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Wettability study of mineral wastewater treatment filter media

Yang, Binwu; Chang, Qing; He, Chao; et al.
CHEMICAL ENGINEERING AND PROCESSING Volume: 46 Issue: 10 Pages: 975-981 DOI: 10.1016/j.cep.2007.06.002 Published: OCT 2007

Filtration is a typical tertiary treatment method for oily water. The wettability of oil-in-water emulsions to filter media probably has a significant effect on oil removal efficiency during oil-bearing wastewater treatment using filtration process. Based on Washburn's equation, a lipophilic hydrophilic ratio (LHR) concept was defined and used to compare quantitatively the wettabilities of five filter media. The selected mineral filter media were magnetite, zeolite, manganese sand, quartz sand and ceramsite sand particles with a size range of +0.45-0.9 mm and the wetting liquids were apolar cyclohexane and polar deionized water. At the same time, the surface morphologies and chemical compositions of these five filters were also characterized using scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). The desirable reproducibility and high precision are achieved by strict control of experimental parameters. The calculated LHR values of magnetite, zeolite, manganese sand, quartz sand and ceramsite sand are 1.057, 0.640, 0.736, 0.652 and 0.877, respectively. Magnetite seems slightly lipophilic, while others are comparatively hydrophilic because of the presence of polar hydrophilic Si-O bonds on surfaces. Probably owing to smoother surface, wetting rates of both cyclohexane and water for ceramsite sand are the lowest consistently. These different results of wetting behaviors and LHR values could be attributed to the differences of not only surface morphology but also chemical composition. (c) 2007 Published by Elsevier B.V.

Behavior of uranium under conditions of interaction of rocks and ores with subsurface water

Omel'yanenko, B. I.; Petrov, V. A.; Poluektov, V. V.
GEOLOGY OF ORE DEPOSITS Volume: 49 Issue: 5 Pages: 378-391 DOI: 10.1134/S1075701507050042 Published: OCT 2007

The behavior of uranium during interaction of subsurface water with crystalline rocks and uranium ores is considered in connection with the problem of safe underground insulation of spent nuclear fuel (SNF). Since subsurface water interacts with crystalline

rocks formed at a high temperature, the mineral composition of these rocks and uranium species therein are thermodynamically unstable. Therefore, reactions directed toward the establishment of equilibrium proceed in the water-rock system. At great depths that are characterized by hindered water exchange, where subsurface water acquires near-neutral and reducing properties, the interaction is extremely sluggish and is expressed in the formation of micro-and nanoparticles of secondary minerals. Under such conditions, the slow diffusion redistribution of uranium with enrichment in absorbed forms relative to all other uranium species is realized as well. The products of secondary alteration of Fe-and Ti-bearing minerals serve as the main sorbents of uranium. The rate of alteration of minerals and conversion of uranium species into absorbed forms is slow, and the results of these processes are insignificant, so that the rocks and uranium species therein may be regarded as unaltered. Under reducing conditions, subsurface water is always saturated with uranium. Whether water interacts with rock or uranium ore, the equilibrium uranium concentration in water is only <= 10-8 mol/l. Uraninite ore under such conditions always remains stable irrespective of its age. The stability conditions of uranium ore are quite suitable for safe insulation of SNF, which consists of 95% uraninite (UO_2) and is a confinement matrix for all other radionuclides. The disposal of SNF in massifs of crystalline rocks at depths below 500 m, where reducing conditions are predominant, is a reliable guarantee of high SNF stability. Under oxidizing conditions of the upper hydrodynamic zone, the rate of interaction of rocks with subsurface water increases by orders of magnitude and subsurface water is commonly undersaturated with uranium. Uranium absorbed by secondary minerals, particularly by iron hydroxides and leucoxene, is its single stable species under oxidizing conditions. The impact of oxygen-bearing water leads to destruction of uranium ore. This process is realized simultaneously at different hypsometric levels even if the permeability of the medium is variable in both the lateral and vertical directions. As a result, intervals containing uranyl minerals and relics of primary uranium ore are combined in ore-bearing zones with intervals of completely dissolved uranium minerals. A wide halo of elevated uranium contents caused by sorption is always retained at the location of uranium ore entirely destroyed by weathering. Uranium ore commonly finds itself in the aeration zone due to technogenic subsidence of the groundwater table caused by open-pit mining or pumping out of water from underground mines. The capillary and film waters that interact with rocks and ores in this zone are supplemented by free water filtering along fractures when rain falls or snow is thawing. The interaction of uranium ore with capillary water results in oxidation of uraninite, accompanied by loosening of the mineral surface, formation of microfractures, and an increase in solubility with enrichment of capillary water in uranium up to 10-4 mol/l.

Secondary U(VI) minerals, first of all, uranyl hydroxides and silicates, replace uraninite, and uranium undergoes local diffusion redistribution with its sorption by secondary mineral of host rocks. The influx of free water facilitates the complete dissolution of primary and secondary uranium minerals, the removal of uranium at the sites of groundwater discharge, and its redeposition under reducing conditions at a greater depth. It is evident that the conditions of the upper hydrodynamic zone and the aeration zone are unfit for long-term insulation of SNF and high-level wastes because, after the

failure of containers, the leakage of radionuclides into the environment becomes inevitable.

Recovery of nickel powder from copper bleed electrolyte of an Indian copper smelter by electrolysis.

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Powder Technology, 177 (3). pp. 133-139.

When nickel concentration increases in the copper sulphate electrolyte during electrolysis, it starts electrodepositing on the copper cathode thereby affecting the purity of the copper. In order to produce high quality copper cathodes with less than 1 ppm Ni, it became necessary to bleed-off large volumes of foul electrolyte contaminated with nickel and other impurities. The study reported in this paper was part of the effort aimed at devising a cost effective and an ecofriendly method for the production of value added powders from a waste stream, for P/M application. A part of copper salts and regenerated acid was used back into the system. As discussed in our paper on copper recovery from copper bleed stream (CBS), a process involving decopperisation and crystallisation–solvent extraction (SX) separation–electrowinning (EW) has been attempted as an alternative to the conventional process. Optimum conditions for nickel recovery from this type of solution have been investigated through a series of experiments carried out in a rectangular electrolytic bath with SS as cathode and Pb–Sb as anode. A quantitative and selective recovery was found for nickel deposition under suitable conditions. The purity of the electrolytic nickel powders so produced was found to be 99.89%. The compact density of the annealed nickel powder was 7.72 g/cc. Other properties of the nickel powders such as flow-ability, particle size, etc. were also evaluated to assess its suitability for its use in P/M applications.

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Recovery of copper powder from copper bleed electrolyte of an Indian copper smelter by electrolysis.

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Minerals Engineering, 20 (1). pp. 95-97.

Copper bleed solution generated from an Indian Copper smelter contains high amount of copper and nickel along with several impurities. Attempts have been made to develop a new process for the production of pure copper powder from such streams. The purity of the electrolytic copper powder produced from such bleed streams was found to be 99.93%. Properties such as compact density of the annealed copper powder, flow-

ability, particle size, etc. were evaluated and were found to be suitable for the powder metallurgical applications.

http://dx.doi.org/10.1016/j.mineng.2006.05.001

Mathematical modeling of separation characteristics of a coal-washing spiral.

Das, Suchandan K and Godiwalla, K M and Panda, Lopamudra and Bhattacharyya, K K and Singh, Ratnakar and Mehrotra, S P
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International Journal of Mineral Processing, 84 (1-4). pp. 118-132.

An improved mathematical model to simulate the particle and flow behavior in a coal-washing spiral has been developed. The modeling framework addresses three main components of the spiral system: (i) geometry of the spiral and its trough, (ii) fluid motion along the curvilinear path of the spiral and (iii) principal forces acting on a particle incorporating “Bagnold effect”. This effect has been addressed for both particle–inertial and macro-viscous regimes. The modeling components have been combined seamlessly by assuming that the particles eventually attain dynamic equilibrium in the forward longitudinal direction and static equilibrium in the transverse direction. The resulting force function provides a spectrum of the particle's radial location on the trough according to their size and relative specific gravity. The model predicts relative specific gravity distribution as a function of equilibrium radial position for different particle sizes. It also computes particle size variation as a function of equilibrium radial position for various values of relative specific gravity. Sensitivities of radial equilibrium distribution of particle size and relative specific gravity with respect to mean flow depth have also been investigated. Simulation results validated with the published data, are found to be reasonably consistent. The model provides an analytical tool for understanding of the separation behavior of particles in a coal-washing spiral.

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Effect of frother type in collectorless flotation of two high-rank coking coals of Gondwana origin.

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Coal Preparation, 27 (1-3). pp. 4-27.

Two high-rank coking coals of drift origin, which exhibited strong natural hydrophobicity, were used in this work. As high as 64-74% yield could be achieved through collectorless batch flotation with three different frothers: pine oil, MIBC, and a synthetic frother for three different feed sizes. It appears that a fairly long wetting time minimized the frother consumption. The flotation response of three different sizes, -0.5 mm, -0.5+0.1 mm,and

-0.1 mm of the same feed, was found to be different for the three frothers. Frother performance was also found to vary with the same size of the two coals. The performance of the synthetic frother and MIBC was found to be superior for the -0.5 + 0.1 mm and -0.1 mm feeds, respectively. MIBC performed best for the -0.5 mm feed of one coal, whereas the synthetic frother did the same for the other coal. Frother performance also seems to be dependent on performance evaluation methodology.

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Split and collectorless flotation to medium coking coal fines for multi-product zero waste concept.

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Fuel Processing Technology, 88 (6). pp. 585-590.

The medium coking coal fines of − 0.5 mm from Jharia coal field were taken for this investigation. The release analysis of the composite coal reveals that yield is very low at 10.0% ash, about 25% at 14% ash and 50% at 17% ash level. The low yield is caused by the presence of high ash finer fraction. The size-wise ash analysis of − 0.5 mm coal indicated that − 0.5 + 0.15 mm fraction contains less ash than − 0.15 mm fraction. Thus, the composite feed was split into − 0.5 + 0.15 mm and − 0.15 mm fractions and subjected to flotation separately. The low ash bearing fraction (− 0.5 + 0.15 mm) was subjected to two stages collectorless flotation to achieve the concentrate with 10% ash. The cleaner concentrate (18.9%) with 10% ash was recovered which has an application in metallurgical industries. The concentrate of 30.2% yield with 12.5% ash could be achieved in one stage collectorless flotation which is suitable for use in coke making as sweetener. As the − 0.15 mm fraction contains relatively high ash, collector aided flotation using sodium silicate was performed to get a concentrate of 23.6% yield with about 17% ash. The blending of this product with cleaner tail obtained from − 0.5 + 0.15 mm produces about 35.0% yield with 17% ash and that can be utilized for coke making. The reject from the two fractions can be used for conventional thermal power plant or cement industries using a 23.5% ash after one stage collector aided flotation and the final tailings produced content ash of 61.6% can be used for fluidization combustion bed (FBC). This eventually leads to complete utilization of coal.

http://dx.doi.org/10.1016/j.fuproc.2007.01.011

Refining of a low-grade molybdenite concentrate.

