geology, Volume 112, 1 June 2013, Pages 141-153, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.10.008.

(http://www.sciencedirect.com/science/article/pii/S0166516212002492)

Abstract: The delivery of in-spec coal qualities is essential for an efficient and environmental friendly operation of modern coal-fired power plants. The design of the mining operation systems and blending opportunities plays a key role in homogenising variability and improving the prediction of key quality parameters, such as the calorific value (CV). Modern methods of conditional simulation in geostatistics allow for generating several realisations for large deposits capturing in-situ variability of key quality parameters. Integrating simulated realisations of the deposit with a simulation of transport- and blending models of mining operation leads to valuable insights into its performance as a function of the technical design and operational mode. The contribution first reviews the method of Generalised Sequential Gaussian Simulation (GSGS), which is especially designed for computational efficient simulation of large deposits. In a second step GSGS is applied to a large coal field in Eastern Europe. The practical simulation process is described and applied in a complex geological environment of highly variable seam geometry and quality including multiple split seams. Results are applied to a large open pit coal operation to investigate the variability of the calorific value and its behaviour along the extraction, transportation and blending process in a continuous mining environment. The described approach provides a valuable view into the performance of a continuous mining system in terms of homogenisation. Conclusions can be drawn to optimise the design of key equipment and to adjust the operation mode to ensure that the customer's requirements in terms of coal quality variability are met with high probability.

Brett J. Valentine, Eric A. Morrissey, Andy J. Park, Mark E. Reidy, Paul C. Hackley, Development of web-based organic petrology photomicrograph atlases and internet resources for professionals and students, International Journal of Coal Geology, Volume 111, 1 May 2013, Pages 106-111, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.09.012.

(http://www.sciencedirect.com/science/article/pii/S0166516212002248)

Abstract: With advances in web applications, organic petrography and other related disciplines are in need of updated online resources and educational tools to aid professionals and students in the identification and interpretation of macerals. The U.S. Geological Survey (USGS) Organic Petrology Laboratory along with USGS Eastern Energy Resources Science Center Information Technology staff have developed five web atlases containing images of organic matter in geologic materials: 1. an American Society for Testing and Materials (ASTM) Atlas, 2. an Organic Petrology Taxonomy for International Classification (OPTIC) of Coal Macerals Atlas, 3. an Interactive Gulf Coast Photomicrograph Web Atlas (I-Map), 4. an Organic Material in Shales Atlas (Shale), and 5. an interactive Blue/White/Ultraviolet (UV) Light Atlas (Light). Each web atlas contains images of macerals with associated sample and petrographic data collected by the USGS. These webpages will provide means to preserve and circulate petrographic data collected by the USGS for coal and shale samples from all over the world.

Keywords: Photomicrograph atlas; Organic petrology; Macerals; Web atlas; Online tools

Bruno Valentim, Sandra Rodrigues, Sofia Ribeiro, Geny Pereira, Alexandra Guedes, Isabel Suárez-Ruiz, Relationships between the optical properties of coal macerals and the chars resulting from fluidized bed pyrolysis, International Journal of Coal Geology, Volume 111, 1 May 2013, Pages 80-89, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.11.017.

(http://www.sciencedirect.com/science/article/pii/S0166516212002819)

Abstract: In this study the values of the RIS axes and parameters were calculated using Kilby's method to the characterization of the textural anisotropy and structure of the basic structural units of coal macerals (collotelinite, fusinite, and macrinite). Their microstructural evolution after having been subjected to fluidized bed pyrolysis at 800 °C was investigated, using the same parameters, on their respective char portions (fused char, fusinoids, and inertoids). Thus, this work represents the first attempt to determine the variations of the optical properties of fluidized bed chars. After the thermal treatment, the fusinoids and the inertoids presented similar Rr% values and RIS parameters values, indicating that after pyrolysis these materials are texturally and structurally similar. Collotelinite produced fused chars with a higher reflectance than those resulting from fusinoids and inertoids. Their reflectance increase in lower and decrease in higher rank coals. The highest RMAX%, Rev, and Ram increase occurred in the fused char portions derived from the collotelinite of coals in the 0.86–1.60 Rr% range, indicating substantial chemical and spatial rearrangement.

Sandra Rodrigues, Manuela Marques, Isabel Suárez-Ruiz, Ignacio Camean, Deolinda Flores, Barbara Kwiecinska, Microstructural investigations of natural and synthetic graphites and semi-graphites, International Journal of Coal Geology, Volume 111, 1 May 2013, Pages 67-79, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.06.013.

(http://www.sciencedirect.com/science/article/pii/S0166516212001784)

Abstract: The present work is focused on the characterization of natural samples as end-member products of coalification process—semi-graphites and graphites, and on the characterization of manufactured graphite. To evaluate the properties of the materials a multi-methodology approach was applied using bulk characterization techniques (chemical analysis, X-ray powder diffraction, and helium density measurements), as well as techniques which permitted the identification and characterization of the different components found in the samples, such as optical microscopy, scanning electron microscopy (SEM), and micro-Raman spectroscopy. Good correlations were found between: i) chemical and Rev RIS parameters for less evolved materials (anthracite C—semi-graphite) indicating that the transformations are mainly of chemical nature in this range of coalification; and ii) optical (RMIN%

and Ram) and X-ray diffraction parameters in the range of semi-graphite–graphite, showing that transformations are mainly of physical character with strong rearrangement of BSUs, increase of degree of packing and crystalline sizes. Additionally, micro-Raman spectroscopy allowed assessing the properties of all graphitic structures found in the studied samples. The data showed similarities between: i) graphite basal planes (GBP) of both natural and synthetic graphites; ii) graphite edge planes (GEP) of natural graphites, flakes and microspheres of synthetic graphites, crystalline aggregates and lamellae from semi-graphites; and dense particles from semi-graphites. The analysis performed by micro-Raman spectroscopy, optical microscopy measurements, and SEM observations showed that graphitic structures such as flakes found in synthetic graphites are indeed corresponding to the GEP of natural graphites.

Olivier Bertoli, Andrew Paul, Zach Casley, Doug Dunn, Geostatistical drillhole spacing analysis for coal resource classification in the Bowen Basin, Queensland, International Journal of Coal Geology, Volume 112, 1 June 2013, Pages 107-113, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.12.010.

(http://www.sciencedirect.com/science/article/pii/S0166516213000037)

Abstract: Geostatistical drill hole spacing analysis ('DHSA') for resource classification using the global estimation variance technique has been used across BHP Billiton Mitsubishi Alliance ('BMA') Coal Operation's various mines and projects since 2004. Analysis of the results points to the emergence of possible patterns in the results for projects pertaining to specific coal measures being mined by BMA. This correlation may be a useful guide to assist in developing resource classifications for projects based on the coal measures in which they occur. Comparison of the results of classification using the Coal Guidelines versus classification using the geostatistical DHSA method for a selection of BMA's operating mines in Queensland's Bowen Basin indicates that the non-geostatistical approach leads to level of uncertainty that does not always agree with the complexity of the geology.

Keywords: Drill hole spacing analysis; Polygonal kriging; Australian Coal Guidelines; Bowen Basin; Global uncertainty

A.E. Tercan, B. Sohrabian, Multivariate geostatistical simulation of coal quality data by independent components, International Journal of Coal Geology, Volume 112, 1 June 2013, Pages 53-66, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.10.007.

