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Effect of hematite on thiosulphate leaching of gold

Author(s): D. Feng, J.S.J. van Deventer
International Journal of Mineral Processing, Volume 82(3), April 2007, Pages 138-147

Hematite, as a typical iron oxide slime in sulphide ore slurries, was artificially added into the leaching systems of pure gold and a sulphide ore respectively, in an attempt to investigate the effect of iron oxide slimes on the ammoniacal thiosulphate leaching of gold. The presence of hematite significantly reduced the dissolution of gold and this detrimental effect became more pronounced with increasing hematite concentration. Hematite formed coatings on gold surfaces, which could prevent leach solution from diffusing to the gold surfaces and hence, inhibit gold dissolution. Hematite catalysed the oxidative decomposition of thiosulphate to polythionates with oxygen present. XPS studies indicated a thin layer of iron oxide coating as well as the deposition of some copper and sulphur species on gold surfaces. SEM images revealed a lesser extent of corrosion for gold after leaching in the presence of hematite.

The gold extraction from the sulphide ore was reduced with the addition of hematite and this effect became more noticeable with an addition of hematite at a higher concentration. A natural guar type surfactant (Gempolym M47) reduced the detrimental effect of hematite on gold extraction likely due to the prevention of hematite coating on gold and mineral particles and the dispersion of the mineral slurry. Gempolym M47 stabilised thiosulphate by weakening the interaction between cupric ions and thiosulphate and by minimising the catalytic effect of hematite on thiosulphate decomposition.

Semi-automated petrographic assessment of coal by coal grain analysis

Author(s): Graham O'Brien, Barry Jenkins, Philip Ofori, Kirsty Ferguson
MINERALS ENGINEERING, Volume: 20 Issue: 5 Pages: 428-434

A new classification method, coal grain analysis, which uses optical imaging techniques for the microscopic characterisation of the individual grains present in coal samples is discussed. This differs from other coal petrography imaging methods in that a mask is used to remove the pixels of mounting resin to obtain compositional information of the maceral (vitrinite, inertinite and liptinite) and mineral abundances on each individual

grain within each image. Experiments were conducted to establish the density of individual constituents in order to enable the density of each grain to be determined and the results reported on a mass basis. The grains were sorted into eight grain classes of liberated (single component) and composite grains. By analysing all streams (feed, concentrate and tailings) of the flotation circuit at a coal washing plant, the flotation response of the individual grain classes was tracked. This has implications for flotation process diagnostics and optimisation.

Estimation of mineral grain size using automated mineralogy

Author(s): David Sutherland
MINERALS ENGINEERING, Volume: 20 Issue: 5 Pages: 452-460

The sizes of mineral grains control liberation and the subsequent separation. Automated mineralogy provides a basis for making a useful estimation of this very important parameter. But the estimation is not straightforward, partly due to the stereological aspects of the problem, and partly due to the ill-defined nature of mineral grains.

The present paper gives suggestions for making these estimates. The suggestions are made on the basis of past experimental studies, supplemented by computer simulation of different shapes and sizes of grains. It is concluded that phase specific surface area provides the best “size basis” for ranking different ores. The magnitude of shape effects and size distribution effects are discussed. But the next step of predicting the extent of liberation from grain size measurements is still difficult and needs experimental support.

Utilization of optical image analysis and automatic texture classification for iron ore particle characterisation

Author(s): Donskoi, E.; Suthers, S. P.; Fradd, S. B.; et al.
Conference: Automated Mineralogy Conference 2006 Location: Brisbane, AUSTRALIA Date: JUL, 2006, Source: MINERALS ENGINEERING Volume: 20 Issue: 5 Pages: 461-471 DOI: 10.1016/j.mineng.2006.12.005 Published: APR 2007

Optical image analysis is a very convenient tool for obtaining comprehensive information about fine iron ore size fractions. Data can be obtained on mineral abundances, porosity, particle shape and ore textures with a high level of accuracy. A range of techniques has been used to characterise iron ore samples on a particle-by-particle basis. Automatic textural classification of iron ore particles was used to establish classes containing particles with very similar mineral composition and texture. Image analysis coupled with probe analysis and mineral density measurements provided information about the chemical composition and density of each particle class. The combination of these results enabled a "virtual feed" to be created, which can be a key input into a beneficiation unit model for predicting its performance. Identification and classification of the textural type of each particle was performed according to the CSIRO-Hamersley Iron Ore Group Classification Scheme. If more detailed classification is needed, further classification can be performed based on dimensional, chemical or

mineral criteria, such as the presence of certain minerals in particles or total iron content. Some deficiencies of the current image analysis procedures and their further improvement and automation are also discussed. (C) 2007 Elsevier Ltd. All rights reserved.