Kumar, Manoj and Mankhand, T R and Murthy, D S R and Mukhopadhyay, R and Prasad, P M
Hydrometallurgy, 86 (1-2). pp. 56-62.

This study aims to refine an indigenous off-grade molybdenite [41.5% Mo] to one of high-grade MoS2 for industrial applications. Investigations were carried out on the removal of the oxide/silicate gangue and the base metal sulphide associations by their selective dissolution in two acids, namely, HCl or HF deployed singly, sequentially or in the mixed mode. Under optimum conditions practically all the oxide and silicate gangue and 90% of the metallic impurities were removed. Starting from the low-grade molybdenite concentrate a refined molybdenite (97.8% MoS2) was made whose composition compares well with that of a technical-grade MoS2 of the Climax Molybdenum Company.

http://dx.doi.org/10.1016/j.hydromet.2006.11.003

Towards sustainable solutions for fly ash through mechanical activation.

Kumar, Rakesh and Kumar, Sanjay and Mehrotra, S P (2007)
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Resources, Conservation and Recycling, 52 (2). pp. 157-179.

This paper is a critical overview on fly ash utilisation with emphasis on mechanical activation of fly ash in developing processes for medium to high volume utilisation of fly ash. Applications of mechanical activation that are particularly highlighted include blended cement containing high volume (50–60%) of fly ash, and geopolymer materials, such as high compressive strength (up to 120 MPa) geopolymer cements and self glazed tiles. The schemes for the utilisation of fly ash involving mechanical activation are worked out that have potential to evolve as sustainable solutions.

http://dx.doi.org/10.1016/j.resconrec.2007.06.007

Influence of reactivity of fly ash on geopolymerisation.

Kumar, Sanjay; Kumar, Rakesh and Alex, T C and Bandopadhyay, A and Mehrotra, S P
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Advances in Applied Ceramics, 106 (3). pp. 120-127.

The reactivity of fly ash has been altered through an increase in glass content by air classification and mechanical activation using vibratory and attrition mills. The effect of the reactivity on fly ash geopolymerisation has been investigated with specific reference to edging of fly ash with alkali at 27°C and geopolymerisation schemes involving edging and thermal curing or direct thermal curing at 60°C. The effect of improved reactivity of fly ash on the resulting geopolymers was studied through determination of compressive strength, phase formation by X-ray diffraction and microstructural evaluation by scanning electron microscopy. The improvement in compressive strength is found to be related to the improved reactivity and resulting formation of compact microstructure.

Selection of geopolymerisation scheme is found to be a key factor to realise beneficial effect of improved reactivity. Isothermal conduction calorimetry studies along with differential thermal analysis (TG/DTA) were carried out to elucidate the influence of improved reactivity during geopolymerisation. Finer particle size resulted in greater dissolution of fly ash during edging. However, the overall process of geopolymerisation and strength development was found to depend not only on dissolution but also on subsequent stages of geopolymerisation. Mechanically induced reactivity is found to have far greater influence on geopolymerisation and strength development vis-à-vis reactivity induced by finer particle size and higher glass content obtained through air classification.

http://10.1179/174367607X159293

Hydrometallurgical recovery of copper and nickel powders from the copper bleed solution of Indian sea nodules.

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Korea on Minerals and Materials Processing and Utilization, 11 (1). pp. 56-63.

Abstract : The copper bleed solution containing -40 g/L Cu, 20 g/L Ni and 180 g/L sulphuric acid is generated during the separation and recovery of metals by solvent extraction-electrowinning (SX-EW) in a close-loop operation for the ammoniacal leach liquor of Indian Ocean nodules. This paper describes the development of a process to produce high value copper and nickel powders following partial decopperisation, crystallization of mixed sulphate salt and aqueous hydrogen reduction. The copper powder was produced in an autoclave from the sulphate solution at initial hydrogen pressure of 26 bar in 90 minutes at 413 K. Subsequently, nickel powder was recovered (99%) in two stages from the solution of pH 4.5 at 40 bar pressure and 463 K after removal of residual copper as sulphide. Nickel recovery in one stage was however observed to be 98% when hydrogen reduction was carried out from an ammoniacal solution in the pH range 9-11. P/M grade copper and nickel powders of acceptable purity were produced from the bleed solution.

http://eprints.nmlindia.org/2625/

Solvent Extraction Studies for Removal of Hazardous Metals from the Sulfate Leach Solution of Electronic Wastes.

Kumar, Vinay and Kumar, Manoj and Bagchi, D and Jha, Manis K and Jeong, Jinki and Lee, Jae-chun
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Proceedings of International Symposium of resource recycling . pp. 138-143.

With rapid industrialisation, the amount of e-wastes is in-creasing enormously in the world. In order to conserve res-ources and reduce environmental pollution, attempts are be-ing made to recover the valuables from such wastes. The present paper reports the studies carried out for separat-ion of metals viz.copper,cadmium,zinc and nickel expected from leaching of e-wastes. Initially, studies have been made to establish the condition required for cadmium extra-ction. The solvent,DEHPA was found suitable for extraction of cadmium and complete extraction can be achieved at pH 4.5 , O/A in 2 minutes from the sulfate solution . The studies carried out with model mixed solution containing copper, cadmium, zinc and nickel showed that copper can be selectively extracted with LIX84 leaving other metals in aqueous raffmate at O/A ratio 1 and above pH2. Subsequent-ly,the raffinate containing cadmium, zinc and nickel could be separated with DEHPA under the controlled pH.

http://eprints.nmlindia.org/2965/

Characterisation of iron ore from the Jilling area of eastern India with a view to beneficiation.

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Iron Ore Conference 2007, Proceedings . pp. 179-186.

The Precambrian iron ore of Singhbhum-North Orissa region of eastern India occurs as part of the horseshoe-shaped broad synclinorium known as the Iron Ore Group (IOG) of rocks, which hosts the most important iron ore deposits in India. The Jilling-Langalota iron ore deposits are part of the IOG. Detailed mineralogical characterisation of different ore types has been carried out using transmitted and reflected light microscopy. Scanning electron microscope-energy dispersive spectroscopy (SEM-EDS), X-ray diffraction (XRD) and X-ray fluorescence (XRF) have also been used with a view to test the amenability of these ore types for beneficiation requirements. It has been observed that haematite, martite and goethite are the main iron-bearing minerals. Kaolinite and quartz are the major gangue mineral phases. Considerable mineralogical, textural and compositional variations have been observed among the different ore types. Characterisation data reveals that the massive and hard-laminated ores are of higher grade with very few interlocking textures having haematite and martite as major mineral constitutents. The soft-laminated lateritic and friable ores are relatively low-grade varieties containing various proportions of impurities with complex interlocking textures. The soft-laminated and lateritic ores are porous in nature and contain friable oxide and hydroxides of iron along with kaolinite, gibbsite and quartz. The occurrence of kaolinite, gibbsite and hydrated oxides along the cavities and weaker mineral planes of haematite and martite has been observed. The friable nature and high alumina content of these ores are attributed to these secondary phases. The nature of these ores is responsible for producing large amounts of alumina-rich slime during mining and handling

operations. Suitable beneficiation schemes have been recommended for each type based on detailed characterisation investigations on these ores.

http://eprints.nmlindia.org/3421/

Feasibility of Producing Pellet Grade Concentrate by Beneficiation of Iron Ore Slime in India.

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Separation Science and Technology, 42 (14). pp. 3271-3287.

Beneficiation of low grade iron ore slime from Chitradurga, India was studied with a view to produce pellet grade fines. The slime sample had a feed grade of 49.86% total Fe, 7.93% Al2O3, and 10.19% SiO2. Kaolinite and quartz was found to be the main gangue minerals and they formed porous and friable oxide and hydroxide of iron. Over 54% of the materials in the slime were less than 20 micron and this size fraction contained higher percentage of gangue minerals. Liberation of free gangue minerals was observed to be substantial in all size classes. Beneficiation studies indicated that excellent rejection of silica and alumina could be obtained through physical separation. The low grade slime could be enriched to 66.36% Fe with 1.75% silica, and 1.44% alumina.

http://www.tandfonline.com/doi/abs/10.1080/01496390701514824

Studies on Recovery of Mineral Values using an Enhanced Gravity Separator.

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Advanced Gravity Separation . pp. 1-6.

Studies were undertaken on recovery of value minerals from iron ore slimes. coal fines and barite sludge samples using multi-gravity separator (MGS), an enhanced gravity separator. For iron ore slimes it was possible to reduce alumina -2% with a yield of 42% from a sample assaying 7.49%A120,. Clean coal products with 74.6% and 82.0% yields with 17.11% and 33.14% ash were obtained from coking and non-coking coal fines respectively. Similarly, from the barite sludge sample studied, conce-ntrates assaying 89.95% BaSO4 was obtained.

http://eprints.nmlindia.org/4156

Fluid inclusion and mineralogical study of vein-type apatite ores in shear zones from the Singhbhum metallogenetic province, West Bengal, India.

Vapnik, Yevgeny and Bushmin, Sergey and Chattopadhyay, A and Dobrovolsky, D D
Ore Geology Reviews, 32 (1-2). pp. 412-430.