(http://www.sciencedirect.com/science/article/pii/S0166516212002480)

Abstract: Quality of a lignite deposit can be characterized by many variables such as calorific value, ash content, and moisture content. These variables show complex spatial relationships with each other. Multivariate geostatistical simulation allows to reproducing such complex relations between the quality variables. In this paper we present independent component analysis and introduce this method as a

factorization tool in multivariate geostatistical simulation based on factor approach. The method is based on deriving independent components of multivariate data and simulating each one independently. Independent component simulation technique is applied to geostatistical simulation of three quality variables for a part of the lignite seam subject to severe tectonic movement and regularly variable in quality. The lignite seam belongs to the Lower Coal succession deposited in the Soma coal field, Manisa, Turkey. Ash content, lower calorific value and moisture content are quality variables under consideration. For simulation purposes the independent factors are derived from a linear combination of these quality variables by using independent component analysis, the variograms for the factors are calculated and modeled. After ensuring that the factors are spatially orthogonal, they are independently simulated by direct sequential simulation and the simulated values are back-transformed into original space. The application shows that input statistics such as mean, histogram, variogram and correlation coefficient for the quality variables are reproduced well and independent component simulation can be used in simulation of multivariate data.

K. Modis, K.I. Vatalis, Ch. Sachanidis, Spatiotemporal risk assessment of soil pollution in a lignite mining region using a Bayesian maximum entropy (BME) approach, International Journal of Coal Geology, Volume 112, 1 June 2013, Pages 173-179, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2012.11.015.

(http://www.sciencedirect.com/science/article/pii/S0166516212002790)

Abstract: The present paper aims to map pollution and assess the risk for agricultural soils in a wider lignite opencast mining and industrial area. Geochemical data related to environmental studies show that the waste characteristics favor solubilization and mobilization of inorganic contaminants and in some cases the generation of acidic leachates. The spatiotemporal distribution of soil contamination is studied by the application of the Bayesian Maximum Entropy (BME) theory which allows merging spatial and temporal estimations in a single model. Results reveal a correlation range of contaminant concentrations up to 5000 m and indicate a potential forecasting range up to 4 years. Inspection of the produced spatiotemporal maps indicates that the whole study area is contaminated by As and various heavy metals, a situation which seems to be more or less stable over time.

S. Al-Thyabat, T. Nakamura, E. Shibata, A. Iizuka, Adaptation of minerals processing operations for lithium-ion (LiBs) and nickel metal hydride (NiMH) batteries recycling: Critical review, Minerals Engineering, Volume 45, May 2013, Pages 4-17, http://dx.doi.org/10.1016/j.mineng.2012.12.005.

(http://www.sciencedirect.com/science/article/pii/S0892687513000022)

Abstract: Production of LiBs and NiMH batteries is expected to increase rapidly due to the soaring price of oil and gas which increases interest in renewable energy as well as the introduction of hybrid vehicles (HVs), and electric vehicles (EVs) which used secondary batteries as an effective energy storage device. Development of an efficient recycling scheme to recover the valuable parts and safely dispose the harmful one at batteries end life is a necessity. The challenge, however, is how to recover all the valuable metals without sacrificing the economics of recycling process. Several LiBs and NiMH batteries recycling processes have been developed in recent years. A review of these processes and their development timeline was presented in this paper. It was found that the major drawback of these recycling processes is the losses of some of batteries valuable parts since these recycling processes are not originally developed for this type of batteries. Also, some of these processes are expensive and designed for specific types of batteries which ignore contamination of recycling stream with impurities and other type of batteries. Using minerals processing operations such as grinding, sieving, magnetic, electrostatic, and gravity separations to liberate batteries electrodal materials and concentrate valuable metals is critical step in any recycling process. This may be due to the simplicity, efficiency, flexibility, and high throughput of these separation processes. The literature showed that applying these processes reduces the volume of LiBs and NiMH scrap, liberates their valuables, reduces the need for leachate purification in hydrometallurgical process, and facilitates the decomposing of battery's electrolyte. Based on these results a flowsheet to recycle mixed stream LiBs, and NiMH battery scrap was proposed.

Meijiao Deng, Qingxia Liu, Zhenghe Xu, Impact of gypsum supersaturated solution on surface properties of silica and sphalerite minerals, Minerals Engineering, Volumes 46–47, June 2013, Pages 6-15, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.03.013.

(http://www.sciencedirect.com/science/article/pii/S0892687513000873)

Abstract: In some sulphide mineral flotation operations, the process water contains high concentrations of calcium and sulphate ions that exceed the solubility limit of gypsum. It has been speculated that the gypsum supersaturated process water would lead to precipitation of gypsum which could coat on mineral surfaces by either nucleation or coagulation, resulting in reduced flotation recovery and selectivity. In this study, a laboratory prepared gypsum supersaturated solution is used to represent the gypsum supersaturated process water, the effect of gypsum supersaturated solution on the surface properties of silica and sphalerite minerals was investigated using zeta potential distribution measurements, scanning electron microscope (SEM), X-ray photon spectroscopy (XPS), Auger electron spectroscopy (AES), and quartz crystal microbalance with dissipation (QCM-D). Our results show that silica and sphalerite minerals carry identical surface charge (−10 mV of zeta potential) in the gypsum supersaturated solution at pH 10 although they are

charged differently in simple electrolyte solution at the same pH. Needle shape gypsum precipitates are found in both silica and sphalerite minerals systems conditioned with gypsum supersaturated solution. The gypsum precipitates do not grow on the minerals surfaces but form in the bulk gypsum supersaturated solution. The heterocoagulation between the examined minerals and gypsum particles is insignificant in the gypsum supersaturated solution. It is the high calcium concentration in the gypsum supersaturated solution that has significant effect on the surface properties of silica and sphalerite minerals. The zeta potentials of silica and sphalerite in a 800 ppm calcium solution (similar to the calcium concentration in the gypsum supersaturated solution) are similar to those measured in the gypsum supersaturated solutions. Both silica and sphalerite minerals surfaces are indiscriminately coated with calcium. The surface coating of calcium results in the identical surfaces between silica and sphalerite minerals, and ultimately causes problems for the flotation separation of silica and sphalerite.

Keywords: Gypsum supersaturated solution; Sphalerite flotation; Zeta potential distribution; Surface properties; QCM-D

S. Chehreh Chelgani, B. Hart, L. Xia, A TOF-SIMS surface chemical analytical study of rare earth element minerals from micro-flotation tests products, Minerals Engineering, Volume 45, May 2013, Pages 32-40, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.01.011.