Minerals and clay minerals in medical geology

Author(s): Celso de Sousa Figueiredo Gomes, João Baptista Pereira Silva
Applied Clay Science, *Volume 36, Issues 1–3*, *April 2007*,*Pages 4-21*

Medical geology is an emergent field of science that for some authors deals with the relationships between the geological environment and health problems in humans, animals and plants. Chemical elements, minerals, rocks, soils, water and air are the essential components of the geologic environment. Both quality and quantity of these components condition very much the living quality and the life duration, due to the beneficial and hazardous effects they have upon organisms, man, other animals, and plants. Medical geology is a multidisciplinary scientific field shared by specialists of distinct areas and scientific domains, such as earth sciences, environmental sciences, medicine, public health, biology, biochemistry, chemistry, pharmacy, nutrition, and others. Certain diseases are attributed to several minerals *sensu latu* (concept that includes the minerals *sensu restrictu* considered as natural, inorganic and crystalline solids, the so-called oligoelements or trace minerals, the biominerals and mineral resources such as natural mineral water), naturally or humanly derived. Within minerals, clay minerals, the essential constituents of clays, are omnipresent at the earth surface where organisms live, and due to their specific properties they can interact, positively as a rule, with them. Some clay minerals are being used, either as active principles (gastrointestinal protectors, laxatives, antidiarrhoeaics), or as excipients (inert bases, emulsifiers, lubricants) in certain medicines. Also they participate in formulations used for topical applications in both dermopharmacy and dermocosmetics.

Biological treatment of precious metal refinery wastewater: A review

Author(s): Rylan S. Dobson, Joanna E. Burgess

Source: MINERALS ENGINEERING Volume: 20 Issue: 6 Pages: 519-532 DOI: 10.1016/j.mineng.2006.12.007 Published: MAY 2007

The refining of platinum group metals (PGMs) generates large volumes of wastewater which is highly contaminated by organic solvents and contains trace amounts of heavy metals. Treatment to reduce chemical oxygen demand and metal concentration to levels allowing reuse in refinery processes can help to alleviate the demand for clean water in arid/semi arid mining regions of the world. Traditional physicochemical treatment options have been favoured in the past for treatment of PGM wastewater but biological treatment is becoming increasingly popular. This review examines the need for treatment of PGM wastewater and various physicochemical technologies that are available for treatment of organic solvents and heavy metals. It also introduces various

activated sludge technologies that have been shown to remove 99% of certain solvents, while biosorption has been demonstrated to be very effective in removal of heavy metals. A combination of biological treatment and biosorption can be a viable technology for the treatment of complex and potentially toxic wastewaters. Improved treated wastewater quality can allow for reuse in refinery processes which could lead to significant cost reduction and prove to be environmentally beneficial.

Modeling and optimization of Multi-Gravity Separator to produce celestite concentrate

Author(s): N. Aslan
Powder Technology, *Volume 174, Issue 3*, *25 May 2007*, *Pages 127-133*

In this study, a three-level Box–Behnken factorial design combined with response surface methodology (RSM) for modeling and optimizing of some operations parameter of Multi-Gravity Separator (MGS) to produce a celestite concentrate was developed. The three significant operational parameters of MGS, which are drum speed, tilt angle and shake amplitude, were varied and the results evaluated with the Box–Behnken factorial design. Second-order response functions were produced for the celestite grade and recovery of the concentrate. Taking advantage of the quadratic programming, a drum speed of 150 rpm, tilt angle of 6° and shake amplitude of 20 mm have been determined as optimum levels to achieve the maximum $SrSO_4$ concentrate grade of 96.91%, whereas the maximum level of grade was 95.69% in the tests conducted or predicted. In the same way, a drum speed of 250 rpm, tilt angle of 2° and shake amplitude of 10 mm has been determined as optimum levels to achieve the maximum recovery of 98.35%, whereas it was 95.83% in the tests conducted or predicted.

