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Behaviour of inorganic matter during heating of Bulgarian coals - 2. Subbituminous and bituminous coals

Vassileva, CG; Vassilev, SV
FUEL PROCESSING TECHNOLOGY, DEC, 2006, Vol. 87(12), pp. 1095-1116.
10.1016/j.fuproc.2006.08.006

Bulgarian subbituminous (Pernik, Bobov Dol) and bituminous (Balkan) coals were gradually heated under air from 100 degrees C to their fluid ash-fusion temperatures (1400-1600 degrees C) via 100 degrees C intervals and the behaviour of their inorganic matter (IM) was studied. The original minerals and newly formed inorganic phases in the oxidation and combustion products (OCPs) of these coals were identified and the behaviour of 33 minerals and phases was described. The coals studied reveal high detrital abundance and low authigenic mineralization with sulphide-sulphate, carbonate or mixed sulphide-sulphate and carbonate tendencies. The IM of coals is composed mainly of quartz, kaolinite, illite + muscovite, feldspars, pyrite, and calcite, while the other minerals identified have subordinate occurrence. The IM of OCPs includes various pre-existing minerals and newly formed phases. The latter phases are glass, quartz-cristobalite-tridymite, mullite, amorphous clay material, hematite-magnetite, anhydrite, and others originating from the heating of these coals or storage of their OCPs. The physico-chemical processes and temperatures that result in the formation of new phases in OCPs are described. The relationships between the ash-fusion behaviour and chemical and mineral composition of the coals are also discussed. A systematization of the physico-chemical transformations and some comparative characterizations, as well as prediction of certain technological and environmental problems related to the behaviour of IM during heating of Bulgarian lignites, subbituminous and bituminous coals are also described and summarized. (C) 2006 Elsevier B.V. All rights reserved.

Beneficiation of sillimanite by column flotation - a pilot scale study

Prabhakar, S; Raju, GB; Rao, SS
INTERNATIONAL JOURNAL OF MINERAL PROCESSING, DEC, 2006, Vol. 81(3), pp. 159-165.
10.1016/j.minpro.2006.07.012

A fully automated semi-commercial flotation column incorporating state of the art instruments was designed to study the amenability of flotation column for the beneficiation of different minerals. In the present study, beneficiation of sillimanite was investigated by installing the flotation column in the flotation circuit of Orissa Sands Complex, Indian Rare Earths Limited, Chatrapur, Orissa. The effect of process parameters on sillimanite grade and recovery was investigated. At optimum conditions, the flotation column was operated continuously with a feed rate of one ton per hour and demonstrated the efficiency of the technology for the beneficiation of sillimamte. The results show that a concentrate assaying 96% sillimanite at 90% recovery can be obtained in a single column flotation stage. (c) 2006 Elsevier B.V. All rights reserved.

Diffuse reflectance infrared Fourier transform spectroscopy as a tool to characterise water in adsorption/confinement situations

Richard, T; Mercury, L; Poulet, F; d'Hendecourt, L
JOURNAL OF COLLOID AND INTERFACE SCIENCE, Dec-01, 2006, Vol. 304(1), pp. 125-136.
10.1016/j.jcis.2006.08.036

We present experimental data acquired by diffuse reflectance infrared spectroscopy in the mid-IR (4000-400 cm(-1)), on micrometric-sized mineral grain powders. The spectral evolution of the OH-stretching band is followed when the adsorbed water film is thinned under dry conditions, from high to low hydration states. The IR bands are found to be characteristic of the degree of adsorption/confinement of the liquid water. The OH-stretching band is shifted toward shorter wavenumbers than in bulk water, showing that a significant portion of adsorbed water has a higher intermolecular bonding energy. Complementary treatment of the kinetics of water desorption, varying with the surface forces in the water film, confirms the relationships of these bands with the constrained water state. We distinguish different water types obeying liquid-liquid interactions (free and capillary water) or dominated by solid-water interactions (confined and adsorbed water). Part of this study is devoted to mesoporous silica MCM-41, of interest due to the restricted geometries of its mesopores (4.7 nm) favouring the confined water state. The methodology allows us to distinguish bulk and adsorbed/confined water, using spectral analysis Coupled with an understanding of the dynamic behaviour of the desorption process. (c) 2006 Elsevier Inc. All rights reserved.

Investigating sorption-driven dissolved organic matter fractionation by multidimensional fluorescence spectroscopy and PARAFAC

Banaitis, MR; Waldrip-Dail, H; Diehl, MS; Holmes, BC; Hunt, JF; Lynch, RP; Ohno, T
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Soil organic matter is involved in many ecosystem processes, such as nutrient supply, metal solubilization, and carbon sequestration. This study examined the ability of multidimensional fluorescence spectroscopy and parallel factor analysis (PARAFAC) to provide detailed chemical information on the preferential sorption of higher-molecular-weight components of natural organic matter onto mineral surfaces. Dissolved organic matter (DOM) from soil organic horizons and tree leaf tissues was obtained using water extracts. The suite of fluorescence spectra was modeled with PARAFAC and it was revealed that the DOM extracts contained five fluorescing components: tryptophan-like (peak location at excitation < 255 nm:emission 342 nm), tyrosine-like (276 nm:312 nm), and three humic-substance-like components (< 255 nm:456 nm, 309 nm:426 nm, < 255 nm:401 run). In general, adsorption onto goethite and gibbsite increased with increasing DOM molecular weight and humification. PARAFAC analysis of the pre- and post-sorption DOM indicated that the ordering of sorption extent was humic-like components (average 91% sorption) > tryptophan-like components (52% sorption) > tyrosine-like components (29% sorption). This differential sorption of the modeled DOM components in both the soil organic horizon and leaf tissue extracts led to the fractionation of DOM. The results of this study demonstrate that multidimensional fluorescence spectroscopy combined with PARAFAC can quantitatively describe the chemical fractionation process due to the interaction of DOM with mineral surfaces. (c) 2006 Elsevier Inc. All rights reserved.