Apatite ores were sampled from the Beldih–Kutni and Jhalda shear zones of the Purulia District, in the northern part of the Singhbhum copper–uranium belt, India. These apatite–magnetite ores of Kiruna-type sensu lato are of hydrothermal origin as evidenced by their mode of occurrences and mineral composition. The apatite ores contain both sulfide and niobite–tantalite mineralization. Geological and mineralogical data indicate that the process of apatite ore formation can be divided into several stages. The earliest stage is sodium metasomatism of the host rock, which is reflected in the appearance of albite, alkali amphibole and alkali pyroxene. The second stage is carbonatization with the development of calcite, dolomite, and apatite. During progressive carbonatization, the apatite content increases and apatite-rich ores are formed in the central part of hydrothermal flow. Initially, this is a grey apatite ore, but as the process of silicification and ferrugination proceeds, the apatite–quartz and then magnetite–quartz–apatite ores containing rare-metal mineralization were formed. The process was completed with the injection of quartz veins. Fluid inclusion data indicate that the two major components of the fluid during ore precipitation were an aqueous fluid with salinity between 40 and 25 wt.% NaCl equiv., and a CO2 ± CH4 fluid with a mole fraction of CH4 up to 0.2. The two fluid systems are contemporaneous and likely formed as a result of the fluid immiscibility. The conditions of the succession of apatite ore formation determined on the basis of fluid inclusion densities are 150 < T < 350 °C, 0.1 < P < 3.0 kbar.

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Adsorption mechanism of mixed cationic/anionic collectors in feldspar-quartz flotation system.

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Journal of Colloid and Interface Science, 306 (2). pp. 195-204.

The adsorption mechanism of mixed cationic alkyl diamine and anionic sulfonate/oleate collectors at acidic pH values was investigated on microcline and quartz minerals through Hallimond flotation, electrokinetic and diffuse reflectance FTIR studies. In the presence of anionic collectors, neither of the minerals responded to flotation but the diamine flotation of the minerals was observed to be pH and concentration dependent. The presence of sulfonate enhanced the diamine flotation of the minerals by its co-adsorption. The difference in surface charge between the minerals at pH 2 was found to

be the basis for preferential feldspar flotation from quartz in mixed diamine/sulfonate collectors. The infrared spectra revealed no adsorption of sulfonate collector when used alone but displayed its co-adsorption as diamine–sulfonate complex when used with diamine. The presence of sulfonate increased the diamine adsorption due to a decrease in the electrostatic head–head repulsion between the adjacent surface ammonium ions and thereby increasing the lateral tail–tail hydrophobic bonds. The mole ratio of diamine/sulfonate was found to be an important factor in the orientation of alkyl chains and thus the flotation response of minerals. The increase in sulfonate concentration beyond diamine concentration leads to the formation of soluble 1:2 diamine–sulfonate complex or precipitate and the adsorption of these species decreased the flotation since the alkyl chains are in chaotical orientation with a conceivable number of head groups directing towards the solution phase.

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Comminution - Theory and Plant Practice.

Das, Avimanyu and Roy, Subrata
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In: Processing of Iron Ore, Nov. 28-Dec. 01, 2007, NML, Jamshedpur.

Comminution is a major unit operation in iron ore processing. In terms of global quantities of material reduced in size, it has been estimated that the annual tonnage is of the order of several thousand million, and in terms of the energy expended the yearly megawatt hours total several hundred million.

http://eprints.nmlindia.org/5905

Magnetic Separation - Principles and Application in Beneficiation of Iron Ores.

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Magnetic Separation is one of the physical concentration processes that utilizes the differences in magnetic properties of various minerals present in the ore body. The magnetic fraction may be valuable or gangue depending upon its end use in a particular process and so also the non-magnetic fraction, e.g., separation of magnetite (magnetic) from quartz (non-magnetic), separation of tin bearing mineral cassiterite (non-magnetic) from magnetite (magnetic) impurity etc.

http://eprints.nmlindia.org/5907

Processing of electroplating effluent for the recovery of zinc and chromium using ion exchange technique.

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In: Proceedings of International Symposium of resource recycling, 2007, resource recycling.

In order to reduce the pollution and conserve the resourc-es, a process has been proposed to recover zinc and chrom-ium from the electroplating effluent following ion exchange technique. The studies for the extraction of zinc in diffe-rent contact time, pH of the solution, resin dose, mechani-sm of adsorption etc. were made for the recovery of zinc from the solution using cationic resin,Lewatit VP OC 1026. The resin, Lewatit VP OC 1026 has been found to be select-ive for the extraction of zinc from the effluent leaving total chromium in the raffinate. The zinc was effectively eluted from loaded resin with dilute sulphuric acid. The mechanism of extraction of zinc was found to follow the Langmuir isotherm. The chromium was extracted from the raffinate using anionic resin, Amberlite IRA 400 Cl and loaded chromium eluted effectively with 20% NaOH.

http://eprints.nmlindia.org/2969

Geochemistry of Iron Ores.

Mohanta, M K
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In: Processing of Iron Ore, Nov. 28-Dec. 01, 2007, NML, Jamshedpur.

Geochemical process of selective concentration of elements is controlled by the dynamic tectonic evolution of earth in the geological time scale of million of years. Iron crystallizes out from magmatic melt if the evolved basal-tic melt is highly enriched with Fe (high chemical activ-ity of Fe) and suitable pressure temperature (thermo-dynamic) condition to stabilize spinel magnetite and ilmen-ite. Iron is soluble in atmospheric EhpH conditions and is amenable to precipitate as hydroxide, oxyhydroxide, carb-onate and sulphide in localized change in Eh-pH. The sili-cate minerals weather to release Fe which precipitates as goethite, chamosite, siderite, pyrite in sedimentary geochemical environment depending upon the low-temperature thermodynamics prevailing in the depositional site. The phase transition to magnetite andhematite is also possi-ble during metamorphism and martitisation. So, concen-tration of iron in geological set up can occur in widely varied conditions from lacustrine to marine, even magmatic to metamorphic.While sedimentary iron deposit is assoc-iated with sedimentary rocks and to their metamorphic equivalent in case the terrain is metamorphosed, the mag-matic iron deposit is associated with basalt and meta-basalt. It is also suggested that hydrothermal action can selectively leach out carbonate-silicate metasediments with

supergene enrichment of Fe. Majority of the iron ore deposits (Fig.- 5.1) are confined to Banded iron formation (BIF) of Proterozoic volcano-sedimentary sequence (supra-crustal) of age 2.5-2.4Ga, 2.2 - 2.06Ga and 2.0Ga. Thus, Complex genetic process has a control over the mineral-ogical and geochemical attribute of the iron ore, associ-ated rocks and their host rocks. The associated rocks contribute to the gangue component, which is the interest of Mineral Engineering to get rid of. The geochemical data also helps to understand the ore, its' utility and recov-ery of valuable metals if any.

http://eprints.nmlindia.org/5904

Copper biodissolution from a low grade chalcopyrite ore by unadapted/adapted acidithiobacillus ferrooxidans.

Pal, S C and Mehta, K D and Abhilash, and Kumar, Vinay and Pandey, B D and Mankhand, T R
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In: Proceedings of Mineral Biotechnology – 2007.

The depletion of high-grade deposit of copper around the world has drawn attention for the utilisation of low-grade reserves . Malanjkhand Copper Project (MCP) in India is a low-grade ore containing -0.3% Cu in which copper metal is found to be present as chalcopyrite associated with pyrite in quartz veins and granitic rocks. In order to extract copper from this material , an alternate processing option such as bioleaching has been followed. Bench scale bioleaching experiments were carried out using Acidithiobacillus ferrooxidans (Ac. Ti) isolated from mine water. On using unadapted Ac. Tf isolate directly at pH 2.0 and 35°C, the optimum leaching conditions in shake flask were found to be 5% pulp density (PD), 2.OpH , 35°C temperature for <50p .m particles , yielding 72% Cu biorecovery in 35days. The Tf isolate when adapted to the ore and employed for the bioleaching of the ore at 5% PD (w/v), 2.OpH and 25 °C with three particle sizes viz.150 -76µm, 76-5011m and <50µm, resulted in recovery of 38 .31%, 29.68% and 47.5% Cu respectively with a rise in Eh from 530 to 654 mV in 35 days. Under similar conditions , the unadapted strain gave maximum recovery of 44.0 % for <50pm ore size with rise in Eh from 525 to 650mV . Copper biorecovery increased to 75.3% with the adapted isolates at 35°C for the finer particles of <50gm at 2.OpH with a rise in cell count from lx l 07 cells/mL to 1.13x109 cells/mL in 35 days. The biodissolution of copper from chalcopyrite with the involvement of adapted Ac. Tf species resulted in the improvement of iron oxidation rate (Fe2+ to Fe`) and consequently higher redox potential.

http://eprints.nmlindia.org/2630

Separation response of iron ores during gravity concentration.

Roy, Subrata and Das, Avimanyu and Sarkar, B and Bhattacharyya, K K
Email: adas@nmlindia.org
In: Advanced Gravity Separation, Aug 30 - Sept 1, 2007, NML Jamshedpur.

Two types of iron ores namely soft laminated ore and goethitic-lateritic ore is studied in details from Jilling-Langalota deposit, Singhbhum-N, Orissa Craton, Eastern India. The soft laminated iron ore contained relatively high hematite as compared to Goethitic-lateric ore which contained goethite in large quantity. Beneficiation of iron ores by gravity separation method is studied. The ore samples are beneficiated with a view to produce sinter quality concentrate. The soft laminated ore contained 61.29% total iron, 5.04% silica and 4.29% alumina while the Goethitic-lateritic ore contained 53.34% total iron, 7.4% silica and 5.49% alumina. Liberation analysis of different size fraction suggested that grain size reduction lower than 150 mm size would be necessary to achieve sufficient liberation of iron ore minerals from the associated gangue (kaolinite and gibbsite). However, the percentage of interlocking is higher in case of Goethitic-lateritic ore compared to soft laminated ore. Considering the characterisation data, the soft laminated ore is ground separately to three size fractions namely 300 mm, 250 mm and 150 mm sizes, while the goethitic ore is ground to 150 mm size and subjected to flowing film concentration in Wilfley Table. The grade of the soft laminated ore is improved from 61% Fe to 66% Fe while for the Goethitic-lateritic ore the Fe content is enriched from 53% to 64% in simple one-stage concentration operation. The nature of the ore mineral plays important role in the separation process. Due to enrichment of goethite and friable nature of Goethitic-lateritic ore significant amount of Fe is lost during the process as compared to soft laminated ore.

http://eprints.nmlindia.org/1357/

Designing Process for Beneficiation of Low Grade Iron Ore Samples from Orissa.