Floatability of chalcopyrite and molybdenite in the presence of lignosulfonates. Part I. Adsorption studies

Author(s): Ansari, Anita; Pawlik, Marek
Source: MINERALS ENGINEERING Volume: 20 Issue: 6 Pages: 600-608 DOI: 10.1016/j.mineng.2006.12.007 Published: MAY 2007

The adsorption of six lignosulfonates on molybdenite and chalcopyrite was studied through direct adsorption measurements and size exclusion chromatography at natural pH (5.0-5.5) and pH 11. The tests were carried out using different reagents for pH adjustments, i.e., potassium hydroxide (KOH), lime (CaO), and sodium carbonate (soda ash - Na2CO3). In the case of chalcopyrite, all the tests were performed in the presence of potassium ethyl xanthate - a chalcopyrite collector - added ahead of lignosulfonates. Overall, lignosulfonates give higher adsorption densities on chalcopyrite than on molybdenite. The adsorption density on both minerals was a function of not only the pH but also of the type of pH modifier used. Additions of lime enhanced lignosulfonate adsorption at higher pH but the adsorption of lignosulfonates dramatically decreased when soda ash or KOH were used for pH control. For all the lignosulfonates tested,

higher molecular weight fractions tended to preferentially adsorb over lower molecular weight components. The results also indicated that electrostatic forces and chemical interactions between the anionic polyelectrolytes and metal-hydroxy sites on the mineral surfaces largely controlled the adsorption process.

Floatability of chalcopyrite and molybdenite in the presence of lignosulfonates. Part II. Hallimond tube flotation

Author(s): Ansari, Anita; Pawlik, Marek
Source: MINERALS ENGINEERING Volume: 20 Issue: 6 Pages: 609-616 DOI: 10.1016/j.mineng.2006.12.008 Published: MAY 2007

The effect of six lignosulfonates on the Hallimond tube flotation of chalcopyrite and molybdenite was studied as a function of pH, with the use of common pH modifiers (soda ash, potassium hydroxide, and lime). By comparing the flotation results with the adsorption data collected in Part I of this contribution, it becomes evident that the depression of chalcopyrite flotation takes places only when lignosulfonates adsorb on the mineral surface and, at the same time, a fraction of the xanthate collector is desorbed from the mineral surface. These two conditions are met only at high pH adjusted with lime. The depression of the natural floatability of molybdenite is relatively easy using all six lignosulfonates, but once the mineral is rendered strongly hydrophobic by the addition of an oily collector (dodecane), the depression of molybdenite by lignosulfonates is very difficult and only calcium lignosulfonates, and the highest molecular weight sodium salt, produce significant levels of depression. Overall, the results suggest that it is possible to selectively float chalcopyrite from molybdenite using lignosulfonates by depressing molybdenite. This can be achieved over a wide pH range provided that a pH modifier other than lime is used for pH control. Although the results showed that chalcopyrite flotation and molybdenite depression can be achieved under similar physicochemical conditions, further tests with real ores under industrial conditions have to be carried out with particular attention to the effect of process water quality.

Air bubble and oil droplet interactions in centrifugal fields during air-sparged hydrocyclone flotation

Author(s): Niewiadomski, M.; Nguyen, Anh V.; Hupka, J.; et al.

Source: INTERNATIONAL JOURNAL OF ENVIRONMENT AND POLLUTION, Volume: 30(2), Pages: 313-331 DOI: 10.1504/IJEP.2007.014707 Published: 2007

The interactions of air bubbles and oil droplets in centrifugal flotation have been considered with respect to process conditions present during Air-sparged Hydrocyclone (ASH) flotation. Encounter efficiency of oil droplets with air bubbles has been found to be significantly smaller when compared to encounter efficiency of mineral particles.

Collision and sliding contact times have been determined. Collision has been found to be insufficient for successful contact between oil droplets and air bubbles while sliding allows for film rupture depending on specific system conditions. Although the tenacity of oil droplet attachment to an air bubble is believed to be greater than the tenacity of a mineral particle, emulsification makes oil flotation in centrifugal devices with large dissipation of energy inefficient and hence requires the use of high molecular weight polymeric flocculants.