(http://www.sciencedirect.com/science/article/pii/S0892687513000137)

Abstract: The Thor lake deposit is a world class resource of rare earth (REE) metals and minerals in Canada. Development work to optimize a REE mineral recovery process flow sheet is underway, however, given the ore mineralogy; the developed reagent scheme is relatively complex. As part of a research project, micro-flotation tests were conducted on a feed sample in order to examine factors affecting stream partitioning. SEM–EDX was performed to evaluate variability in grain composition between streams (concentrate and tails) and TOF-SIMS surface analysis was used to determine statistically significant differences in surface species particularly related to potential activation (or depression) of the examined mineral phases. SEM–EDX analysis reveal that the concentrate has a significantly higher proportion of REE bearing grains (carbonates and phosphates) relative to the tail (almost none were identified). Spectral fingerprinting by TOF-SIMS has allowed for the identification of all reagent species investigated. Reagent signal intensity discrimination on test stream mineral surfaces was observed by the TOF-SIMS analysis using reagents at plant concentration levels. TOF-SIMS analysis confirmed that REE bearing grains reporting to the concentrate are doing so in response to collector attachment whereas grains reporting to the tail are doing so in response to a lack of collector and/or in combination with the presence of the depressant. The surface analysis of gangue phases reveal a similar reagent discrimination; the signal intensity of collector species was significantly higher on the concentrate samples relative to the tails while depressant species were significantly enriched on the surface of the

gangue phases in the tail samples. A detailed evaluation of the surface species representing the various reagents used in flotation scheme revealed a distinct competitive relationship between two of the reagents. The surface analysis identified that when used in concurrently, there appears to be a negative feedback resulting in a significant reduction in loading for several of the collectors on grains reporting to the concentrate. An evaluation of the effect of reagents on REE mineral in pilot plant is currently under way.

Keywords: Rare earth minerals; Flotation; Surface chemistry; TOF-SIMS; SEM–EDX

Ngonidzashe Chimwani, David Glasser, Diane Hildebrandt, Mathew J. Metzger, François K. Mulenga, Determination of the milling parameters of a platinum group minerals ore to optimize product size distribution for flotation purposes, Minerals Engineering, Volumes 43–44, April 2013, Pages 67-78, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.09.013.

(http://www.sciencedirect.com/science/article/pii/S0892687512003214)

Abstract: Most concentrators desire to operate under optimal design configuration that guarantees high mineral recovery and low operational costs. The optimal design configurations are determined through studying the material to be milled in a laboratory mill under standard conditions. This is achieved through determining the selection and breakage function parameters and applying the mathematical simulation of the grinding process in order to optimize the size reduction process. The desired particle size is determined by the downstream processes, in our case, flotation. To this end, three mono-size classes feeds 850–600 μm, 600–425 μm and 425–300 μm of a platinum ore were ground using three different ball sizes (10, 20 and 30 mm) in a laboratory mill for the grinding times 0.5, 1, 2, 4, 8, 15 and 30 min. The data collected was used to determine breakage and some of the selection function parameters. The remaining parameters were back-calculated within the population balance model framework. The parameters were then used to obtain the product size distribution (PSD) that was later compared with the experimentally measured one. The milling kinetics for the desired size class for flotation was also simulated. There was a good match between the predicted and the experimentally measured PSD. The results of the milling done for further 60, 90, 120 and 240 min to validate the simulated milling kinetics from the determined parameters also showed good match between the simulated and the experimental one. This further confirms the validity of the determined parameters. From this, it becomes possible to determine the grinding conditions for optimal flotation.

Keywords: Grinding; Population balance model; First-order kinetics; Selection function; Breakage function

Huifen Yang, Qiongyao Tang, Chuanlong Wang, Jinlong Zhang, Flocculation and flotation response of Rhodococcus erythropolis to pure minerals in hematite ores, Minerals Engineering, Volume 45, May 2013, Pages 67-72, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.01.005.

(http://www.sciencedirect.com/science/article/pii/S0892687513000071)

Abstract: Rhodococcus erythropolis as a flotation collector for hematite was evaluated in the study. The surface morphology and cell wall composition of R. erythropolis was analyzed. Zeta potentials for four pure minerals from hematite ores were measured before and after adsorption by R. erythropolis. Pure mineral flotation tests and mixed mineral separation tests were performed to describe adsorption characteristics and mechanisms. A rod-shaped bacterium was detected with CH2, CH3 and COO groups on its cell wall that imparted hydrophobicity and negative charges. The ability of R. erythropolis to collect hematite was stronger than its ability to collect quartz, kaolinite and apatite. For a pulp pH of 6 and a cell concentration of 75 mg/L, recovery rate of hematite was 89.67%. The recovery differences between hematite and quartz, kaolinite and apatite were 66.43%, 60.36% and 54.30%, respectively. These data indicated that electrical properties of hematite surface were more suitable for adsorption of R. erythropolis than other three minerals. The adsorbed hematite particles appeared as large agglomerates after interaction with R. erythropolis. The quartz, kaolinite and apatite particles, however, were in the form of dispersed particles or small agglomerates. The chemical adsorption of hematite on bacterial cell wall resulted in agglomeration. The effects of flocculation and flotation of R. erythropolis on micro-fine hematite particles were characterized for the first time. The results showed that R. erythropolis can act as a flotation collector for hematite from hematite ores.

Keywords: R. erythropolis; Bacteria; Hematite ore; Flotation; Flocculation; Agglomerate

R.A. Bearman, Step change in the context of comminution, Minerals Engineering, Volumes 43–44, April 2013, Pages 2-11, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2012.06.010.

(http://www.sciencedirect.com/science/article/pii/S0892687512002385)

Abstract: Much has been written about innovation and the need for ‘‘game-changing’’ step change. There is no doubt that there are many challenges facing the mining and minerals industry and hence it is appropriate that the industry examines the level of response required. ‘‘Step Change’’ should not be regarded as a tightly defined, prescriptive descriptor, rather the industry needs to consider what it should mean in the context of the current and future challenges. In terms of comminution, the area bears much of the burden for the use of energy in the mining–processing system. Given this specific issue it is reasonable to consider that step change should be targeted at the reduction of the energy input per unit of final product. It is

important to consider energy in terms of the final output, as without this, effort could be misdirected. To ensure the maximum effectiveness of innovation in this field, comminution must be regarded as a component of the wider system that encompasses the size reduction from the in situ rock mass to a saleable product. In regard to the total system, some of the key considerations are philosophical, not technological. Such points include the need to simplify circuits, increase flexibility, examine the impact of variability and consider the end-game. In essence the total system is not about breaking rocks to a size, it is about breaking only what requires size reduction, to the point at which a saleable product can be generated. With this in mind the context for step change is set and this forms the basis for the discussion.

Keywords: Comminution; Sorting methods; Liberation

T. Chimbganda, M. Becker, J.L. Broadhurst, S.T.L. Harrison, J.-P. Franzidis, A comparison of pyrrhotite rejection and passivation in two nickel ores, Minerals Engineering, Volumes 46–47, June 2013, Pages 38-44, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.03.031.

(http://www.sciencedirect.com/science/article/pii/S0892687513001052)

Abstract: The non-stoichiometric sulfide mineral pyrrhotite (Fe1-xS) occurs almost ubiquitously inter-grown with the principal nickel mineral, pentlandite ((Fe,Ni)9S8). During Ni processing, pyrrhotite is generally rejected to the tailings stream by flotation to produce a low tonnage, high grade (Ni) smelter feed and reduce SO2 emissions. In this study, the effect of different pyrrhotite flotation rejection strategies (artificial oxidation and TETA: SMBS addition) are evaluated on a magnetic (Ore A) and non-magnetic (Ore B) pyrrhotite ore to determine if either may effectively depress and potentially passivate the pyrrhotite surface during flotation to produce benign tailings without compromising pentlandite recovery. For both ores, the best pyrrhotite rejection (pentlandite/pyrrhotite recovery) was obtained using TETA: SMBS. Differences in the flotation performance of the two ores are considered more a function of BMS content, liberation and ore handling rather than a difference in sulfide passivation from the inherent pyrrhotite mineralogy (magnetic vs non-magnetic pyrrhotite). Pyrrhotite passivation could possibly provide a means of rendering the tailings non-reactive and thus mitigate acid rock drainage (ARD) formation.