Singh, Ratnakar and Maulik, S C and Rath, R K and Dey, Shobhana and Das, Avimanyu and Nayak , B and Bhattacharyya, K K (2007)
Email: rs@nmlindia.org
In: International Conference on Mineral Processing Technology (MPT – 2007).

The paper deals with the results of characterization and beneficiation studies carried on low grade iron ore samples from Orissa. Beneficiation of the two individual samples and their compostite based on gravity and magnetic separation techniques resulted in products with varying yield and grade of the products.The results of laboratory studies were validated through pilot scale trials. Based on the studies undertaken process was designed for bene-ficiation of the composite sample, comprising 60% S I and 40% S2, to a high grade product assaying over 65% Fe. Detailed material balance for the designed process was also undertaken.

http://eprints.nmlindia.org/4161

Froth Flotation and its Application to Concentration of Low Grade Iron Ores.

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In: Processing of Iron Ore, Nov. 28-Dec. 01, 2007, NML, Jamshedpur.

Froth flotation is a process used to separate minerals, suspended in liquids, by attaching them to gas bubbles to provide selective levitation of the solid particles. It is most extensively used process for the separation of chemi-cally similar minerals, and to concentrate ores for econo-mical smelting. Flotation is a selective process and can be used to achieve separation from complex ores such as lead-zinc, copper- zinc etc.Initially developed to treat the sulphides of copper, lead, and zinc, the field of flotation has now expanded to include oxides, such as hematite and cassiterite, oxidised minerals, such as mala-chite and cerussite, and non-metallic ores, such as fluo-rite, phosphates, and fine coal.

http://eprints.nmlindia.org/5908

The separation of arsenic from copper in a Northparkes copper–gold ore using controlled-potential flotation

L.K. Smith, W.J. Bruckard
International Journal of Mineral Processing, Volume 84, Issues 1–4, 19 October 2007, Pages 15-24

In order for the high-arsenic regions of the Northparkes copper–gold orebody to be beneficiated economically, tennantite ($(Cu,Fe)_{12}As_4S_{13}$) present in the ore needs to be rejected to enable copper concentrates to meet the typical smelter penalty level of 2000 ppm As. Using a composite sample of high-arsenic drill cores from Northparkes it was possible to selectively separate tennantite from chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4) using controlled-potential flotation. The separation was made on a bulk copper–arsenic concentrate after reducing the pulp potential to about − 150 mV SHE at pH 12 and floating the tennantite from the other copper minerals. The basis of the separation relies on findings that the lower limiting pulp potential threshold for tennantite is lower than that for chalcopyrite such that there is a potential window in the reducing region where tennantite is strongly floatable but chalcopyrite is not. Little or no selectivity between tennantite and chalcopyrite was found in the oxidising pulp potential region for the range examined. From the composite sample tested, which had a head grade of 0.11% As and 1.2% Cu, it was possible to produce a low-arsenic high-copper concentrate containing 52% of the non-tennantite copper and assaying 2600 ppm As. Computer simulations have shown that for a feed containing a more typical arsenic and copper level (200 ppm As and 1% Cu) the efficiency of separation should be sufficient to concentrate about 61% of the copper in a product assaying less than 2000 ppm As. A

conceptual flowsheet for arsenic rejection from Northparkes copper–gold ore, based on the findings from this study, is presented and discussed in this paper.

Stagewise analysis of flotation by factorial design approach with an application to the flotation of oxidized pentlandite and pyrrhotite

B. Nanthakumar, S. Kelebek
International Journal of Mineral Processing, Volume 84, Issues 1–4, 19 October 2007, Pages 192-206

A three-variable and two-level (2^3) factorial study was used to assess simultaneous effects of TETA, EDTA and KAX on pentlandite and pyrrhotite in flotation of a severely oxidized nickel–copper sulphide ore. The main effects of these reagents on recovery of pentlandite and pyrrhotite were consistently negative, positive and positive, respectively. The approach used is novel in that the factorial analysis was carried out for every stage of flotation recoveries cumulatively. This revealed how statistical significance of the reagent effects varies with the progress of flotation. For example, the effect of KAX as a collector was not significant in the initial period of flotation, suggesting that these minerals were mostly relying on their self-induced floatability due to involvement of a metastable form of sulphur. This occurred to a much greater extent for pyrrhotite, accounting for 82% of floatable pyrrhotite compared to 22% of floatable pentlandite. Presence of elemental sulphur as well as metal ions was established by extraction studies. Separation efficiency between pentlandite and pyrrhotite was generally poor due to similar characteristics induced by oxidation.

Uptake and desorption of copper ion using functionalized polymer coated silica gel in aqueous environment

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Separation and Purification Technology, Volume 57(1), 1 October 2007, Pages 47-56

A resinous functionalized polymer, aniline formaldehyde condensate (AFC) coated on silica gel was used as an adsorbent to remove copper (Cu^{2+}) from aqueous solution under conditions of different initial Cu^{2+} concentration, adsorbent loading, pH and adsorption time. Coordination bond formation between amine group and Cu^{2+} ion was the main mechanism of copper removal. Adsorption increased from 20% at pH 4 to 71% at pH 6 due to less competition from proton. Adsorption equilibrium was achieved within 120–150 min. The kinetics of adsorption followed second order model with rate constant of 0.0021 g/mg min. The adsorption data gave good fit with Langmuir isotherm and yielded Langmuir monolayer isotherm uptake of 76.33 mg/g and adsorption equilibrium parameter of 0.022 L/mg at solution pH of 5.4–5.7 and temperature of 22–25 °C. During desorption studies 97–100% of adsorbed copper ion released in solution in presence of 1N strength of mineral acids HCl, H_2SO_4 and HNO_3. Dynamic study shows that column

breakthrough was achieved at 264 bed volume at initial Cu^{2+} of 25 mg/L. Further studies are recommended on regeneration and reuse of AFC coated silica gel after desorption of copper ion.

Clean fuel-magnesia bonded coal briquetting

Yildirim I. Tosun
Fuel Processing Technology, Volume 88, Issue 10, October 2007, Pages 977-981

Benefaction from coal fines as solid fuel in Turkey is very much important for economical development. Beneficiation from washed coal fines in the industry using solid fuel at lump size and in the municipal areas as an household solid fuel may be only provided by hot briquetting of the coal fines. The most practical common way of that benefication from coal fines in our country have been hot binding by sulfite liquor–sulfite liquor-melas and lime mixtures. Harmful the flue content of sulfite liquor-melas may only be eliminated by lime, a type of solid additive. However, cold bonded briquettes produced from coal fines are environmentally free. Just ash contents of these briquettes increase at a certain degree and heat content of them decrease at a certain extent. By using magnesia binder showed in this study, Tunçbilek lignite fines have been briquetted by cold and hot briquetting techniques. The qualities of briquettes produced by cold binders were compared with to those produced by other hot binding methods As a result, magnesia binder showed the similar characteristics with those of the briquettes produced by only cold bonded gypsum. Use of magnesite mixture and gypsum just as only cold binder was not suitable for the requirements from the coal briquettes to be used as solid fuels, particularly from household fuels, but just only as cold additive should be used.

Genetic algorithms — A novel technique to optimize coal preparation plants

Vishal Gupta, Manoj Mohanty, Ajay Mahajan, S.K. Biswal
International Journal of Mineral Processing, Volume 84, Issues 1–4, 19 October 2007, Pages 133-143

A coal preparation plant typically operates with multiple cleaning circuits based on the particle size distribution of run-of-mine coal. Clean coal product from a plant commonly has to satisfy multiple product quality constraints, including product ash, product sulfur, heating value, moisture content, etc. Numerous studies in the past illustrate that the optimal yield of the plant can be obtained by operating each circuit to produce the same incremental product quality. This equal incremental product quality approach optimizes the plant yield considering only one product quality at a time. Thus, when required to simultaneously satisfy multiple product quality constraints, the process not only becomes increasingly complex and cumbersome, but also may lead to erroneous conclusions in many cases. A novel plant optimization technique was developed using genetic algorithms (GA) to maximize the overall revenue generated by a coal

preparation plant by searching the best possible combination of overall yield and multiple product quality constraints. This approach is based on an evolutionary algorithm that maximizes the overall plant revenue based on a single objective function, which was developed by incorporating clean coal yield, targeted product ash content, product heating value, and product SO_2 emission potential. Comparative results discussed in this publication indicate the suitability of the proposed GA-based plant optimization approach.

Characterising the sintering behaviour of pulverised fuel ash using heating stage microscopy

V. Adell, C.R. Cheeseman, M. Ferraris, M. Salvo, F. Smeacetto, A.R. Boccaccini
Materials Characterization, Volume 58, Issue 10, October 2007, Pages 980-988

Heating stage microscopy was used to investigate the sintering behaviour of pulverised fuel ash (PFA). The effect of chemical composition, heating rate, maximum temperature and metal inclusions on densification was studied. It was confirmed that dimensional changes of PFA powder compacts can be controlled by selecting appropriate conditions of sintering temperature and heating rate. It was also found that the sintering behaviour of PFA can be modified with the addition of metal inclusions. The results suggest that development of pores and microstructure of lightweight aggregates (LWA) manufactured from PFA can be controlled by changing the key sintering parameters such as temperature, time and heating rate.

Effect of frothers and solid particles on the rate of water transfer to froth

Francisco Melo, Janusz S. Laskowski
International Journal of Mineral Processing, Volume 84(1–4), 19 Oct 2007, Pages 33-40

The effect of flotation frothers on the rate of water transfer to foam/froth has been tested. Two-phase experiments with aqueous solutions of the frothers, and three-phase experiments in the presence of solid particles have been carried out. It has been shown that while the rate of water transfer to foam (two-phase system) is well correlated with the fundamental properties of the frothers, the water transfer rates may be quite different when solid particles are present in the system. These water transfer rates may be further modified if also oily collector (e.g. diesel oil) is used.

Particle texture analysis using polarized light imaging and grey level intercepts

Eric Pirard, Sophie Lebichot, William Krier
International Journal of Mineral Processing, Vol. 84(1–4), 19 Oct 2007, Pages 299-309

The usual characterization of particulate ore material with image analysis includes modal analysis and liberation analysis. Both methods include stereological corrections based on intercept length distributions within each phase of interest. The first principle of stereology relies on a simple assumption of uniform random sectioning, whereas the liberation models require all particles to have similar textural properties. However, for the sake of adequate prediction of ore behavior in industrial processes it is becoming more and more important to be able to describe particle populations in terms of texture classes. Among the texture analysis techniques, this paper focuses on mean intercept length (MIL). It brings two important improvements: the first one is to improve grain boundary imaging by using images of bireflectant minerals under plane polarized illumination, the second one is to consider intercept analysis on grey level images instead of binary ones. The method is illustrated on a selection of critical hematite textures found within banded iron formations.