Natural attenuation processes for remediation of arsenic contaminated soils and groundwater

Wang, SL; Mulligan, CN
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Arsenic (As) contamination presents a hazard in many countries. Natural attenuation (NA) of As-contaminated soils and groundwater may be a cost-effective in situ remedial option. It relies on the site intrinsic assimilative capacity and allows in-place cleanup. Sorption to solid phases is the principal mechanism immobilizing As in soils and removing it from groundwater. Hydroxides of iron, aluminum and manganese, clay and sulfide minerals, and natural organic matter are commonly associated with soils and aquifer sediments, and have been shown to be significant As adsorbents. The extent of sorption is influenced by As speciation and the site geochemical conditions such as pH, redox potential, and the co-occurring ions. Microbial activity may catalyze the transformation of As species, or mediate redox reactions thus influencing As mobility. Plants that are capable of hyperaccumulating As may translocate As from contaminated soils and groundwater to their tissues, providing the basis for phytoremediation. However, NA is subject to hydrological changes and may take substantial periods of time, thus requiring long-term monitoring. The current understanding of As NA processes remains limited. Sufficient site characterization is critical to the success of NA. Further research is required to develop conceptual and mathematical models to predict the fate and transport of As and to evaluate the site NA capacity. Engineering enhanced NA using environmentally benign products may be an effective alternative. (c) 2006 Elsevier B.V. All rights reserved.

Preparation, treatment and characterisation of nanocrystalline mesoporous ordered layers

Grosso, D; Boissiere, C; Nicole, L; Sanchez, C
JOURNAL OF SOL-GEL SCIENCE AND TECHNOLOGY, DEC, 2006, Vol. 40, pp. 141-154.
10.1007/s10971-006-8990-6

The general approach to mesoporous ordered silica and crystalline metal oxide thin films, involving soft chemistry, liquid deposition technique, surfactant templating and tuned annealing conditions, is presented. Highly ordered cubic mesoporous structures, made of amorphous SiO2 xerogels or nanocrystalline particles such as anatase TiO2, gamma-Al2O3, ilmenite CoTiO3, or perovskite SrTiO3 have been chosen to illustrate this article. In situ time resolved SAXS analyses, involving synchrotron high flux, were used to assess the various phenomena involved during deposition, thermal treatment and crystallisation. It will be demonstrated that the self-assembly is not only critically dependant on the structuring agent to inorganic volume fraction, but also on chemical and processing parameters such as the inorganic degree of condensation and the atmosphere applied during the deposition. A general model of self-assembly, based on a Tunable Stated State, is proposed. Concerning the crystallisation step, we will show that, depending on the heating regime, ordered mesoporous nanocrystalline framework can be obtained through a rigorous control of nucleation, growth and diffusive sintering taking successively place in the mineral matrix. Finally, the porosity and pore size distribution of these silica and non silica layers were assessed using ellipsometry porosimetry. This novel and very efficient technique provides the full characteristics of the layer porosity by measuring the variation of optical constant associated to the adsorption/desorption of a gas within the porous network.

A mechanism for the formation of the mineralized Mn deposits at Merehead Quarry, Cranmore, Somerset, England

Turner, R

MINERALOGICAL MAGAZINE, DEC, 2006, Vol. 70(6), pp. 629-653

10.1180/0026461067060359

Mississippi Valley type galena deposits emplaced into Carboniferous limestones throughout the Mendip Hills during the late Permian or Triassic period were locally exposed to the action of seawater during the Jurassic period following regional uplift and erosion of the intervening strata. Oxidation of galena initiated the deposition of manganate minerals from the seawater, and these adsorbed heavy metals from both the seawater and local environment. A subsequent hydrothermal event heated the lead-manganate deposits causing decomposition of the galena and creating the conditions which led to the formation of the suite of unusual secondary minerals - including a number of rare oxychlorides - now found at Merehead. Heating of the manganate phases converted them to Mn oxides and released the entrained heavy metals which were then incorporated into unusual mineral phases. The impervious Mn oxide coating which enclosed the cooling Pb-rich areas isolated them chemically, leading to closed-system behaviour. The high-T phases at Merehead are similar to those found in the Pb-bearing silicic skarns at Langban, whilst the suite of secondary minerals which evolved in the closed-system environments bears striking similarities to the 'anomalous sequence' of minerals found at the Mammoth-St. Antony Mine. The complexity of these formation processes probably explains the rarity of Mendip-type Pb-Mn deposits. The collective importance of the disconformity, the hydrothermal event, and subsequent sealing of the deposits are recognized for the first time, and the temperature of the hydrothermal event is shown to have been much greater than has heretofore been realized. Silurian volcanic strata underlying the Carboniferous limestones which have previously been assumed to be the source of heavy metals are shown to have been uninvolved in the process.