Flotation of chromite and serpentine

Author(s): G.P. Gallios, E.A. Deliyanni, E.N. Peleka, K.A. Matis
Separation and Purification Technology, Volume 55(2), 15 June 2007, Pages 232-237

Chromite is an important strategic mineral usually associated with other gangue minerals, mainly silicates. A good knowledge of the flotation behaviour of chromite and the establishment of conditions for its selective separation from the gangue minerals might help the future exploitation of chromite deposits. In this paper, the floatability of chromite and serpentine fine particles by sodium oleate was investigated in-depth, aiming to separation during mineral processing, i.e. to float chromite from serpentine. Process parameters investigated were the effect of collector concentration, the pH value, the type and concentration of various modifiers on the flotation behaviour of chromite. The conditions investigate where selective flotation from gangue minerals (serpentine) would be possible.

Solid wastes generation in India and their recycling potential in building materials

Author(s): Asokan Pappu, Mohini Saxena, Shyam R. Asolekar
Building and Environment, Volume 42, Issue 6, June 2007, Pages 2311-2320

Presently in India, about 960 million tonnes of solid waste is being generated annually as by-products during industrial, mining, municipal, agricultural and other processes. Of this ~350 million tonnes are organic wastes from agricultural sources; ~290 million tonnes are inorganic waste of industrial and mining sectors and ~4.5 million tonnes are hazardous in nature. Advances in solid waste management resulted in alternative construction materials as a substitute to traditional materials like bricks, blocks, tiles, aggregates, ceramics, cement, lime, soil, timber and paint. To safeguard the environment, efforts are being made for recycling different wastes and utilise them in value added applications. In this paper, present status on generation and utilization of both non-hazardous and hazardous solid wastes in India, their recycling potentials and environmental implication are reported and discussed in details.

Operating parameters that affect the carrying capacity of column flotation of a zinc sulfide mineral

Author(s): Uribe-Salas, A.; Perez-Garibay, R.; Nava-Alonso, F.
Source: MINERALS ENGINEERING Volume: 20 Issue: 7 Pages: 710-715 DOI: 10.1016/j.mineng.2007.01.008 Published: JUN 2007

Test work performed in a pilot-scale flotation column (4 in height x 0.057 in diameter) processing an industrial zinc concentrate (51% w/w Zn as sphalerite, 10.5%, Fe, 0.77% Pb, 0.62% Cu, 7.3% NSG, d(80) = 110 mu m), confirmed the findings of previous work conducted by the authors, that showed there exists a limit in the mass flow rate of solids that can be processed in the column without adversely affecting recovery and solids carrying-rate; this limit is related to the onset of an unusual accumulation of gas in the lower section of the cell due to overloading of gas bubbles. In the present work, the effect of slurry rate (J(t) = 0.3-1.7 cm/s) and slurry density (15-35% w/w solids) onto solids recovery and solids carrying-rate were studied under the following experimental conditions: J(g) = 1.45 cm/s, 15 ppm Dowfroth, pH = 9.5 and 60 g isopropyl xanthate/ton; froth depth = 0.3 m.

The results showed that solids carrying-rate may be maximized by operating the column with a combination of a relatively dense slurry and a relatively small slurry rate. The above behavior is explained in terms of the solids load that air bubble transport under the different operating conditions imposed, which is reflected by the axial air-holdup profile established in the column, as a result of the accumulation of overloaded bubbles in the lower part of the collection zone.

It is argued that the slurry rate plays an important role on the onset of this phenomenon since it directly affects the rising velocity of overloaded bubbles, thus being the responsible of such unusual accumulation of gas and of phenomena such as bubble coalescence and lost of bubble surface area. (C) 2007 Published by Elsevier Ltd.

Bio-beneficiation of multimetal black shale ore by flotation

Author(s): Langwaldt, Jorg; Kalapudas, Reijo

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Within the framework of the EU co-funded Bioshale project the bio-benefication of multimetal black shale ore was studied. The EU-co-funded Bioshale project aims to define innovative biotechnological processes for "eco-efficient" exploitation of black shale ores. The ore sample was. from the Talvivaara deposit in Finland. In the black shale ore sample, the total amount of sulphides was 31.5% of which the Ni-minerals pentlandite and altered pentlandite is 0.52%. Nickel is distributed into pyrrhotite and oxidized pyrrhotite, 32.5%, and pentlandite and altered pentlandite, 66.0%. Other sulphides are chalcopyrite (Cu), sphalerite (Zn), pyrite (Co) and alabandite (Mn). The ore sample contanied 12.3% graphite as a fine mixture with other minerals. In standard flotation, a low grade sulphide concentrate with 0.67 % Ni and nickel recovery of 74 % was obtained from the studied black shale ore. The mass of concentrate was then