The flotation of metallic arsenic as a function of pH and pulp potential — A single mineral study

W.J. Bruckard, I. Kyriakidis, J.T. Woodcock
International Journal of Mineral Processing, Volume 84(1–4), 19 Oct 2007, Pages 25-32

Arsenic is a penalty element in base metal gravity and flotation concentrates and during beneficiation efforts are often made to reduce its level in concentrates destined for smelting. In some Australian tin and tantalum circuits this arsenic can occur as elemental arsenic, lollingite, or arsenopyrite. A great deal is known about the flotation of arsenopyrite, but little is known about the flotation of lollingite and arsenic. This paper is concerned with the flotation of metallic arsenic with ethylxanthate as a function of pulp pH and pulp potential (Eh). A synthetic mixture of arsenic metal and quartz was used in all tests. Arsenic was found to be strongly floating (up to 95% recovery in 8 min flotation with Aerofroth 65 frother and 40 g/t of KEX) over the pH range 5–10. At more alkaline conditions, the recovery dropped off slowly with increasing pH. At pH 6, arsenic was strongly floating over the pulp potential range + 125 mV to + 275 mV vs. SHE (Standard Hydrogen Electrode) but exhibited an upper limiting threshold value of about + 375 mV vs. SHE. The flotation response dropped off slowly with more reducing conditions below about + 125 mV vs. SHE. Here the flotation kinetics were slow. At pH 10, arsenic was found to be strongly floating in the potential range − 300 mV vs. SHE up to about + 225 mV vs. SHE. Interestingly, no lower limiting potential in the reducing potential range tested (down to − 300 mV vs. SHE) was identified. The rate data indicated fast flotation kinetics at pH 10 at potentials less than about + 225 mV vs. SHE. At pH 6, little genuine flotation of metallic arsenic in the absence of collector was observed and it appears that metallic arsenic does not exhibit any significant natural flotability as do some other metals. Importantly, the results of this study show that metallic arsenic could potentially be readily removed from base metal concentrates by controlled potential flotation over a wide range of pH values by a simple reagent combination.

Boddington gold mine - An example of sustaining gold production for 30 years

Dunne, R.; Hart, S.; Parker, B.; et al.; Book Editor(s): Avraamides, J; Deschenes, G; Tucker, D
Conference: World Gold Conference on the By and Co-Products and the Environment Location: Cairns, AUSTRALIA Date: OCT 22-24, 2007
Sponsor(s): Barrick; Newmont; Orica Mining Chem; Orica Mining Serv; QML ; Source: WORLD GOLD 2007: BY AND CO-PRODUCTS AND THE ENVIRONMENT Book Series: AUSTRALASIAN INSTITUTE OF MINING AND METALLURGY PUBLICATION SERIES Issue: 9 Pages: 213-220 Published: 2007

This paper provides a history of the challenges that were experienced while treating both the clayey oxide gold ores and the supergene copper-gold ores at the Boddington Gold Mine during the period 1989 to 2001. However the bigger challenge was to find a process flow sheet that would allow the economic treatment of the large low-grade competent gold-copper resource that underlies the oxide and supergene gold resource. Metallurgical test work and engineering studies on this resource started in the mid 1990s and culminated in the approval in 2006 of the 35 Mtpa Boddington Expansion Project to treat this material. The process flow sheet provides the basis of an energy efficient comminution circuit that includes high pressure grinding rolls and a treatment circuit with gravity separation, flash and conventional flotation to produce a precious metal low-grade copper concentrate followed by cyanide leaching of the rougher-scavenger and cleaner tailings streams. The treatment circuit allows maximum removal of copper minerals prior to cyanide leaching and so provides an environmentally responsible tailings disposal circuit.

Treatment of sulfide tailings from base metal and gold operations - A source of saleable by-products and sustainable waste management

Bruckard, W. J.; McCallum, D. A.; Book Editor(s): Avraamides, J; Deschenes, G; Tucker, D
Conference: World Gold Conference on the By and Co-Products and the Environment Location: Cairns, AUSTRALIA Date: OCT 22-24, 2007
Sponsor(s): Barrick; Newmont; Orica Mining Chem; Orica Mining Serv; QML ; Source: WORLD GOLD 2007: BY AND CO-PRODUCTS AND THE ENVIRONMENT Book Series: AUSTRALASIAN INSTITUTE OF MINING AND METALLURGY PUBLICATION SERIES Issue: 9 Pages: 85-91 Published: 2007

With depth, many gold ores become sulfidic with minerals such as pyrite, pyrrhotite and arsenopyrite becoming prevalent. In addition, many underground gold mines use tailings backfill to bind and store the waste. In these cases, acid mine drainage (AMD) can become an issue. One approach to the control of AMD is desulfurisation whereby the sulfide minerals are removed prior to disposal. Four sulfide tailings samples, representing different ore types and gold and base metal operations, were selected for assessment and testing using simple physical beneficiation techniques. The aim was to determine the extent to which mineral processing methods were suitable for separating

sulfides from non-sulfides and for extracting potentially marketable by-products front the tailings. In order to streamline the testing procedure a simple diagnostic separation technique was developed to enable quick screening of bulk sulfide tailings for suitability for reprocessing. The testing procedure involved detailed characterisation and a sequential set of testing regimes based on simple unit processes including water washing, classification, gravity concentration, magnetic separation and bulk flotation. The preliminary test results indicate each unit process can play an important part in producing effective sulfide/non-sulfide separations and in generating useful by-products from the tailings. Potential valuable products identified include coarse. benign silica sands, bulk iron sulfide products rich in pyrite and/or pyrrhotite, high-grade iron products (magnetite) low in silica, low-volume bulk sulfide concentrates and low-grade molybdenite and talc products. The work presented shows how sulfide tailings can be viewed as a resource rather than a waste stream, and identifies a pathway for developing a more sustainable approach to (he environmental management of sulfide tailings for the future.

Particle texture analysis using polarized light imaging and grey level intercepts

Eric Pirard, Sophie Lebichot, William Krier
International Journal of Mineral Processing, Volume 84, Issues 1–4, 19 October 2007, Pages 299-309

The usual characterization of particulate ore material with image analysis includes modal analysis and liberation analysis. Both methods include stereological corrections based on intercept length distributions within each phase of interest. The first principle of stereology relies on a simple assumption of uniform random sectioning, whereas the liberation models require all particles to have similar textural properties. However, for the sake of adequate prediction of ore behavior in industrial processes it is becoming more and more important to be able to describe particle populations in terms of texture classes. Among the texture analysis techniques, this paper focuses on mean intercept length (MIL). It brings two important improvements: the first one is to improve grain boundary imaging by using images of bireflectant minerals under plane polarized illumination, the second one is to consider intercept analysis on grey level images instead of binary ones. The method is illustrated on a selection of critical hematite textures found within banded iron formations.

Effects of coal composition and flotation reagents on the water resistance of binderless briquettes

Motaung, S. R.; Mangena, S. J.; de Korte, G. J.;
COAL PREPARATION, Volume: 27 Issue: 4 Pages: 230-248 DOI: 10.1080/07349340701672102 Published: OCT-DEC 2007

The difference in the physical properties, particularly the water resistance or wet strength, of the binderless coal briquettes produced from flotation feed and concentrate was investigated using six bituminous coals from two collieries in the Witbank Coalfield. The coal samples were analyzed for their proximate, petrographic, and mineralogical properties. The presence, in the flotation concentrates, of the reagents used during the froth flotation process was also investigated using gas chromatography. Pillow-shaped binderless briquettes were produced from coal samples at various moisture contents and a pressure of approximately 17 Mpa using a Komarek B-100A double-roll press. The briquettes were tested for some physical properties (i.e., dry- and wet-compressive strengths), which were thereafter compared with the properties determined for the coal samples. The binderless briquettes produced from the flotation concentrates were more water-resistant than those produced from the flotation feed. The flotation feed and concentrates of the coals tested were found to have similar petrographic properties. As expected, the ash and kaolinite contents were found to be lower in the flotation concentrates than in the flotation feed. Flotation reagents were detected in the flotation concentrates from both collieries. From the results obtained it is concluded that the increased water resistance of the binderless briquettes produced from flotation concentrates of the coals tested is due to a combination of the fineness of the coal particles, assisted by the amount of reactive macerals (most particularly vitrinite) with the lower ash and kaolinite contents, together with the presence of the flotation reagents, particularly the collector, in the flotation concentrate.

Flotation cell technology and circuit design - an Anglo Platinum perspective

Rule, C. M.; Anyimadu, A. K.
Journal of the South African institute of mining and metallurgy, Volume: 107 Issue: 10 Pages: 615-622 Published: OCT 2007

Froth flotation is the primary mineral processing separation step employed in the beneficiation of PGM ore bodies. Anglo Platinum operates a significant portion of the total installed flotation capacity in the PGM industry, which is installed at 20 operating plants across the Bushveld. PGM flotation has undergone a considerable evolution in both the capacity of flotation cells employed as well as in the circuit design configuration over the past 30 years. Certain of Anglo Platinum's flotation circuits have been in operation for a relatively long time (in some operations installed equipment dates from the 1960s), and this allows comparative operating performance between various equipment types and circuits to be evaluated. This paper summarizes some aspects of this experience. Research trends in flotation are continuously monitored so that appropriate findings can be incorporate into existing and future circuit designs. Continuous evaluation and monitoring of flotation performance is undertaken to identify opportunities for increasing flotation efficiencies. Mineralogical and fractional analyses of plant composites and survey samples are analysed to interrogate speciation and association data. This analysis has enabled a better understanding of priorities and opportunities for improved metallurgical performance. These opportunities are divided into three improvement areas: stability, liberation, and fines flotation. The paper

discusses these, as well as the circuit design improvements required to take full advantage of the opportunities identified.