Maximising overall value in plant design

Huband, S; Tuppurainen, D; While, L; Barone, L; Hingston, P; Bearman, R
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10.1016/j.mineng.2006.07.007

Existing plant designs are often conservative and as a consequence the opportunity to achieve full value is lost. Even for well-designed plants, the usage and profitability of mineral processing circuits can change over time, due to a variety of factors from geological variation through processing characteristics to changing market forces. Consequently, plant designs often require optimisation in relation to numerous variables, or objectives. To facilitate this task, a multi-objective evolutionary algorithm has been developed to optimise existing plants against multiple competing process drivers, as evaluated by simulation. A case study involving primary through to quaternary crushing is presented, in which the evolutionary algorithm explores a selection of flowsheet configurations, in addition to local machine setting optimisations. Results suggest that significant improvements can be achieved over the existing design, promising substantial financial benefits. An extension of the evolutionary algorithm to employ wider flowsheet modifications is also discussed. (C) 2006 Elsevier Ltd. All rights reserved.

Spreadsheet-based simulation of closed ball milling circuits
Irannajad, M; Farzanegan, A; Razavian, SM
MINERALS ENGINEERING, DEC, 2006, Vol. 19(15), pp. 1495-1504
10.1016/j.mineng.2006.08.010

Grinding, particularly at finer sizes to achieve the required degree of liberation or specific surface, is a critical unit operation in terms of energy consumption and process optimization. Nowadays, considering the significant developments made in computer hardware and software, using simulation programs to optimize design and operation of various ore treatment plants could be very beneficial to the mineral process engineers. Currently, there are a number of steady-state simulators that can be run under DOS(TM) or WINDOWS(TM) environments such as BMCS, MODSIM(TM) and JKSimMet(TM). In this paper, COMSIM, a new simulator which runs under Excel spreadsheet will be introduced which uses a Population Balance Model (PBM) to simulate ball mills. Plitt and Nageswararao models have been used to describe the performance of hydrocyclones, which by linking to the ball mill model allow for closed-circuit simulations. To describe material flow through the ball mills, two tanks-in-series models called Weller's model and one plug flow unit plus n perfect mixers units (1PF+nPM) model have been used. Utilizing Microsoft(TM) Excel(TM) capabilities such as graphics and VBA programming to implement new macro-based user functions, the authors developed an easy-to-use comminution simulation environment. By comparing the outputs of COMSIM with measured grinding data and previously existing simulators, particularly BMCS, its performance was firmly tested both in terms of accuracy and precision of obtained results. (C) 2006 Elsevier Ltd. All rights reserved.

Analysis of stirred mill performance using DEM simulation: Part 1 - Media motion, energy consumption and collisional environment

Sinnott, M; Cleary, PW; Morrison, R
MINERALS ENGINEERING, DEC, 2006, Vol. 19(15), pp. 1537-1550
10.1016/j.mineng.2006.08.012

Stirred mills are becoming increasingly used for fine and ultra-fine grinding. This technology is still poorly understood when used in the mineral processing context. This makes process optimisation of such devices problematic. 3D DEM simulations of the flow of grinding media in pilot scale tower mills and pin mills are carried out in order to investigate the relative performance of these stirred mills. Media flow patterns and energy absorption rates and distributions are analysed here. In the second part of this paper, coherent flow structures, equipment wear and mixing and transport efficiency are analysed. (C) 2006 Published by Elsevier Ltd.

Analysis of stirred mill performance using DEM simulation: Part 2 - Coherent flow structures, liner stress and wear, mixing and transport

Cleary, PW; Sinnott, M; Morrison, R
MINERALS ENGINEERING, DEC, 2006, Vol. 19(15), pp. 1551-1572
10.1016/j.mineng.2006.08.013

Stirred Mills are becoming increasingly used for fine and ultra-fine grinding. This technology is still poorly understood when used in the mineral processing context. This makes process optimisation of such devices problematic. 3D DEM simulations of the flow of grinding media in pilot scale tower mills and pin mills are carried out in order to investigate the relative performance of these stirred mills. In the first part of this paper, media flow patterns and energy absorption rates and distributions were analysed to provide a good understanding of the media flow and the collisional environment in these mills. In this second part we analyse steady state coherent flow structures, liner stress and wear by impact and abrasion. We also examine mixing and transport efficiency. Together these provide a comprehensive understanding of all the key processes operating in these mills and a clear understanding of the relative performance issues. (C) 2006 Elsevier Ltd. All rights reserved.