Keywords: Acid rock drainage; Pyrrhotite rejection; Pyrrhotite passivation; Polyethylene polyamines

R. Ram, F.A. Charalambous, S. McMaster, M.I. Pownceby, J. Tardio, S.K. Bhargava, Chemical and micro-structural characterisation studies on natural uraninite and associated gangue minerals, Minerals Engineering, Volume 45, May 2013, Pages 159-169, http://dx.doi.org/10.1016/j.mineng.2013.02.004.

(http://www.sciencedirect.com/science/article/pii/S0892687513000472)

Abstract: Composition, structure, texture and gangue minerals associated with three naturally occurring uraninite samples (USG – Saxony, Germany; UPA – Palette mine, Australia and; UEA – El Sharana mine Australia) were investigated. The UEA sample contained uraninite associated with uranyl oxide species, Pb-rich uranylphosphate and Pb/Al phosphate phase with trace levels of galena and sulphides. The UPA sample contained uraninite associated with meta-autunite, Pb/Al phosphate phase and other minor phases including carbonates, quartz, fluorapatite, gold and various Zn/Fe/Cu sulphides. The USG mineralogy was dominated by the sulphides sphalerite and galena with uraninite only a minor component along with unidentified Fe/Mg-rich aluminosilicate, muscovite, coffinite and other sulphides. All samples exhibited complex textural and chemical modifications compared to stoichiometric UO2. The uraninites were substituted mainly by Ca and radiogenic Pb and were highly altered. Alteration was associated with significant variations in chemistry with unaltered uraninite in samples UPA and UEA typically being richer in U, Ca and Pb compared to altered regions. The altered uraninite also was more hydrated. Altered uraninite in sample USG had higher Fe, Pb, S and As compared to less altered uraninite and was significantly depleted in U and Ca. The high Pb in the uraninite was opposite to that observed in the UEA and UPA samples but may be related to the high abundance of galena in the sample. The compositional, textural and microstructural aspects of uraninite are likely to play an important role in any process to extract uranium from uraninite-containing ores.

Keywords: Uraninite; Uranium ore gangue minerals; Uraninite Saxony Germany; Uraninite Palette mine; Uraninite El Sharana mine

Diana M. Arroyave G., Darío Gallego S., Marco A. Márquez G., Evaluation of residence time distribution and mineralogical characterization of the biooxidation of sulfide minerals in a continuous stirred tank reactor, Minerals Engineering, Volumes 46–47, June 2013, Pages 128-135, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.03.012.

(http://www.sciencedirect.com/science/article/pii/S0892687513000861)

Abstract: The residence time distribution (RTD) of the liquid phase and the mineralogical characterization of the biooxidation of refractory gold mineral was studied in a continuous stirred tank reactor. The latter was achieved using a native mixed culture of acidophilic mesophiles. The RTD was assessed using a mathematical model of stirred tanks in parallel. The oxidation of sulfide and the phases generated through the biooxidation process were evaluated via X-ray diffraction (XRD).The results indicated that the experimental RTD fit to the model. The reactor has a high tendency to behave as a completely mixed reactor. However, the mixed flow inside the reactor has disturbances such as by-pass and dead zones. The estimated mean residence time for the model was approximately 36% greater than the theoretical residence time. It was probably caused by the delay in the outflow of the tracer due to gas hold-up, foaming at the top and the design of the reactor outlet structure. The XRD outcomes showed that the oxidation of

arsenopyrite was greater than that of pyrite. Similarly, the formation of jarosite and brushite was observed. It was concluded that the dead zones could increase the probability of jarosite precipitations.

Keywords: RTD; Biooxidation; Tracer; Jarosite; XRD; CSTR

Weihua Gui, Jinping Liu, Chunhua Yang, Ning Chen, Xi Liao, Color co-occurrence matrix based froth image texture extraction for mineral flotation, Minerals Engineering, Volumes 46–47, June 2013, Pages 60-67, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.03.024.

(http://www.sciencedirect.com/science/article/pii/S0892687513000988)

Abstract: It is well accepted that the surface texture appearance of the flotation froth involves crucial information about its separation process, which can be used as an effective criterion for the qualitative assessment of the flotation performance. To obtain the distinctive characteristic of the froth surface appearance under various production conditions, a texture feature extraction method based on color co-occurrence matrix (CCM) is presented compared to the commonly used gray level co-occurrence matrix (GLCM). First, the HIS (Hue, Saturation and Intensity) color space is employed to exhibit and quantify the froth image, which yields a more intuitive description of the color properties in comparison with the RGB (Red, Green and Blue) color space. Then, the CCM is computed and the corresponding feature statistics of the froth surface texture are extracted based on the proposed matrix. Next, a new feature parameter is defined and extracted to describe the froth texture complexity based on the aforementioned texture feature statistics. After adequate offline froth images have been obtained from a bauxite flotation plant located in China under various production statuses with the corresponding concentrate grade in the froth assayed manually, the qualitative relationship between the texture complexity and the corresponding concentrate grade is investigated. Consequently, the optimal texture complexity range to achieve satisfactory production index is obtained for the further research of the optimal control of the flotation process. Experimental results have verified the effectiveness of the method and demonstrated its superiority over the previous texture feature extraction methods based on GLCM.

Keywords: Froth flotation; Froth image; Color co-occurrence matrix; Gray level co-occurrence matrix; Texture complexity

F. Ngoroma, J. Wiese, J.-P. Franzidis, The effect of frother blends on the flotation performance of selected PGM bearing ores, Minerals Engineering, Volumes 46–47, June 2013, Pages 76-82, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.03.017.

(http://www.sciencedirect.com/science/article/pii/S0892687513000915)

Abstract: Concentrators processing PGM bearing ores make use of polysaccharide depressants to reduce the recovery of the undesired naturally floatable gangue minerals, mainly silicates, present in the ore. Recent work has shown that high depressant dosages can completely depress naturally floatable gangue and thus prevent it from reporting to the concentrate. These high depressant dosages can, however, have a negative effect on the recovery of valuable minerals present in the ore by reducing the stability of the froth. In order to counterbalance the effects of depressant addition, frothers are added. It is, however, preferable to maintain independent control over bubble size and froth stability which is difficult to achieve with only one frother. An alternative strategy is to use a blend of frothers, e.g. a weaker frother in combination with a stronger frother. Such a system allows an additional degree of freedom: changing the ratio of the two frothers provides more independent control of bubble size and froth stability. This study demonstrates through the use of batch flotation tests how blending low molecular weight alcohols with commercially available frothers impacts the solids and water recovery, as well as the valuable mineral recovery and concentrate grade in different PGM ores. Higher water and solids recoveries together with higher valuable mineral recoveries (>90% copper and >70% nickel) were obtained from tests using frother blends.

Neymayer P. Lima, George E.S. Valadão, Antonio E.C. Peres, Effect of amine and starch dosages on the reverse cationic flotation of an iron ore, Minerals Engineering, Volume 45, May 2013, Pages 180-184, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.03.001.