Interactive software platform of intelligent supervisory control for the mineral grinding process

Ding, Jinliang; Cao, Yang; Chai, Tianyou; et al.; Book Group Author(s): IEEE
Conference: IEEE Conference on Control Applications Location: Singapore, PEOPLES R CHINA Date: OCT 01-03, 2007
Sponsor(s): IEEE, Source: PROCEEDINGS OF THE 2007 IEEE CONFERENCE ON CONTROL APPLICATIONS, VOLS 1-3 Book Series: IEEE International Conference on Control Applications Pages: 1386-1391 Published: 2007

The mineral grinding process is an important procedure in the mineral processing. Its technical performance index is the particle size, which is closely related to the overall performance of the mineral processing. In this paper, we present the construction of a software platform of the supervisory control of the grinding process to control its particle size into the target range. The platform provides the researcher and the engineer with an interactive tool to investigate the supervisory control algorithms and their parameters selection. The supervisory control strategy, the structure and the function of the software platform are given in the paper, where two experiments are given to evaluate the software platform and the results show its validity and efficiency.

Convective-dispersive gangue transport in flotation froth

Stevenson, Paul; Ata, Seher; Evans, Geoffrey M.
CHEMICAL ENGINEERING SCIENCE Volume: 62 Issue: 21 Pages: 5736-5744
DOI: 10.1016/j.ces.2007.05.038 Published: NOV 2007

The transport of gangue through flotation froth has been described by solving the convection-diffusion equation. Gangue recovery is predicted to be proportional to liquid recovery, which is consistent with experimental observation. In addition, it is seen that the dependency of gangue recovery upon particle size is due to processes within the pulp phase rather than the froth, insofar as the transport of particles in a given froth is approximately independent of size. The importance of maintenance of positive bias in column flotation, previously stressed by other workers, is reinforced. This model utilises a simplified representation of the froth and, as a consequence, it does not necessarily give accurate gangue recovery estimates for practical flotation processes. However, the convective-diffusive model does illuminate the physical processes behind gangue recovery in the concentrate which will aid the development of automatic control strategies.

Leaching of manganese ores using sawdust as a reductant

Minerals Engineering, Volume 20, Issue 14, November 2007, Pages 1293-1295
D. Hariprasad, B. Dash, M.K. Ghosh, S. Anand

In this study sawdust was used as reductant for sulphuric acid leaching of manganese ore. Effects of pulp density, amount of acid, temperature, particle size of ore and amount of sawdust were studied. Manganese extraction of ~98% was achieved under the conditions: leaching time 8 h, 5% H_2SO_4 (v/v), 10% pulp density, 90 °C and 5% sawdust (w/w), i.e. 0.5 g/g ore. Other Mn containing materials like low grade manganese ore, manganese nodule and Mn-nodule leach residues were tested and all these materials responded well giving more than 98% Mn extraction.

How fine particles on haematite mineral ultimately define the mineral surface charge and the overall floatability behaviour

Montes, S.; Atenas, G. Montes; Valero, E.
JOURNAL OF THE SOUTH AFRICAN INSTITUTE OF MINING AND METALLURGY Volume: 107 Issue: 11 Pages: 689-695 Published: NOV 2007

Mineral floatability is strongly connected with mineral structure and composition. The complexity of mineral surfaces has meant that few attempts have been made to understand the effect of impurities (trace elements) on the flotation process. Zeta potential technique has been extensively used to evaluate the surface charge of mineral particles. Nevertheless, those measurements consider only an average of mineral particles surface charge. The presence of fine particles and inclusions covering a mineral may influence the local reagent adsorption process, which will ultimately be reflected in the subsequent global response of the mineral froth flotation efficiency. The current work assesses the iron oxide mineral, haematite (Fe2O3). Zeta potential and streaming potential techniques were used to determine the surface charge of fine and coarser particles of haematite.

Further analysis was performed to determine the point of zero charge (PZC) of the mineral in addition, adsorption isotherms of alkylammonium chloride reagents with different lengths of carbon chains were carried out. it was found haematite floatability depends strongly on the isoelectric point (IEP) value, which is affected by other mineral species present at the mineral surface. Haematite floatability became significant only at relatively high tetradecyl ammonium chloride collector concentrations (concentration greater than 4 x 10(-4) M), which does not happen with other oxides such as quartz. Unlike quartz, haematite develops a low surface charge over a wide range of pH, disabling all long-range attractive interactions between the mineral and the collector. Therefore, hydrophobic chain interaction is probably the most likely mechanism acting to promote collector adsorption and enhance further floatability. Diffused reflectance infrared Fourier transform spectroscopy (DRIFTS) was used to suggest a possible mechanism to understand the sequence of collector adsorption and the effect of trace species on it.

Life cycle inventory for base metal ingots production in Japan including mining and mineral processing processes by cost estimating system database

Adachi, T.; Mogi, G.
Conference: International Conference of Nonferrous Materials (ICNFM) Location: Changsha, PEOPLES R CHINA Date: NOV 25-30, 2007
Sponsor(s): China Nonferrous Met Ind Assoc; Cent S Univ. ; Source: TRANSACTIONS OF NONFERROUS METALS SOCIETY OF CHINA Volume: 17 Special Issue: 1 Pages: S131-S135 Part: A Published: NOV 2007

CO2 emission levels of copper and zinc mines from which Japanese smelters import ore concentrates into Japan, were estimated by using a database called MLED. Eleven copper mines selected from data availability of mine site covered 84% of the total imported concentrates. Adding inventories of sea transportation and smelting processes to mine development process, total CO2 emission level for copper and zinc ingots produced in Japan were calculated. The results show that the emission share of mining and mineral processing processes for each mine is indicated around 30%-70% of total emission for ingots, which implies the importance of including the mining activities to the inventory of upper stream products.

The role of cationic polyacrylamide in the reverse flotation of diasporic bauxite

Guangyi Liu, Hong Zhong, Yuehua Hu, Shenggui Zhao, Liuyin Xia
Minerals Engineering, Volume 20, Issue 13, November 2007, Pages 1191-1199

The reverse flotation separation of kaolinite and diaspore has been achieved by using the collector dodecylamine (DDA) and depressant cationic polyacrylamide (CPAM) at pH 5.5–8.5. The flotation results have been explained by adsorption measurement, solution chemistry and density functional theory (DFT) calculations.

Ultrafine coal classification using 150 mm gMax cyclone circuits

Honaker, R. Q.; Boaten, F.; Luttrell, G. H.
Minerals Engineering, Volume: 20, Issue: 13 Pages: 1218-1226 DOI: 10.1016/j.mineng.2007.06.004 Published: NOV 2007

A two-stage classification circuit using 150 mm diameter gMax cyclones was installed and evaluated in a coal preparation plant in an effort to achieve a clean coal product without the use of froth flotation. Particle size separations of around 37 mu m were achieved while limiting ultrafine bypass to less than 10% in the circuit underflow stream. As a result, approximately 81% of the ash-bearing material in the circuit feed was rejected to the circuit overflow stream. The feed ash content was reduced from around 50% to values in the range of 22-30% in the circuit underflow stream with a mass recovery of about 30%. Further reductions in the coarse product ash content were

limited due to the particle density effect and the remaining presence of a significant quantity of high-ash slime material in the coarse product. The typical D-50 for the coal particles was 40 mu m while the estimated value for mineral matter was 17 pm. Based on the findings of the study, the use of classification to recover a low-ash, coarse fraction in the feed of a fine coal circuit is limited by the density effect regardless of the ability to eliminate ultrafine bypass.

Novel waste processing by means of Mechanochemical treatment

Zhang, Qiwu; Saito, Fumio; Book Editor(s): Chang, YW; Kim, NJ; Lee, CS
Conference: 6th Pacific Rim International Conference on Advanced Materials and Processing Location: Cheju Isl, SOUTH KOREA Date: NOV 05-09, 2007
Sponsor(s): Korean Inst Met & Mat; Chinese Soc Met; Japan Inst Met; Minerals, Met & Mat Soc; Inst Mat Engn Australia; Source: PRICM 6: SIXTH PACIFIC RIM INTERNATIONAL CONFERENCE ON ADVANCED MATERIALS AND PROCESSING, PTS 1-3 Book Series: MATERIALS SCIENCE FORUM Volume: 561-565 Pages: 1569-1573 Part: 1-3 Published: 2007

As the extension of mineral processing, recycling metals from wastes is very important for a sustainable society. We have been working on mechanochemistry and its engineering applications. One of the applications is to recover and separate useful components from different kinds of wastes emitted in our society. When a waste sample is subjected to grinding in air so called mechanical treatment, it changes its structure to disordered system, resulting in chemical reactions with other substances when it takes over the certain level of energy. Depending on the existing states of target elements in the wastes, mechanical activation and mechanochemical (MC) reaction can be applied for the recycling of useful compositions and a process based on MC treatment has been developed. We will report several examples from our research experiences at the conference. The first example is to recover rare earths from fluorescent powders in waste lamps. The waste is firstly Subjected to dry grinding to cause amorphization of their structures. This amorphization makes it possible to dissolve the rare earths from the waste at high yield by leaching with mild acid solution at room temperature. Similar phenomenon can be seen in the case of ITO (indium tin oxide) scrap when it is ground, followed by leaching with acid solution.

In this case, dry grinding the scrap induces disordering the In2O3 in the scrap, leading to high dissolution of In2O3 by leaching with weak acid solution at room temperature. The presence of alumina (alpha-Al2O3) in the scrap plays a significant role to the amorphization. Another advanced waste processing is to recover molybdenum (Mo), vanadium (V) and nickel (Ni) sulphide in catalysts in oil refineries. The processing is based on MC reactions between the sulphides and additives. That is, the sulphides are subjected to dry grinding with additives such as CaO, MnO_2 and Na2CO3 to transform them into molybdate and vanadate. Subsequent water leaching allows us to recover Mo and V from the ground product. Other successful example is dry grinding metals or their oxides with polyvinyl chloride (PVC) to transform into chlorides, which dissolve easily in

water at ambient condition. The waste processing described above is now in the investigation on industrial applications, and this is a great expectation in the field of industries which emit such waste materials.