Extracting values from mine dumps and tailings

Watson, JHP; Beharrell, PA
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The mineral processing industry is the largest user of magnetic separation. This market is largely made up of low-gradient separators using iron circuits. The Superconducting High Gradient Magnetic Separators (SHGMS), originally developed at English China Clays, has resulted in approximately 30 large machines using liquid helium, with separation channels of 0.5-1 m diameter, distributed throughout the world. The recently developed so-called Dry Superconducting Magnetic Separators with two stage coolers used between 8 and 12 kW replace the liquid helium. These machines are lighter and much more mobile than the liquid helium machines and show promise for the upgrading of many low grade ores. There is a continual pressure in the mineral industry to cut costs or increase efficiency and this applies particularly to the metal industry. This pressure comes from at least two quarters and these are the discovery and use of replacement materials and the use of lower grade ores having lower concentrations of value and with a smaller liberation size. This paper considers a few examples of where superconducting separators can be used to concentrate low grade minerals from mine dumps which exist across the world. Often the gangue materials are coated with small quantities of magnetite which saturates at less than 2 T but with 6 T available from SHGMS, there is a large difference in magnetic moment between the gangue materials and the value to be concentrated. This paper discusses the concentration of uranium and gold from the leached residues from Witwatersrand, South Africa, dumps from other regions of South Africa for the concentration of platinum group metals, concentration of V, Pb and Zn from dumps of 8 million tonnes in Zambia. The recovery of titanium from mining dumps in China is also a real possibility as described below. The recovery of U and Au from Olympic Dam, Australia, the extraction of Au from slag at Zalau, Romania, the extraction of tungsten and tin from mining dumps in England are interesting possibilities. Mining dumps exist throughout the world and can be exploited whenever the economics are suitable. (C) 2006 Elsevier Ltd. All rights reserved.

Magnetic susceptibility measurement applied to the minerals industry

Cavanough, GL; Holtham, PN; Powell, TM
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The efficiency of numerous mineral processing operations can be determined by measuring the magnetic properties of the process streams. This measurement, if done at all, is currently performed by laboratory testing of spot samples. This is an inherently slow process and, where feed grades are variable, optimum performance is generally not achieved. This paper describes the rapid measurement of the magnetic properties of minerals. AC measurement techniques, including the analysis of the phase component of the magnetic vector; frequency dependent magnetic susceptibility and the effect of applied magnetic field strength will be discussed. Industrial applications in mineral sands, copper smelting, ferrosilicon testing and drill core scanning will be reported. (C) 2006 Elsevier Ltd. All rights reserved.

Photochemical oxidation processes for the elimination of phenyl-urea herbicides in waters

Benitez, FJ; Real, FJ; Acero, JL; Garcia, C
JOURNAL OF HAZARDOUS MATERIALS, Nov, 2006, Vol. 138(2), pp. 278-287
10.1016/j.jhazmat.2006.05.077

Four phenyl-urea herbicides (linuron, chlorotoluron, diuron, and isoproturon) were individually photooxidized by monochromatic UV radiation in ultra-pure aqueous solutions. The influence of pH and temperature on the photodegradation process was established, and the first-order rate constants and quantum yields were evaluated. The sequence of photodecomposition rates was: linuron > chlorotoluron > diuron > isoproturon. The simultaneous photooxidation of mixtures of the selected herbicides in several types of waters was then performed by means of UV radiation alone, and by UV radiation combined with hydrogen peroxide. The types of waters used were: ultra-pure water, a commercial mineral water, a groundwater, and a lake water. The influence of the independent variables in these processes - the presence or absence of tert-butyl alcohol, types of herbicide and waters, and concentration of hydrogen peroxide - were established and discussed. A kinetic study was performed using a competitive kinetic model that allowed various rate constants to be evaluated for each herbicide. This kinetic model allows one to predict the elimination of these phenyl-urea herbicides in contaminated waters by the oxidation systems used (UV alone and combined UV/H2O2). The herbicide concentrations predicted by this model agree well with the experimental results that were obtained. (c) 2006 Elsevier B.V All rights reserved.

Leaching behaviour of low level organic pollutants contained in cement-based materials: Experimental methodology and modelling approach

Tiruta-Barna, L; Fantozzi-Merle, C; de Brauer, C; Barna, R
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The aim of this paper is the investigation of the leaching behaviour of different porous materials containing organic pollutants (PAH: naphthalene and phenanthrene). The assessment methodology of long term leaching behaviour of inorganic materials was extended to cement solidified organic pollutants. Based on a scenario-approach considering environmental factors, matrix and pollutants specificities, the applied methodology is composed of adapted equilibrium and dynamic leaching tests. The contributions of different physical and chemical mechanisms were identified and the leaching behaviour was modelled. The physical parameters of the analysed reference and polluted materials are similar. A difference in the pore size distribution appears for higher naphthalene content. The solubility of the PAH contained in the material is affected by the ionic strength and by the presence of a co-solvent; the solution pH does not influence PAH solubility. The solubility of the major mineral species is not influenced by the presence of the two PAH nor by the presence of the methanol as co-solvent in the range of the tested material compositions. In the case of the leaching of a monolith material the main transport mechanism is the diffusion in the porous system. For both mineral and organic species we observed at least two dynamic domains. At the beginning of the leaching process the released flux is due to the surface dissolution and to the diffusion of the main quantity dissolved in the initial pore solution. The second period is governed by a stationary regime between dissolution in pore water and diffusion. The model, coupling transport and chemical phenomena in the pore solution, at the monolith surface and in the leachate simulates satisfactory the release for both mineral and organic species. (c) 2006 Elsevier B.V. All rights reserved.