(http://www.sciencedirect.com/science/article/pii/S0892687513000757)

Abstract: In iron ore concentration, reverse cationic flotation of quartz has been successfully employed for particles below 150 μm previously deslimed. Amine and starch are used, respectively, as quartz collector and iron oxides depressant. Understanding the mechanisms of reagents interaction is relevant to improve the separation selectivity, especially for high amine dosages. The term clathrate was used to explain this interaction, meaning a molecular compound in which molecules of one species occupy the empty spaces in the lattice of the other species, resulting in the depression of hydrophobic minerals. Laboratory scale experiments were carried out with itabirite iron ore in three different size ranges. The clathrate formation between molecules of amine and starch may explain the increase of SiO2 content in the concentrates of the coarse size range (−150 + 45 μm) due to an increase in amine dosage.

Keywords: Flotation; Flotation reagents; Flotation depressants

Klaas Peter van der Wielen, Richard Pascoe, Alex Weh, Frances Wall, Gavyn Rollinson, The influence of equipment settings and rock properties on high voltage breakage, Minerals Engineering, Volumes 46–47, June 2013, Pages 100-111, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.02.008.

(http://www.sciencedirect.com/science/article/pii/S0892687513000654)

Abstract: High voltage breakage is a novel comminution method that relies on highly energetic electrical pulses to weaken or fully fragment rocks. The potential of this technology to improve liberation and increase the grindability of ores has been demonstrated previously, but the fragmentation process is not fully understood. In this study a total of 20 rock types were treated in a SELFRAG Lab device to determine the influence of equipment parameters on breakage. Rock mass properties and Bond Work Index were determined for each rock type to identify their relation to breakage behaviour. Results show how, by influencing total applied energy, the number of discharges and voltage are the two major influences on the resultant product size. It has also been shown that coarser feed sizes are more amenable to high voltage breakage. Acoustic impedance, porosity and quartz content were found to relate to breakage but Bond Work Index only correlates loosely.

Keywords: Comminution; High voltage pulse breakage; SELFRAG; Electric pulse disaggregation; Electrical comminution; Energy efficiency

George V. Franks, Muhamad Firdaus, Jun Oshitani, Copper ore density separations by float/sink in a dry sand fluidised bed dense medium, International Journal of Mineral Processing, Volume 121, 10 June 2013, Pages 12-20, ISSN 0301-7516, http://dx.doi.org/10.1016/j.minpro.2013.02.008.

(http://www.sciencedirect.com/science/article/pii/S0301751613000550)

Abstract: Two types of copper ore have been separated based on density by float/sink in a dry sand fluidised bed dense medium. This is the first report of dry separation of lump copper ores using a dry sand fluidised bed dense medium. The separation point density and the separation efficiency, characterised by the probable error, can be controlled by changing the amount of different density sand particles in the medium mixture and the fluidisation air velocity. It has been shown that separation point densities between about 2200 and 3700 kg/m3 with probable errors typically in the range of 0.01 to 0.06 can be obtained. Ores with particles in the size range of between about 10 and 25 mm can be treated. Depending on the ore mass–density distribution and copper-density distribution, between about 20 to more than 40% of the low density ore could potentially be rejected prior to wet grinding with little loss of valuable copper. This would significantly reduce the amount of energy and water required for wet grinding and down stream processing such as flotation.

Keywords: Copper ore; Dry processing; Fluid bed

Diego M. Marques, João Felipe C.L. Costa, An algorithm to simulate ore grade variability in blending and homogenization piles, International Journal of Mineral Processing, Volume 120, 10 April 2013, Pages 48-55, ISSN 0301-7516, http://dx.doi.org/10.1016/j.minpro.2013.01.003.

(http://www.sciencedirect.com/science/article/pii/S0301751613000306)

Abstract: Homogenization piles are largely used in the mining industry for variability reduction in the head grades of the ore feeding the processing plants. Various methods are used when designing homogenization piles, and most fail to incorporate the in situ grade variability that is intrinsic to the mineral deposit. The methodology proposed here combines longitudinal piles and geostatistical simulations to emulate the in situ variability as well as the reclaimed pile grade variability. A blending/homogenization simulator for longitudinal stockpiles has been developed, where the input to the algorithm consists of the pre-defined mining sequence, and has been applied to several simulated scenarios of the mineral deposit. This sequence is re-arranged by the algorithm, which selects the blocks that will form the pile of each simulated block model, and simulates the operation of the stacking and reclaiming equipment. The output sequence of the algorithm reflects the quality fluctuation of the grade after the blending/homogenization and reclamation. Using this methodology one can evaluate, within a certain time period, the expected grade variability for various pile sizes as well as the internal grade variability when a given pile is reclaimed. Results from a case study at two large iron mines operated by Vale S.A. proved the usefulness and functionality of the method. It is demonstrated that the rate of variability decreases as the pile size increases. It is also demonstrated that the internal grade variability decreases for a given pile size, when the number of layers in the pile is increased.

Keywords: In situ variability; Homogenization pile; Geostatistical simulation

Yunliang Zhao, Yimin Zhang, Tao Liu, Tiejun Chen, Ying Bian, Shenxu Bao, Pre-concentration of vanadium from stone coal by gravity separation, International Journal of Mineral Processing, Volume 121, 10 June 2013, Pages 1-5, ISSN 0301-7516, http://dx.doi.org/10.1016/j.minpro.2013.02.014.

(http://www.sciencedirect.com/science/article/pii/S0301751613000616)

Abstract: In China, more than 87% of vanadium is discovered from stone coal. However, because the vanadium grade in stone coal is generally low, current vanadium extraction technology faces challenges in terms of large ore tonnage and high energy consumption, acid consumption and cost. A new process for pre-concentration of vanadium from stone coal by gravity separation was investigated based on mineralogical study. It was confirmed that the vanadium occurred in muscovite and illite, and the acid consuming minerals were pyrite and calcite. The process comprised three key steps: decarburization, selective grinding and gravity separation. In the decarburization stage, the thermal energy of carbon in the stone coal can be used and the V2O5 grade increased to some extent. The differences of V2O5 grade among different size fractions increased through the selective grinding stage. In the gravity separation stage, 28.9% of the feed ore were rejected as final tailings, while the V2O5 loss was 9.7%. The pre-concentration of vanadium from stone coal can improve the V2O5 grade and decrease the content of high acid

consuming minerals. The benefits of the pre-concentration process in terms of cost savings and solving processing problems were discussed.

Vinod Kumar, Jae-chun Lee, Jinki Jeong, Manis Kumar Jha, Byung-su Kim, Ratnakar Singh, Novel physical separation process for eco-friendly recycling of rare and valuable metals from end-of-life DVD-PCBs, Separation and Purification Technology, Volume 111, 25 June 2013, Pages 145-154, ISSN 1383-5866, http://dx.doi.org/10.1016/j.seppur.2013.03.039.

(http://www.sciencedirect.com/science/article/pii/S138358661300186X)

Abstract: Present paper reports a simple and eco-friendly physical separation process for the recycling of metallic values from PCBs. The separation of material is based on distribution of metallic and non-metallic constituents in different size fractions depending on their liberation size due to their malleable or ductile nature. The studies showed the enrichment of metals in coarser particles (−1000 + 150 μm) and non-metals in the finer particles −150 μm following pneumatic separation and froth flotation process. A grade of 88% with 75% recovery was achieved by froth flotation, but lower grade of ~75% with ~65% recovery were obtained by pneumatic separation with −1500 μm powder. Overall grade of metals was achieved up to 88% by controlling the feed and air flow rates during pneumatic separation. Using this beneficiation technique, the concentration of rare metals in the different fractions varying from 1.88% to 4.18% was enriched up to 9%.