Effects of pyrite ash and silica fume on compressive strength properties of briquettes

Celik, O.; Damci, E.; Karaveziroglu, E. C.; et al.; Book Editor(s): Wang, Y; Li, SC; Huang, P; et al.
Conference: International Symposium on Environmental Science and Technology Location: Beijing, PEOPLES R CHINA Date: NOV 13-16, 2007,

Source: PROGRESS IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY, Vol. I Pages: 477-480 Published: 2007

Environmental pollution have become one of the most serious problems today in the world. The basic aim of this study is to contribute preventing environmental pollution. For this purpose industrial wastes were used to evaluate. In this study silica fume and pyrite ash were used as industrial wastes. The wastes were evaluated in producing briquettes as mineral admixtures. It is very significant that utilization of various industrial wastes such as silica fume and)pyrite ash causes to produce useful building materials is an important process because it not only converts the waste into useful materials but it also prevents the environmental pollution. In this study, it was investigated the effects of addition silica fume and pyrite ash on the compressive strength properties of briquettes)y using industrial wastes. Before preparing the briquettes hydrometer analysis, sieve analysis (particle size distribution oy thermal gravinnetric analysis (TG) analysis, IR analysis and tests of consistency limits were performed for clay. After the tests different mixtures were prepared in the ratio of 5%, 10%, 20% with,and without lime. The mixtures were moulded and sintered at 950 and 1000 C-circle in the sintering oven. After sintering of the briquettes, compressive strength tests were performed according to the Turkish Standard(TS 705).

It is concluded that briquettes with compressive strength value of 353.72 kgf/cm(2) can be produced. This result was obtained from briquette which was prepared with silica fume in ratio of 20% and the same result was obtained briquette which was prepared with silica fume in ratio of 10% These are very high values because Turkish Standard (TS 705) requires 100-240 kgf/cm2. It is also recorded that compressive strength values at, 1000 degrees C are higher than 950 degrees C for every briquette which was prepared pyrite ash and silica fume. After compressive strength testing of sintered briquettes, XRD analysis of briquettes with 10% pyrite ash and 20% silica fume which have the most compressive strength value were performed.

Sorption of Cs, Pu and Am on clay minerals

Lujaniene, G.; Motiejunas, S.; Sapolaite, J.
Conference: 1st International Conference on Applications of Radiotracers in Chemical Environmental and Biological Sciences Location: Saha Inst Nucl Phys, Kolkata, INDIA Date: JAN 23-27, 2006; Sponsor(s): Board Res Nucl Sci; Council Sci & Ind Res; Dept Sci & Technol; Dept Bio-Technol; India Council Med Res; India Natl Sci Acad

Source: JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY Volume: 274(2) Pages: 345-353 DOI: 10.1007/s10967-007-1121-1 Published: NOV 2007

Performance assessment of radioactive waste disposal requires modeling of long-term migration of radionuclides through the engineered barriers and the geological environment. The chemical complexity of sorption-desorption processes is usually reduced to integrated parameter distribution coefficients (K-d). There are a great number of publications on K-d determination, however, the existing data on K-d of radionuclides on different geological materials are for general understanding only and are not very useful for performance assessment, since changes of the geological conditions result in variability of K-d values by two orders of magnitude. In order to obtain realistic sorption data sets for safety relevant radionuclides present in a cement/concrete based repository some preliminary studies were carried out. The development of sorption database for the near-surface repository was started with measurements of cesium, plutonium and americium K-d values. Several experiments were performed in order to determine the chemical composition of cement water which could originate from infiltration of precipitation and from contact of groundwater with concrete. More than 100 batch sorption experiments were conducted with two clay samples. Cs, Pu and Am K-d values were determined for rainwater, groundwater and cement-water of different chemical compositions. Cs, Pu, Am K-d values ranged from 450 to 9700, from 15000 to 21000 and 15000 to 80000 ml/g, respectively. Changes in the geochemical conditions resulted in the variability of Cs, Pu and Am K-d values.

Industrial mineral powder production in China

Zheng, Shuilin
Source: CHINA PARTICUOLOGY, Volume: 5 Issue: 6 Pages: 376-383 DOI: 10.1016/j.cpart.2007.06.006 Published: DEC 2007

The recent annual output of major industrial mineral powders in the mainland of China has been more than 100 million t, accompanied by active development of such supporting technology as comminution, classification, separation/purification, and surface modification. In particular, the present paper reviews technologies for preparing ultra-fine particles involving dry and wet processing, modification and composition, calcination of kaolin clay, and processing of spherical/acerous industrial minerals. (c) 2007 Chinese Society of Particuology and Institute of Process Engineering, Chinese Academy of Sciences. Published by Elsevier B.V.

Effect of ionic activity products on the structure and composition of mineral self assembled on three-dimensional poly(lactide-co-glycolide) scaffolds

Shin, Kyungsup; Jayasuriya, Ambalangodage C.; Kohn, David H.
Source: JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A Volume: 83A Issue: 4 Pages: 1076-1086 DOI: 10.1002/jbm.a.31437 Published: DEC 15 2007

A biomimetic approach involving the self-assembly of mineral within the pores of three-dimensional porous polymer scaffolds is a promising strategy to integrate advantages of inorganic and organic phases into a single material for hard tissue engineering. Such a material enhances the ability of progenitor cells to differentiate down an osteoblast lineage in vitro and in vivo, compared with polymer scaffolds. The mechanisms regulating mineral formation in this one-step process, however, are poorly understood, especially the effects of ionic activity products (IP) of the mineralizing solution and incubation time. The aims of this study were to define the structure and composition of mineral formed within the pores of biodegradable polymer scaffolds as a function of IF and time. Three-dimensional poly(lactide-co-glycolide) scaffolds were fabricated by solvent casting /particulate leaching and incubated for 4-16 days in six variants of simulated body fluid whose IPs were varied by adjusting ionic concentrations. Scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy demonstrated the formation of carbonated apatite with sub-micrometer sized crystals that grew into spherical globules extending out of the scaffold pore surfaces. As IP increased, more mineral grew on the scaffold pore surfaces, but the apatite became less crystalline and the Ca/ P molar ratio decreased from 1.63 +/- 0.005 to 1.51 +/- 0.002. Since morphology, composition, and structure of mineral are factors that affect cell function, this study demonstrates that the IP of the mineralizing solution is an important modulator of material properties, potentially leading to enhanced control of cell function. (c) 2007 Wiley Periodicals, Inc.

Quantitative measurement of copper mineralogy using magnetic resonance

Bennett, Daniel; Mijak, David; Khachan, Joe
Source: MINERALS ENGINEERING Volume: 20 Issue: 15 Pages: 1344-1350 DOI: 10.1016/j.mineng.2007.08.009 Published: DEC 2007

A prototype instrument using magnetic resonance has been constructed for quantitative measurement of selected copper minerals, in bulk samples obtained from a number of commercial ore deposits. The instrument has been developed to provide rapid on-line determination of phase concentration. The on-line measurement of copper mineral phase would be of considerable assistance to the mineralogist or process engineer for process optimisation. Ultimately, the underlying method may be applied in ore streams on conveyors or batch samples. This paper describes the development of the instrument and measurement methods, with particular emphasis on chalcopyrite, focusing on the design route for instrument deployment. Quantitative results regarding detection limits and accuracy for dilute ore concentrations are presented. In addition, effects due to crushing and grinding are discussed. Owing to the very high selectivity of

the technique, it has been possible to demonstrate mineral phase resolution of 0.1 wt% in bulk samples.

Additional investigations on the separation of titanoferrous impurities from kaolin by high shear pretreatment and froth flotation - Part I

Raghavan, P.; Chandrasekhar, S.; Vogt, V.; et al.
Source: APPLIED CLAY SCIENCE Volume: 38 Issue: 1-2 Pages: 33-42 DOI: 10.1016/j.clay.2007.02.004 Published: DEC 2007

Additional investigations were carried out in the laboratory for the separation and removal of colouring titanoferrous impurities from cryofiltered kaolin so as to elucidate more information on the effect of high shear pretreatment. The procedure consists of high shear agitation of a high solids clay slurry with the dispersant (high shear dispersion - HSD) followed by high shear agitation with the collector (high shear conditioning - HSC) as pretreatment steps and subsequently, reducing the pulp density and carrying out reverse flotation to float out the titanoferrous minerals. The flotation feed was prepared from a clay sample collected from Mamuara area of Gujarat, India. The raw clay was processed by centrifugation and cryofiltration. The cryofiltered clay forms the feed to flotation and consisted of 88 - 90% particles below 2 pm and about 70% below 1 mu m. This material assayed 1.06% of TiO2 and 0.29% Fe2O3 and measured a brightness of 83.4% and a yellowness of 7.1% ISO. Earlier studies gave the indication of interdependence of HSD and HSC (time) which was experimentally confirmed in the present investigation. It could be shown that impurity removal increases as total pretreatment time increases up to a certain limit and the time required for HSC is at least twice of HSD time. Higher shear intensities favour both the impurity liberation and collection. Most importantly, the shear frequency is found more influential than the shear rate for the overall flotation performance. At high shear frequencies, i.e., when a stirrer with more number of teeth on the rotor is used, the HSD/HSC time ratio shifts towards higher values so as to reduce the total time for pretreatment with improved titania removal. Re-optimisation of collector dosage based on these improved pretreatment conditions helped to remove more titanoferrous impurities. Lowest product titania achieved is 0.35% from a feed value of 1.06%. The flotation product measured 85% ISO brightness at a clay recovery of 86.4%. The brightness was further improved to 85.7% by reductive bleaching. (c) 2007 Elsevier B.V. All rights reserved.

Fluid flow and kinetic modelling in flotation related processes: Columns and mechanically agitated cells - A review

Yianatos, J. B.
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In this paper, fluid flow and kinetic models related to minerals flotation process are presented and the advantages and limitations of using this type of models are discussed. The modelling of such processes was firstly developed assuming perfect mixing for the whole system as a black box. Then, a more realistic approach was developed recognizing the interaction between two zones, the particle-bubble collection zone and the froth transport zone. From a hydrodynamic point of view, experimental data showed that single large mechanical flotation cells can deviate significantly from perfect mixing, while the mixing conditions in a flotation bank of mechanical cells (three to nine cells in series) can be well described as a series of continuous perfectly mixed reactors. From plant experience, it was observed that performance of large industrial pneumatic flotation columns, originally regarded as a counter-current operation, also operate closer to a single perfectly mixed reactor. Advances in the field of modelling and design of flotation cells and columns, have been achieved because the fluid flow regime, the mass transport conditions at the pulp/froth interface and the froth transport mechanisms are better known and understood. Key parameters such as the bubble surface area flux, related to the bubble generation and the rate of particle collection, bubble loading related to the mass transport across the pulp-froth interface and froth recovery, which is mainly related to the gas residence time in the froth, are relevant for a deeper understanding of this type of equipment.