Adsorption mechanisms of selenium oxyanions at the aluminum oxide/water interface

Peak, D
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Sorption processes at the mineral/water interface typically control the mobility and bioaccessibility of many inorganic contaminants such as oxyanions. Selenium is an important micronutrient for human and animal health, but at elevated concentrations selenium toxicity is a concern. The objective of this study was to determine the bonding mechanisms of selenate (SeO42-) and selenite (SeO32-) on hydrous aluminum oxide (HAO) over a wide range of reaction pH using extended X-ray absorption fine structure (EXAFS) spectroscopy. Additionally, selenate adsorption on corundum (alpha-Al2O3) was studied to determine if adsorption mechanisms change as the aluminum oxide surface structure changes. The overall findings were that selenite forms a mixture of outer-sphere and inner-sphere bidentate-binuclear (corner-sharing) surface complexes on HAO, selenate forms primarily outer-sphere surface complexes on HAO, and on corundum selenate forms outer-sphere surface complexes at pH 3.5 but inner-sphere monodentate surface complexes at pH 4.5 and above. It is possible that the lack of inner-sphere complex formation at pH 3.5 is caused by changes in the corundum surface at low pH or secondary precipitate formation. The results are consistent with a structure-based reactivity for metal oxides, wherein hydrous metal oxides form outer-sphere complexes with sulfate and selenate, but inner-sphere monodentate surface complexes are formed between sulfate and selenate and alpha-Me2O3. (c) 2006 Published by Elsevier Inc.

XPS and XAS studies of copper(II) sorbed onto a synthetic pyrite surface

Naveau, A; Monteil-Rivera, F; Guillon, E; Dumonceau, J
JOURNAL OF COLLOID AND INTERFACE SCIENCE, 2006, Vol 303(1), pp. 25-31
10.1016/j.jcis.2006.07.022

Compounds containing copper are likely candidates to delay iodide migration in environmental media through the formation of sparingly soluble phases. Preliminary experiments showed that iodide was neither sorbed onto chalcopyrite nor by a binary system pyrite/copper(II), although significant amounts of copper were present at the pyrite surface. In the present study, spectroscopic studies (XPS, XANES and EXAFS) were thus performed to determine the nature of sorbed copper species. Although ntroduced as Cu(II), copper was mainly present at the oxidation state (I) on the pyrite surface suggesting a heterogeneous reduction process. Moreover, copper appeared tetrahedrally coordinated to two sulfur and two oxygen atoms onto the pyrite surface, a chemical environment, which seemingly stabilized the metal and made it unreactive towards iodide. (c) 2006 Elsevier Inc. All rights reserved.

EXAFS study of U(VI) uptake by calcium silicate hydrates

Harfouche, M; Wieland, E; Dahn, R; Fujita, T; Tits, J; Kunz, D; Tsukamoto, M
JOURNAL OF COLLOID AND INTERFACE SCIENCE, 2006, Vol. 303(1), pp. 195-204
10.1016/j.jcis.2006.07.019

Among the different cement minerals, calcium silicate hydrates (C-S-H) are the prime candidates for heavy metal binding because of their abundance and appropriate structure. Immobilization processes of heavy metals by cementitious materials, and in particular C-S-H phases, thus play an important role in multibarrier concepts developed worldwide : or the safe disposal of hazardous and radioactive wastes. In this study, the uptake of U(VI) by C-S-H has been investigated using X-ray absorption fine structure (XAFS) spectroscopy. C-S-H phases were synthesized using two different procedures: One is based on the mixing of CaO and SiO2 solids ("direct reaction" method); for the other one starting solutions of Ca and Si are used ("solution reaction" method). XAFS investigations were carried out on samples doped with U(VI). U(VI) was either sorbed onto previously precipitated C-S-H phases (sorption samples) or added during C-S-H synthesis (coprecipitation samples). The coordination environment of U(VI) in the sorption samples was found to be independent of the procedure used for C-S-H synthesis. A split equatorial oxygen shell (O-eq1 : R = 2.23-2.27 angstrom; O-eq2: R = 2.36-2.45 angstrom), neighboring silicon atoms at short (R = 3.07-3.11 angstrom) and long (R = 3.71-3.77 angstrom) distances, and neighboring Ca atoms (R = 3.77-3.81 and 4.15-4.29 angstrom) were observed for all the samples. The structural parameters resemble those reported for uranophane. The coordination environment of U(VI) in the coprecipitation samples depends on the method used for C-S-H synthesis, and further, the spectra differ from those determined for the sorption samples. U-U backscattering contributions were observed in the samples prepared using the direct reaction method, whereas no split equatorial shell appeared in the samples prepared using the solution reaction method. (c) 2006 Elsevier Inc. All rights reserved.

Simulation study of the optimal distribution of cyanide in a gold leaching circuit

de Andrade Lima, LRP; Hodouin, D
MINERALS ENGINEERING, NOV, 2006, Vol 19(13), pp. 1319-1327
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The mineral industry has been using cyanidation to recover gold from ores for more than a century; however, a systematic study of the best reactant addition strategy in a cascade of agitated leaching tanks is not available in the open literature. A phenomenological mathematical model of the gold cyanidation process, calibrated with a set of industrial data from an Australian plant, together with an economic performance index is used to analyze this problem. The simulated results show that the best compromise between the two antagonistic effects, cyanide consumption and gold recovery, which are both function of cyanide concentrations, leads to a reagent distribution that depends on the leaching and cyanide consumption kinetics, pulp feed characteristics, and economic factors such as the gold market value. For the specific studied plant, in the operating range of low cyanide consumption and fast gold dissolution, all the cyanide must be added in the first tank; however, in the operating conditions of high cyanide consumption, cyanide has to be distributed in the first, second and third tanks. (c) 2005 Elsevier Ltd. All rights reserved.