34.5% of the ore feed. The recoveries of copper and zinc were 91%, of cobalt 89% and of manganese 53%. The content of carbon in the concentrate was 11.3% as graphite represents a naturally floating harmful mineral in the ore. The bioflotation tests showed that collector chemicals, i.e xanthates, had to be supplied to achieve reasonable flotation results. Out of the three tested. bacterial strains, Staphylococcus carnosus, Bacillusfirmus and Bacillus subtilis, the minor hydrophobic strain S. carnosus yielded the best test results. However, results of bioflotation tests failed to substantially improve the product recovery or grade.

Some factors that affect beneficiation of sulphide nickel-copper ores

Author(s): Kirjavainen, Vesa; Heiskanen, Kari

Source: MINERALS ENGINEERING Volume: 20 Issue: 7 Pages: 629-633 DOI: 10.1016/j.mineng.2007.01.001 Published: JUN 2007

Sulphide Ni-Cu deposits occur typically in mafic and ultramafic igneous rocks and intrusions. The occurrence of minerals affects the separation efficiency of the sulphides. Coarse grained ores are often relatively easy to process, but some ores have altered in metamorphosis. Disseminated secondary minerals often require fine grinding for mineral liberation. Fine serpentine, however, causes problems in flotation processes, for example, by increasing the viscosity of the pulp. The floatability of minerals also depends on process variables. Process iron is usually in galvanic contact with particles and has an effect on the surface reactions of sulphides. Oxidation and dissolved ions in process water are also essential factors in the flotation processes.

Basis of optimal mineral inorganic waste processing methods

Author(s): Noviks, Gotfrids, Book Editor(s): Noviks, G
Conference: 6th International Scientific and Practical Conference on Environment, Technology, Resources Location: Rezekne, ROMANIA Date: JUN 20-22, 2007 Sponsor(s): Rezekne Higher Educ Inst, Fac Engn

Source: ENVIRONMENT, TECHNOLOGY, RESOURCES, PROCEEDINGS Pages: 87-101 Published: 2007

Inorganic waste materials are important part of total waste amount in the world and must be utilized in the best optimal way. Among the inorganic materials there arc, such different materials as quarry by-products from screening, settling ponds, baghouse fines, coal fly ash, sewage sludge ash and so on. Any proposal to incorporate a waste or by product materials into technologies requires engineering evaluation. A I first, it is necessary to analyze chemical composition of waste materials, then- structure and particle size distribution, chemical and physical properties. The paper presents results of analyzes and collection of chemical and structural characteristics mentioned above

inorganic materials and by-products. The presented data will serve for next investigations in finding better way for their utilization.

Recovery of copper, nickel and cobalt from acidic pressure leaching solutions of low-grade sulfide flotation concentrates

Author(s): Kun Huang, Qi-wei Li, Jing Chen

MINERALS ENGINEERING, Volume: 20 Issue: 7 Pages: 722-728 DOI: Published: JUN 2007

Recovery of copper, nickel and cobalt from the acidic pressure leaching solutions of Jinbaoshan (YN Province, PRC) low-grade sulfide flotation concentrates was investigated. The proposed technique includes four major steps: (1) the acidity adjustment of the acidic pressure leaching solutions; (2) solvent extraction (SX) separation of copper by organic reagent XD5640, and then stripped from the loaded organic phase by H_2SO_4 solution for copper recovery; then (3) iron in raffinates after copper extracting is selectively removed by high-temperature hydrolysis precipitation in an autoclave; and lastly (4) nickel and cobalt are selectively precipitated by Na_2S from the final solutions after removing iron. The experimental results for treating 1 L acidic leaching solutions per batch by this new technique were reported, and some evaluation and further comparisons with previous investigations were also carried out. It was reported that the total percent recovery of Cu could reach 95% or more, and that of Ni and Co were all more than 99%. In the processing, the percent removal of impurities, such as Fe, Mg and Ca, were all also near to 99%.