Mineralogy of the hardpan formation processes in the interface between sulfide-rich sludge and fly ash: Applications for acid mine drainage mitigation

Perez-Lopez, Rafael; Nieto, Jose Miguel; Alvarez-Valero, Antonio M.; et al.
Source: AMERICAN MINERALOGIST Volume: 92 Issue: 11-12 Pages: 1966-1977
DOI: 10.2138/am.2007.2686 Published: NOV-DEC 2007

In the present study, experiments in non-saturated leaching columns were conducted to characterize the neoformed phases that precipitate at the interface between two waste residues having different chemical characteristics: an acid mine drainage producer residue (i.e., pyritic sludge) and an acidity neutralizer residue (i.e., coal combustion fly ash). A heating source was placed on top of one of the columns to accelerate oxidation and precipitation of newly formed phases, and thus, to observe longer-scale processes. When both residues are deposited together, the resulting leachates are characterized by alkaline pH, and low sulfate and metal concentrations. Two mechanisms help to improve the quality of the leachates. Over short-time scales, the leaching of pyrite at high pH (as a consequence of fly ash addition) favors the precipitation of ferrihydrite, encapsulating the pyrite grains and attenuating the oxidation process. Over longer time scales, a hardpan is promoted at the interface between both residues due to the precipitation of ferrihydrite, jarosite, and a Ca phase-gypsum or aragonite, depending on carbonate ion activity. Geochemical modeling of leachates using PHREEQC software predicted supersaturation in the observed minerals. The development of a relatively rigid crust at the interface favors the isolation of the mining waste from weathering processes, helped by the cementation of fly ash owing to aragonite precipitation, which ensures total isolation and neutralization of the mine residues.

Additional investigations on the separation of titanoferrous impurities from kaolin by high shear pretreatment and froth flotation — Part I

P. Raghavan, S. Chandrasekhar, V. Vogt, E. Gock, N. Suresh
Applied Clay Science, *Volume 38, Issues 1–2*, *December 2007*, *Pages 33-42*

Additional investigations were carried out in the laboratory for the separation and removal of colouring titanoferrous impurities from cryofiltered kaolin so as to elucidate more information on the effect of high shear pretreatment. The procedure consists of high shear agitation of a high solids clay slurry with the dispersant (high shear dispersion – HSD) followed by high shear agitation with the collector (high shear conditioning – HSC) as pretreatment steps and subsequently, reducing the pulp density and carrying out reverse flotation to float out the titanoferrous minerals. The flotation feed was prepared from a clay sample collected from Mamuara area of Gujarat, India. The raw clay was processed by centrifugation and cryofiltration. The cryofiltered clay forms the feed to flotation and consisted of 88–90% particles below 2 μm and about 70% below 1 μm. This material assayed 1.06% of TiO_2 and 0.29% Fe_2O_3 and measured a brightness of 83.4% and a yellowness of 7.1% ISO. Earlier studies gave the indication of interdependence of HSD and HSC (time) which was experimentally confirmed in the present investigation. It could be shown that impurity removal increases as total pretreatment time increases up to a certain limit and the time required for HSC is at least twice of HSD time. Higher shear intensities favour both the impurity liberation and collection. Most importantly, the shear frequency is found more influential than the shear rate for the overall flotation performance. At high shear frequencies, i.e., when a stirrer with more number of teeth on the rotor is used, the HSD/HSC time ratio shifts towards higher values so as to reduce the total time for pretreatment with improved titania removal. Re-optimisation of collector dosage based on these improved pretreatment conditions helped to remove more titanoferrous impurities. Lowest product titania achieved is 0.35% from a feed value of 1.06%. The flotation product measured 85% ISO brightness at a clay recovery of 86.4%. The brightness was further improved to 85.7% by reductive bleaching.

Laser induced breakdown spectroscopy for bulk minerals online analyses

M. Gaft, I. Sapir-Sofer, H. Modiano, R. Stana
Spectrochimica Acta Part B: Atomic Spectroscopy, *Volume 62, Issue 12*, *December 2007*, *Pages 1496-1503*

The purpose of the work was to prove the ability of LIBS to provide on-line analyses for raw ores in field conditions. An industrial LIBS machine was developed and successfully tested for on-belt evaluation of phosphate measuring Mg, Fe, Al, Bone Phosphate Lime (BPL), Insoluble phase and Metal Impurity Ratio (MER) and of coal measuring its ash content. The comparison of LIBS on-line data with control analyses revealed good correlation, which corresponds to the required detection limits and accuracy. With

frequent elemental data from a LIBS system, process engineers have the tools to best optimize the process. These processes could be minerals blending and separation to meet customer specifications, monitoring and controlling the efficiency of a minerals process, or a minerals accounting function.

Reaction kinetics of gold dissolution in acid thiourea solution using ferric sulfate as oxidant

Jinshan Li, Jan D. Miller
Hydrometallurgy, *Volume 89, Issues 3–4*, *December 2007*, *Pages 279-288*

Reaction kinetics of gold dissolution in acid (pH 1–2) thiourea solutions using ferric sulfate as the oxidant were investigated with the rotating disk technique. Experiments for the kinetic study on the intrinsic reaction of gold dissolution were designed to measure the influence of system variables on the rate of gold dissolution and to determine the important parameters which govern the kinetic response of the gold leaching system. The variables tested included gold disk rotational speed, ferric sulfate concentration, thiourea concentration, pH, and temperature dCAu(I)dt=k[Tu]0.25[H+]−0.2. The surface reaction had a reaction constant, *k*, at 25 °C of 5.93×10^{-7} $mol^{0.95}/l^{0.95}$ min (or 3.58×10^{-7} $mol^{0.95}$ $l^{0.05}/cm^2$ min) and an apparent activation energy of 13.9 kcal/mol or 58.1 kJ/mol.

Kinetics of sulphuric acid leaching of a zinc silicate calcine

A.D. Souza, P.S. Pina, E.V.O. Lima, C.A. da Silva, V.A. Leão
Hydrometallurgy, *Volume 89, Issues 3–4*, *December 2007*, *Pages 337-345*

Recent developments of acid leaching and solvent extraction of zinc silicate ores have produced renewed commercial interest. However, the leaching kinetics of these concentrates has received little attention. This work, therefore, addresses the leaching of a zinc silicate concentrate in sulphuric acid. The effects of particle size (0.038–0.075mm), temperature (30–50°C) and initial acid concentration (0.2–1.0mol/L) were studied. The results show that decreasing the particle size while increasing the temperature and acid concentration increase the leaching rate. As leaching occurs, there is a progressive dissolution of willemite while the quartz and iron-containing phases remain inert. Among the kinetic models of the porous solids tested, the grain model with porous diffusion control successfully described the zinc leaching kinetics. The model enabled the determination of an activation energy of 51.9 ± 2.8kJ/mol and a reaction order of 0.64 ± 0.12 with respect to sulphuric acid, which are likely to be a consequence of the parallel nature of diffusion and chemical reaction in porous solids.

Surface characteristics and flotation behaviour of platinum and palladium arsenides

N.J. Shackleton, V. Malysiak, C.T. O'Connor
International Journal of Mineral Processing, *Volume 85(1–3)*, *5 Dec 2007*, *Pages 25-40*

Research on the flotation behaviour of platinum group minerals (PGM) has mainly focused on the flotation of base metal sulphides because of their association with the PGMs and due to the assumption that the PGMs would respond similarly to such sulphides in their flotation behaviour. It has been reported, however, that significant losses of PGMs may occur due to the poor floatability of arsenides of the platinum group elements which contribute around 21% of the PGMs present in the Platreef ore. Investigating the reasons for their poor floatability is the focus of this paper. The surface characteristics and flotation behaviour of synthetic sperrylite ($PtAs_2$) and palladoarsenide (Pd_2As) has been investigated. The results revealed that, of the two synthetic sperrylite samples described, the one synthesised at a short initial thermal treatment, floated well in the presence of xanthate whereas the other, synthesised for a longer period, floated poorly irrespective of the reagent suite used. The XRD spectra and bulk compositions of both samples were identical. The former sample however exhibited many Pt blebs within the material whereas the latter was a more homogeneous sample of $PtAs_2$. The latter sample when crushed to < 38 μm showed increased recoveries possibly due to the exposure of such Pt blebs. Zeta potential, ToF-SIMS and XPS results showed that, in the presence of copper sulphate, the surface was covered with colloidal $Cu(OH)_2$ precipitate. When a xanthate collector (SIBX) was subsequently added to the copper activated sample, the copper was reduced to the Cu^{+1} form presumably due to the formation of Cu(I)X. Surprisingly activation with copper sulphate resulted in a slight decrease in flotation recovery compared to the case of only xanthate present. Proposals are made to explain these observations.

Electrochemical interactions of industrially important platinum-containing minerals

M.K.G. Vermaak, J.D. Miller, J. Lee
Minerals Engineering, *Volume 20, Issue 15*, *December 2007*, *Pages 1337-1343*

$Pt–Te_2$ and Pt–Bi–Te are two important platinum-carrying minerals typically found in altered platinum reserves. Mineralogical studies indicate the Pt–Pd–Bi–Te class to react poorly on the flotation stimuli and indications are that these minerals are slow floaters. This paper investigates the fundamental interactions of potassium ethyl xanthate with these minerals by employing electrochemically controlled contact angle measurements, FT-IR spectroscopy and voltammetry. The electrochemical investigations revealed that $Pt–Te_2$ is more noble than Pt–Bi–Te at potentials lower than 300 mV (SHE) in sodium tetraborate buffer solution and the reduction peak observed during the return sweep of Pt–Bi–Te is mainly associated with the reduction of bismuth oxidation products. Both the minerals show increased anodic currents when polarised at 0.3 V (SHE) in a 0.05 M $Na_2B_4O_7$ solution containing 1×10^{-3} M potassium ethyl xanthate. According to the results of the rest potential measurements, formation of dixanthogen should be

thermodynamically favourable and the very high rest potentials are attributed to the catalytic effect of platinum on the oxygen reduction reaction. The formation of dixanthogen on both the minerals was confirmed by *ex situ* FT-IR spectroscopy. Contact angle measurements revealed the surface of Pt–Bi–Te to be hydrophobic in nature whereas small contact angles were realized on Pt–Te_2. Surface roughness of the mineral could be responsible for these small contact angles.