Short-cut method for flotation rates modelling of industrial flotation banks

Yianatos, JB; Henriquez, FD
MINERALS ENGINEERING, NOV, 2006, Vol. 19(13), pp. 1336-1340
10.1016/j.mineng.2005.12.010

The knowledge of the distributed performance of a flotation bank, consisting of a number of cells in series, is a key factor for different purposes such as process design, scale-up, diagnosis, operation, control and optimization. A common practice in plant operation is to develop mass balances around the whole flotation bank in order to characterize the overall recovery, typically in rougher flotation. However, testing to fit flotation rate models are seldom developed on industrial flotation banks because they are high consumers of human labor during sampling, mineral samples preparation and chemical analysis development. In this paper a short-cut method is proposed which allows obtaining the relevant information for flotation rate modeling in a flotation bank with minimum effort and cost, and within a reasonable accuracy (less than 1-2% error in estimating cell recovery along the bank). The procedure considers two mass balances, one around the first cell of the bank and the second is the overall mass balance around the whole flotation bank, with a total of only 5 sampling streams. Examples developed in four rougher flotation banks located in three industrial concentrators illustrate the merit of this procedure. (c) 2006 Elsevier Ltd. All rights reserved.

Rapid measurement of calcite concentration in copper ore using fluorescence spectroscopy

Escarate, P; Guesalaga, A; Otero, A
MINERALS ENGINEERING, NOV, 2006, Vol.19(13), pp. 1373-1376
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This work presents the development of a rapid technique for measuring the concentration of calcite in oxidized copper ore. The instrument is based on fluorescence spectroscopy in the visible and infrared range and is excited with a UV-LW lamp. The measurement takes substantially shorter times than standard procedures. Calibration models were adjusted via the correlation coefficient for validation (R-v(2)) and the error of prediction (RMSEP). Correlations higher than 0.92 were achieved for R-2. These results show the potential of the technique for portable or on-line estimation of calcite concentration in mining processes. Its performance under different granulometries is also addressed, showing the best performance for particle size between 0.01 and 0.04 mm. (c) 2005 Elsevier Ltd. All rights reserved.

The separation of Cu/Fe sulfide minerals at slightly alkaline conditions by using ethoxycarbonyl thionocarbamates as collectors: Theory and practice

Liu, GY; Zhong, H; Dai, TG
MINERALS ENGINEERING, NOV, 2006, Vol. 19(13), pp. 1380-1384
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The bench-scale and industrial flotation test results of Jiangxi Copper Corporation Yongping Copper Mine showed that the flotation separation of Cu/Fe sulfide minerals has been achieved at pH values above 13 for xanthates, about 11 for dialkyl thionocarbamates and around 8.5 for ethoxycarbonyl thionocarbamates (ECTC), respectively, and ECTC collectors were powerful for copper minerals and very selective against iron sulfide minerals at pH 8-9. The flotation results have been explained from the structure-reactivity relationship of collectors by generalized perturbation theory and density functional calculation at B3PW91/6-31G(D) level. (c) 2005 Elsevier Ltd. All rights reserved.

Selective leaching of calcareous phosphate rock in formic acid: Optimisation of operating conditions

Zafar, ZI; Anwar, MM; Pritchard, DW
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In this study, formic acid was used to reduce the carbonate content of the ground phosphate rock. Effect of acid concentration, liquid/ solid ratio (v/w),. reaction time and temperature has been studied to get marketable and industrially acceptable phosphate grades. Depending on leaching conditions, it was found that the P2O5% could be raised by 30-35% along with corresponding reduction in CO2% up to 67-72% at a phosphate recovery of more than 70 wt.%. (c) 2006 Elsevier Ltd. All rights reserved.

Sorption of As-V on alumino silicates treated with Fe-II nanoparticles

Dousova, B; Grygar, T; Martaus, A; Fuitova, L; Kolousek, D; Machovic, V
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Adsorption of arsenic on clay surfaces is important for the natural and simulated removal of arsenic species from aqueous environments. In this investigation, three samples of clay minerals (natural metakaoline, natural clinoptilolite-rich tuff, and synthetic zeolite) in both untreated and Fe-treated forms were used for the sorption of arsenate from model aqueous solution. The treatment of minerals consisted of exposing them to concentrated solution of FeII. Within this process the mineral surface has been laden with Fe(III)oxi(hydroxides) whose high affinity for the As-V adsorption is well known. In all investigated systems the sorption capacity of FeII-treated sorbents increased significantly in comparison to the untreated material (from about 0.5 to > 20.0 mg/g, which represented more than 95% of the total As removal). The changes of Fe-bearing particles in the course of treating process and subsequent As sorption were investigated by the diffuse reflectance spectroscopy and the voltammetry of microparticles. IR spectra of treated and As-V-saturated solids showed characteristic bands caused by Fe-III-SO4, Fe-III-O, and As-O vibrations. In untreated As-V-saturated solids no significant As-O vibrations were observed due to the negligible content of sorbed arsenate. (c) 2006 Elsevier Inc. All rights reserved.