Keywords: DVD; PCBs; Pneumatic separation; Froth flotation and metal recovery

Yanxia Guo, Yaoyao Li, Fangqin Cheng, Miao Wang, Xuming Wang, Role of additives in improved thermal activation of coal fly ash for alumina extraction, Fuel Processing Technology, Volume 110, June 2013, Pages 114-121, ISSN 0378-3820, http://dx.doi.org/10.1016/j.fuproc.2012.12.003.

(http://www.sciencedirect.com/science/article/pii/S037838201200450X)

Abstract: The extraction of alumina from coal fly ash is a good direction for its value-added utilization. The presence of the inert matters with high degree of polymerization, such as mullite and other aluminosilicates, makes the reactivity of coal fly ash very poor. The activation of coal fly ash is necessary before its utilization. The thermal activation calcination with the addition of NaOH and Na_2CO_3 was carried out in this research. The results showed that the addition of NaOH and Na_2CO_3 improved the alumina extraction evidently. The maximum alumina extraction reached ~ 60% when calcination at 600–900 °C with the addition of NaOH and that could reach 82% at 900 °C with the addition of Na_2CO_3. Detailed analysis and characterization was carried out by using thermal gravimetric and differential scanning calorimetric analysis (TG-DSC) and X-ray diffraction (XRD). The results indicated that NaOH and Na_2CO_3 facilitated the decomposition of the polymeric phases. At lower temperatures (< 600 °C), NaOH played a main role while Na_2CO_3

did at higher temperatures (> 700 °C). As a result, the mixed additives containing NaOH and Na_2CO_3 made alumina extraction attain 95% at 700 °C.

Keywords: Coal fly ash; Thermal activation; Alumina extraction; NaOH; Na2CO3

Qiang Zhang, Haifeng Liu, Yaping Qian, Menghan Xu, Weifeng Li, Jianliang Xu, The influence of phosphorus on ash fusion temperature of sludge and coal, Fuel Processing Technology, Volume 110, June 2013, Pages 218-226, ISSN 0378-3820, http://dx.doi.org/10.1016/j.fuproc.2012.12.018.

(http://www.sciencedirect.com/science/article/pii/S0378382012004651)

Abstract: Sewage sludge gasification can result in significant environmental benefits. However, the influence of sewage sludge on the process is not recognized in an adequate degree. The purpose of the present study was to investigate the ash fusion temperature (AFT) of coal-sewage sludge (SS) and the influence of phosphorus on it. Ash fusion characteristics of six types of coals, one type of sewage sludge, and the corresponding coal-sewage sludge blends were measured. Chemical and mineralogical compositions of blended ashes at different temperatures were determined. Ash fusion temperatures of most coals are lowered by adding sewage sludge, because Ca and Na in sewage sludge ash can react with refractory minerals from coal to form low temperature eutectic. The influence of phosphorus on mixture AFT depends greatly on the Al2O3/(CaO + Na2O + K2O) (A/CNK) molar ratio of bulk ash. Phosphorus tends to react with calcium to form refractory minerals in subaluminous systems (A/CNK < 1), but mainly exists in amorphous materials and beneficial for decreasing ash fusion temperature in peraluminous systems (A/CNK > 1).

Keywords: Sewage sludge; Coal; Ash fusion temperature; Phosphorus

Denise Bevilaqua, Heidi Lahti, Patrícia H. Suegama, Oswaldo Garcia Jr., Assis V. Benedetti, Jaakko A. Puhakka, Olli H. Tuovinen, Effect of Na-chloride on the bioleaching of a chalcopyrite concentrate in shake flasks and stirred tank bioreactors, Hydrometallurgy, Volume 138, June 2013, Pages 1-13, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.06.008.

(http://www.sciencedirect.com/science/article/pii/S0304386X13001138)

Abstract: Oxidative dissolution of chalcopyrite at ambient temperatures is generally slow and subject to passivation, posing a major challenge for developing bioleaching applications for this recalcitrant mineral. Chloride is known to enhance the chemical leaching of chalcopyrite, but much of this effect has been demonstrated at elevated temperatures. This study was undertaken to test whether 100–200 mM Na-chloride enhances the chemical and bacterial leaching of chalcopyrite in shake flasks and stirred tank bioreactor conditions at mesophilic temperatures. Acidithiobacillus ferrooxidans, Acidithiobacillus thiooxidans and abiotic controls were employed for the leaching experiments. Addition of Na-

chloride to the bioleaching suspension inhibited the formation of secondary phases from chalcopyrite and decreased the Fe(III) precipitation. Neither elemental S nor secondary Cu-sulfides were detected in solid residues by X-ray diffraction. Chalcopyrite leaching was enhanced when the solution contained bacteria, ferrous iron and Na-chloride under low redox potential (< 450 mV) conditions. Scanning electron micrographs and energy-dispersive analysis of X-rays revealed the presence of precipitates that were identified as brushite and jarosites in solid residues. Minor amounts of gypsum may also have been present. Electrochemical analysis of solid residues was in concurrence of the differential effects between chemical controls, chloride ions, and bacteria. Electrochemical impedance spectroscopy was used to characterize interfacial changes on chalcopyrite surface caused by different bioleaching conditions. In abiotic controls, the impedance signal stabilized after 28 days, indicating the lack of changes on mineral surface thereafter, but with more resistive behavior than chalcopyrite itself. For bioleached samples, the signal suggested some capacitive response with time owing to the formation of less conductive precipitates. At Bode-phase angle plots (middle frequency), a new time constant was observed that was associated with the formation of jarosite, possibly also with minor amount or elemental S, although this intermediate could not be verified by XRD. Real impedance vs. frequency plots indicated that the bioleaching continued to modify the chalcopyrite/solution interface even after 42 days.

Keywords: Acidithiobacillus; Bioleaching; Chloride; Chalcopyrite; Electrochemical analysis

Atsushi Shibayama, William Tongamp, Batnasan Altansukh, Kazutoshi Haga, Akira Hosoi, Electronic waste treatment: Part 1. Autoclave oxidation–leaching using pyrite waste from mine tailing, Hydrometallurgy, Volume 137, May 2013, Pages 92-100, http://dx.doi.org/10.1016/j.hydromet.2013.05.007.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000984)

Abstract: A process to co-treat electronic and pyrite (FeS_2) wastes in an autoclave (high pressure and temperature) under oxygen gas atmosphere for extraction of metals from electronic waste was investigated in this study. The electronic waste sample contained high Cu (13–20%), Au (230–360 g/t), Ag (480–1020 g/t), including Pt, Pd and Ni among many other metals. Pyrite samples obtained as mine tailings for the study contained 69.1% FeS_2 (32.5% Fe and 36.6% S) and was used as sulfur source for the generation of H_2SO_4 during autoclave oxidation to subsequently extract Cu and other base metals in the electronic waste. Reaction temperature and time, autoclave pressure, pulp density and H_2SO_4 concentration were investigated to evaluate metals extraction. At temperatures ranging from 120 to 180 °C and autoclave pressure of 2 MPa, pyrite was completely oxidized. Subsequently, Cu extraction reached over 99% and very high extraction of Zn, Ni and Cr metals was achieved within 1 h. The solid products from autoclave oxidation containing precious metals (Au, Ag, Pt, Pd) can be treated separately for their recovery.