Theoretical study of the acid-base properties of the montmorillonite/electrolyte interface: Influence of the surface heterogeneity and ionic strength on the potentiometric titration curves

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The parallel shape of the potentiometric titration curves for montmorillonite suspension is explained using the surface complexation model and taking into account the surface heterogeneity. The homogeneous models give accurate predictions only if they assume unphysically large values of the equilibrium constants for the exchange process occurring on the basal plane. However, the assumption that the basal plane is energetically heterogeneous allows to fit the experimental data (reported by Avena and De Pauli [M. Avena, C.P. De Pauli, J. Colloid Interface Sci. 202 (1998) 195-204]) for reasonable values of exchange equilibrium constant equal to 1.26 (suggested by Fletcher and Sposito [P. Fletcher, G. Sposito, Clay Miner. 24 (1989) 375-391]). Moreover, we observed the typical behavior of point of zero net proton charge (pznpc) as a function of logarithm of the electrolyte concentration (log[C]). We showed that the slope of the linear dependence, pznpc = f (log[C]), is proportional to the number of isomorphic substitutions in the crystal phase, which was also observed in the experimental studies. (c) 2006 Elsevier Inc. All rights reserved.

Chemico-electromechanical coupling in microporous media

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We determine the macroscopic transport properties of isotropic microporous media by volume-averaging the local Nernst-Planck and Navier-Stokes equations in nonisothermal conditions. In such media, the excess of charge that counterbalances the charge deficiency of the surface of the minerals is partitioned between the Gouy-Chapman layer and the Stem layer. The Stem layer of sorbed counterions is attached to the solid phase, while the Gouy-Chapman diffuse layer is assumed to have a thickness comparable to the size of the pores. Rather than using Poisson-Boltzmarm distributions to describe the ionic concentrations in the pore space of the medium, we rely on Donnan distributions obtained by equating the chemical potentials of the water molecules and ions between a reservoir of ions and the pore space of the medium. The macroscopic Maxwell equations and the macroscopic linear constitutive transport equations are derived in the vicinity of equilibrium, assuming that the porous material is deformable. In the vicinity of thermodynamic equilibrium, the cross-coupling phenomena of the macroscopic constitutive equations of transport follow Onsager reciprocity. In addition, all the material properties entering the constitutive equations depend only on two textural properties, the permeability and the electrical formation factor. (c) 2006 Elsevier Inc. All rights reserved.

Formation of metal agglomerates during carbonisation of chromated copper arsenate (CCA) treated wood waste: Comparison between a lab scale and an industrial plant

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This paper compares the results obtained by scanning electron microscopy coupled to X-ray analysis (SEM-EDXA) of the solid product after carbonisation of treated wood waste in a lab scale and in an industrial installation. These setups (lab scale and industrial) are characterized by different operating conditions of the carbonisation process. Moreover, the wood waste input to the processes differs significantly. From this study, it is clear that some similarities but also some differences exist between the lab scale study and the study with the industrial Chartherm plant. In both reactors, a metal (and mineral) agglomeration process takes place, even in the case of untreated wood. The agglomerates initially present in the wood input may serve as a seed for the metal agglomeration process during "chartherisation". The industrial setup leads to a broader range of agglomerates size (0. 1-50 mu m) and composition (all possible combinations of Cu, Cr, As and wood minerals). Some agglomerates contain the three metals but the major part is a combination of wood minerals and one or two of the three preservative metals, while all agglomerates analysed in the lab scale product contain the three metals. The separate influence of wood input characteristics and process conditions cannot be derived from these experiments, but the observations suggest that the higher the CCA retention in the wood input is, the easier is the metal agglomeration process during chartherisation of CCA treated wood waste. From the analyses performed in this study it seems that copper behaves differently in the sense that it agglomerates easily, but the resulting particles are small (< 1 mu m). (c) 2006 Elsevier B.V. All rights reserved.

Anaerobic biogranulation in a hybrid reactor treating phenolic waste

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Granulation was examined in four similar anaerobic hybrid reactors 15.5 L volume (with an effective volume of 13.5 L) during the treatment of synthetic coal wastewater at the mesophilic temperature of 27 +/- 5 degrees C. The hybrid reactors are a combination of UASB unit at the lower part and an anaerobic filter at the upper end. Synthetic wastewater with an average chemical oxygen demand (COD) of 2240 mg/L, phenolics concentration of 752 mg/L and a mixture of volatile fatty acids was fed to three hybrid reactors. The fourth reactor, control system, was fed with a wastewater containing sodium acetate and mineral nutrients. Coal waste water contained phenol (490 mg/L); m-, o-, p-cresols (123.0, 58.6,42 mg/L); 2,4-, 2,5-, 3,4- and 3,5-dimethyl phenols (6.3, 6.3, 4.4 and 21.3 mg/L) as major phenolic compounds. A mixture of anaerobic digester sludge and partially granulated sludge (3:1) were used as seed materials for the start up of the reactors. Granules were observed after 45 days of operation of the systems. The granules ranged from 0.4 to 1.2 mm, in diameter with good settling characteristics with an SVI of 12 mL/g SS. After granulation, the hybrid reactor performed steadily with phenolics and COD removal efficiencies of 93% and 88%, respectively at volumetric loading rate of 2.24 g COD/L d and hydraulic retention time of 24 h. The removal efficiencies for phenol and m/p-cresols reached 92% and 93% (corresponding to 450.8 and 153 mg/L), while o-cresol was degraded to 88% (corresponding to 51.04 mg/L). Dimethyl phenols could be removed completely at all the organic loadings and did not contribute much to the residual organics. Biodegradation of o-cresol was obtained in the hybrid-UASB reactors. (c) 2006 Elsevier B.V. All rights reserved.