Keywords: Electronic waste; Mine tailings; Pyrite; Autoclave oxidation; Copper

Yang Qu, Bin Lian, Binbin Mo, Congqiang Liu, Bioleaching of heavy metals from red mud using Aspergillus niger, Hydrometallurgy, Volume 136, April 2013, Pages 71-77, http://dx.doi.org/10.1016/j.hydromet.2013.03.006.

(http://www.sciencedirect.com/science/article/pii/S0304386X1300073X)

Abstract: Red mud (bauxite residue) is the main waste product of the alkaline extraction of alumina from bauxite with high amounts of metals. In this study, bioleaching of heavy metals from red mud by using the fungus Aspergillus niger was investigated. Bioleaching experiments were examined in batch cultures with the red mud at various pulp densities (1–5%, w/v) under various bioleaching conditions (one-step, two-step and spent medium bioleaching). It was shown that the main lixiviant excreted by A. niger was citric acid. The highest leaching ratios of most various heavy metals were achieved under spent medium leaching at 1% pulp density. The increase in red mud pulp densities resulted in a general decrease in leaching ratios under all bioleaching conditions. However, in the case of the spent medium leaching the decrease in leaching ratios was lowest. The Toxicity Characteristic Leaching Procedure (TCLP) tests showed that the leaching toxicity of the bioleaching residue was far below the levels of relevant regulations. The micromorphology of the red mud particles were changed by the fungal activity during bioleaching process.

Keywords: Red mud; Bioleaching; Heavy metals; Aspergillus niger

Tomoko Radomirovic, Peter Smith, Daniel Southam, Sonam Tashi, Franca Jones, Crystallization of sodalite particles under Bayer-type conditions, Hydrometallurgy, Volume 137, May 2013, Pages 84-91, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.05.006.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000972)

Abstract: The formation of desilication products (DSPs) is an important process in the pre-desilication step of the Bayer process, helping to limit the potential for unwanted scale on the heat exchangers by limiting the amount of silicate in the Bayer liquor. These solids generally have a crystalline sodalite structure, however, the fundamentals of crystallization are still to be fully understood. We show in this work that the DSP formed is initially amorphous when solution silicate is used. When kaolinite solids are present DSP is initially heterogeneously nucleated on the kaolinite but there is also a secondary nucleation event that occurs.

Keywords: Bayer process; DSP; Silicate; Heterogenous nucleation; Kaolin

Wenqing Qin, Kai Liu, Mengxue Diao, Jun Wang, Yansheng Zhang, Congren Yang, Fen Jiao, Oxidation of arsenite (As(III)) by ferric iron in the presence of

pyrite and a mixed moderately thermophilic culture, Hydrometallurgy, Vol. 137, May 2013, PP. 53-59, http://dx.doi.org/10.1016/j.hydromet.2013.05.011.

(http://www.sciencedirect.com/science/article/pii/S0304386X13001023)

Abstract: The oxidation of As(III) by Fe3 + in the presence of pyrite and a mixed moderately thermophilic culture with high As(III)-resistance was investigated under various conditions. The oxidation of As(III) took place on the pyrite surface, and in the presence of excessive Fe3 + the reaction could be classified as a zero-order reaction or a first-order reaction, which depended on whether or not the catalytic sites on the pyrite surface were saturated by As(III). The rate constant of the first-order reaction, 0.0214 h− 1, was calculated from the experimental data, and the rate constant of zero-order reaction was correlated to the pulp density of pyrite. A simple model was built to model the change of As(III) concentration during the biooxidation of arsenic bearing gold concentrates. The model showed that when the content of As in the concentrate was less than 11.4% (w/v) and that of pyrite was more than 60%, the As(III) level in the solution did not significantly increase over time.

Keywords: Arsenite; Biooxidation; Pyrite; Arsenic-bearing gold concentrate; Moderate thermophiles

Pengge Ning, Hongbin Cao, Xiao Lin, Yi Zhang, The crud formation during the long-term operation of the V(V) and Cr(VI) extraction, Hydrometallurgy, Volume 137, May 2013, Pages 133-139, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.05.001.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000856)

Abstract: The roles of the emulsifiers in the crud formation during the long-term operation during the vanadium and chromium extraction were studied. The crud produced in the long-term operation of extraction was determined by GC–MS for organic phase and XPS for solid particles. The results indicate that the redox reaction occurs between Cr(VI) and organic compounds, and the reduction products of Cr(VI) induce more stable emulsion. Additionally, the roles of other types of solid particles and organic compounds confirmed before were carried out by thermodynamic calculation and experiments combined with discussion. Three-dimensional network structure of silica and precipitation of various cations act as the major incentives to stimulate the emulsion. Whereafter, crystallization of sodium sulfate and the reduction of Cr(VI) take place at the surface of emulsion droplet, and the organic compounds are prone to be adsorbed by these fine solids which subsequently consolidate the newly formed surface of droplet. The interactions between emulsion droplets were calculated according to the extended DLVO theory. The comprehensive stabilization mechanisms were also proposed, including the composite interfacial film mechanism, the steric hindrance mechanism and the double electric layer mechanism.

Keywords: Extraction; V(V) and Cr(VI); Interfacial crud; Stabilization mechanism

Jared L. Deutsch, David B. Dreisinger, Silver sulfide leaching with thiosulfate in the presence of additives Part II: Ferric complexes and the application to silver sulfide ore, Hydrometallurgy, Volume 137, May 2013, Pages 165-172, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.03.013.

(http://www.sciencedirect.com/science/article/pii/S0304386X13000807)

Abstract: Ferric complex alternatives to the cupric–ammonia catalyzed thiosulfate system including ferric–EDTA, ferric–oxalate and ferric–citrate were studied with a silver sulfide rotating disk. Of these complexes, ferric–EDTA and ferric–oxalate were the most promising alternatives. All ferric complexes tested were unreactive towards thiosulfate, but are reduced by sulfides present in the ore. When leaching a silver sulfide ore, the most effective lixiviants were ferric–EDTA and the cupric–ammonia thiosulfate systems. None of the thiosulfate alternatives were able to recover as much silver as cyanide leaching, likely due to the presence of other silver minerals which may not be amenable to thiosulfate leaching. Although less silver was recovered, less than 1% of mercury in the ore was leached by thiosulfate complexes compared to 50% mercury recovery by cyanide.

Keywords: Thiosulfate; Silver sulfide; Leaching; Ferric complexes; Cupric–ammonia

Yimin Zhang, Xiaobo Zhu, Tao Liu, Jing Huang, Shaoxian Song, Effect of colloidal potassium alum formation on vanadium recovery from acid leach solutions of stone coal, Hydrometallurgy, Volume 138, June 2013, Pages 54-58, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.06.014.

(http://www.sciencedirect.com/science/article/pii/S0304386X13001217)

Abstract: The nattier-blue colloidal particles precipitated out from the sulfuric acid leach solution of stone coal were identified to be potassium alum (KAl(SO4)2 · 12H2O). The particles were characterized through X-ray diffraction (XRD), scanning electron microscopy (SEM) and theoretical analysis with thermodynamics of ion crystallization. The results show that the particles belonged to potassium alum with micro-scale granular surfaces. The colloidal potassium alum formed with the temperature of the leaching solution cooling to 45 °C. This observation could lead to 27.6% vanadium loss in the vanadium extraction process, which might be attributed to the chemical adsorption of vanadium in the form of the species of VO2 + on the potassium alum surfaces.

Takeshi Kato, Shukuro Igarashi, Yoshiyuki Ishiwatari, Makoto Furukawa, Hitoshi Yamaguchi, Separation and concentration of indium from a liquid crystal display via homogeneous liquid–liquid extraction, Hydrometallurgy, Volume 137, May 2013, Pages 148-155, ISSN 0304-386X, http://dx.doi.org/10.1016/j.hydromet.2013.06.004.

(http://www.sciencedirect.com/science/article/pii/S0304386X13001096)

Abstract: Separation and concentration of indium from a liquid crystal display (LCD) was conducted using homogeneous liquid–liquid extraction (HoLLE) in order to completely recycle the LCD. First, using 2.40 M hydrochloric acid, 1.52 mg of indium was leached from the LCD of a mobile phone while keeping the amount of leached foreign metals, such as iron and aluminum, as low as possible. The ability to recycle the LCD glass is also expected because arsenic and antimony, which are used as antifoamers for the glass, were separated in the leaching residue. Next, on the basis of the metal leaching results for a mobile phone LCD, HoLLE with Zonyl FSA (CF3(CF2)nCH2CH2SCH2CH2COOH, n = 6–8, Du Pont Co.) was conducted via the formation of metal-1,10-phenanthroline chelates on a solution formulated to simulate the leachate from a mobile phone LCD. Using this technique, more than 96.7% of the indium was extracted from the simulated leaching solution into the sedimented liquid phase. After phase separation, the volume ratio (Va/Vs) of the aqueous phase (Va) and the sedimented liquid phase (Vs) was 438 (46 ml → 0.105 ml). In addition, the sedimented liquid phase was dropped on a filter and evaluated using X-ray fluorescence analysis. After determination of the elements concentrated into the sedimented liquid phase, the mass concentration of indium in the sedimented liquid phase was estimated to be 10.4 wt%. This result indicated that the mass concentration ratio was 405 because the mass concentration of indium in the mobile phone LCD was 0.0257 wt% on the basis of being determined by heating and leaching with aqua regia.

Keywords: Homogeneous liquid–liquid extraction; HoLLE; Indium; Liquid crystal display; Recycling

Joana Ribeiro, Silvio R. Taffarel, Carlos H. Sampaio, Deolinda Flores, Luis F.O. Silva, Mineral speciation and fate of some hazardous contaminants in coal waste pile from anthracite mining in Portugal, International Journal of Coal Geology, Volumes 109–110, 1 April 2013, Pages 15-23, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2013.01.007.

(http://www.sciencedirect.com/science/article/pii/S0166516213000104)

Abstract: The coal (anthracite A) in Douro Coalfield (NW of Portugal) has been exploited for many years and has been mainly used as fuel supply by a thermal power plant. The mining activities inevitably impacted the environment, which includes a large number of coal waste piles emplaced over the old mine sites and adjacent areas of the Douro Coalfield. The disposal of coal mining residues represents significant environmental concerns due to their potential influence on soils and sediments, as well as on the surface and groundwater of the surrounding areas. In the present study, the development of sequential extraction combined with various advanced analytical techniques was performed to provide an improved understanding of the complex processes related with sulfide-rich coal waste

oxidation, sequences of mineral formation, and the transport mechanisms of hazardous elements by specific neoformed soluble minerals. The results showed the presence of amorphous iron (oxy-) hydroxides and goethite with various degrees of crystallinity, containing hazardous elements, such as As, Cr, Hg, Mo, Se, Pb, U, and others. Some of the neoformed minerals found in the coal waste material are the same as those commonly associated with coal acid drainage, in which oxidation of sulfides plays an important role. The precipitated neoformed minerals include pickeringite, blödite, and a mixture of epsomite, pickeringite, and hexahydrite. As these sulfates may dissolve after the first rain, they may release above-mentioned elements into surrounding water bodies.

Keywords: Coal mining residues; Sequential extraction; Sulfide oxidation; Sulfate potential environment effects

Shifeng Dai, Weiguo Zhang, Vladimir V. Seredin, Colin R. Ward, James C. Hower, Weijiao Song, Xibo Wang, Xiao Li, Lixin Zhao, Huan Kang, Licai Zheng, Peipei Wang, Dao Zhou, Factors controlling geochemical and mineralogical compositions of coals preserved within marine carbonate successions: A case study from the Heshan Coalfield, southern China, International Journal of Coal Geology, Volumes 109–110, 1 April 2013, Pages 77-100, ISSN 0166-5162, http://dx.doi.org/10.1016/j.coal.2013.02.003.

(http://www.sciencedirect.com/science/article/pii/S0166516213000438)

Abstract: The Late Permian coals in the Heshan Coalfield of southern China are preserved within marine carbonate successions and characterized by super-high organic sulfur (5.13–10.82%). Minerals identified in the coals include quartz, kaolinite, illite, mixed layer illite/smectite, albite, pyrite, marcasite, calcite, and dolomite, along with trace amounts of smectite, fluorite, strontianite, REY-bearing carbonate minerals, jarosite, and water-bearing Fe-oxysulfate. The coals are very rich in trace elements including F (up to 3362 μg/g), V (up to 270 μg/g), Se (up to 24.4 μg/g), Mo (up to 142 μg/g), U (up to 111 μg/g), and, to a lesser extent, Sr, Y, Zr, Nb, Cd, Cs, heavy rare earth elements, Hf, Ta, W, Hg, and Th.

Previous studies attributed the high organic sulfur and elevated trace elements to the seawater influence or the formation of soil horizons before the accumulation of peat in the basin. However, mineralogical and geochemical data presented in this study have shown that the sediment-source region and multi-stage hydrothermal fluids are the dominant influences on the mineralogical composition and elevated trace elements in the coal, although seawater influence also contributed to the composition of the mineral matter. For example, a large proportion of the quartz and clay minerals, as well as almost all the albite, in both the coal benches and the parting mudstones were derived from detrital materials of terrigenous origin in the Yunkai Upland. High concentrations of lithophile trace elements were also derived from the sediment source region. Minerals including fluorite, calcite, dolomite, strontianite, and REY-bearing carbonate minerals were derived from multi-stage

hydrothermal activities. High concentrations of V, Mo, and U that occur through the coal seam sections were probably derived from hydrothermal solutions during peat accumulation or at the early diagenetic stages. The hydrothermal fluids also corroded the syngenetically-formed minerals (quartz, albite, and pyrite) and caused re-distribution of lithophile elements from partings to the underlying coal benches, resulting in higher key element ratios (Yb/La, Nb/Ta, and Zr/Hf) and more abundant heavy rare earth elements in the coal benches than in the immediately overlying partings.

Keywords: Minerals in coal; Trace elements in coal; Late Permian coal; Hydrothermal fluids; Heshan of southern China.