Structural Fe(III) reduction in smectites

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Manipulation of the oxidation state of structural Fe in clay minerals is a potential method for altering important physical-chemical properties of the clay and several studies have focussed on this phenomenon. This paper summarizes current knowledge on reduction of structural Fe(III) in iron-rich dioctahedral smectites and partial stabilization of Fe(II) in reduced SWa-1 ferruginous smectite via fixation of Li+ cations upon heating. Fe(III) in Fe-rich dioctahedral smectites was completely reduced in citrate-bicarbonate buffer using sodium dithionite. Progress in the reduction or reoxidation process was followed by monitoring the Fe(II)-O-Fe(III) intervalence electron transfer transition using visible spectroscopy at 730 nm. Reduction proceeds from basal surfaces rather than from particle edges. One study found that trioctahedral domains and vacancies may occur within the structure of reduced minerals, but another study indicated less radical structural changes. Fully reoxidized minerals contain less OH groups. About 20% of total Fe can be stabilized as Fe(II) in reduced SWa-1 via Li+-saturation and heating the Li-form of a highly reduced mineral in N-2 atmosphere at 260 degrees C for 24 h. Part of the Li+ is trapped in previously vacant octahedral sites, forming trioctahedral AlFe(II)LiOH or Fe(III)Fe(II) LiOH groupings. (c) 2006 Elsevier B.V. All rights reserved.

Production of carbonate and silica nano-particles in stirred bead milling

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This paper presents the experimental results of the mechanical production of silica and carbonate colloidal particles below 100 urn using two types of stirred bead mills (i.e., DCP Superflow 12 and PML H/V). It is shown that the stirred bead mill with very small beads can be used as an efficient equipment for the production of the colloidal particles in nanoscale from the feed materials of several microns in sizes at high energy consumptions. The DCP Superflow mill with high power densities is superior for the effective size reduction and production rate, compared to the conventional PML H/V mill with lower power densities. The smaller particles could be produced by the DCP Superflow mill at the same level of high energy inputs as from the PML H/V mill. The "grinding limit" for the processes in the mills has been discussed. The nanoparticle sizes of the ground products obtained in the mills were determined by a scanning mobility particle sizer (SNIPS), an acoustic particle sizer (APS-100), a nitrogen gas adsorption method (BET), and transmission electron microscopy (TEM). The surface mean particle diameters on the same sample obtained with the different methods for the nanoparticle size analysis are varying due to the different characterisation techniques. The TEM micrographs show a large amount of the primary nanoparticles below 100 nm produced after milling. In addition, the surface and structure of the original and the ground colloidal products have been investigated with some particle/surface characterisation techniques such as X-ray diffraction (XRD), nuclear magnetic resonance (Si-29 NMR) and Fourier transform infrared spectroscopy (FTIR). It is indicated that an intense comminution of carbonate minerals in the stirred bead mills leads to a progressive loss in crystallinity of the basal planes of the crystal structure. An intensive mechanical treatment of silica gives the structural changes and the amorphisation. (c) 2006 Elsevier B.V. All rights reserved.

Flotation and depression control of arsenopyrite through pH and pulp redox potential using xanthate as the collector

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The role of pH and pulp redox potential (EH) to control the flotation and depression of arsenopyrite has been investigated through studies on microflotation of arsenopyrite crystals and batch flotation of an arsenopyritic ore using isopropyl xanthate as collector. The transition between flotation and depression of arsenopyrite is established by the reversible potential of the xanthate/ dixanthogen couple. Adsorption of arsenate ions on ferric hydroxide has been studied through electrokinetics to delineate mechanisms involved in the depression of arsenopyrite using oxidants. Chemical binding between arsenate species and ferric hydroxide sites on arsenopyrite is suggested as the mechanism responsible for depression of arsenopyrite. E-H conditions are given for the flotation and depression of arsenopyite at various pH values for the arsenopyritic ore. (c) 2006 Elsevier B.V. All rights reserved.

Selective leaching of antimony and arsenic from mechanically activated tetrahedrite, jamesonite and enargite

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In this study, the changes in surface area, morphology and leachability of antimony and arsenic from tetrahedrite, jamesonite and enargite mechanically activated by a high-energy planetary mill were investigated. It appears that the leaching of antimony from tetrahedrite and jamesonite and arsenic from enargite in alkaline solution of sodium sulphide is temperature-sensitive reaction. The temperature dependencies of all reactions were investigated in the interval 313-363 K. Resulting experimental activation energies were E-a = 111- 182 kJ mol(-1) for mechanically activated minerals. The values of E-a are characteristic for processes controlled by surface chemical reactions. (c) 2006 Elsevier B.V. All rights reserved.

Fuzzy evaluation of stream sample reliability

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The operation of a mineral-processing plant is investigated regularly by stream sampling. Sampling errors are generated due to material heterogeneity and cutter features. This article presents an innovative method using fuzzy logic to assess the sample reliability, which is assumed to be influenced by the cutter geometry, speed, layout, and path. Fuzzy logic permits sampling situations to be described and processed in linguistic terms such as very reliable, reliable, adequate, doubtful, and very doubtful. Each sample is assigned a sampling performance index. This is the basis for decision-making concerning sampling strategy and the weighting factors in data-reconciliation techniques.

Apatite-group minerals from nepheline syenite, Pilansberg alkaline complex, South Africa

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The nepheline syenites of the Pilansberg alkaline complex (South Africa) have undergone extensive subsolidus equilibration and alteration with a deuteric Cl- and Na-rich fluid phase. Complex assemblages of secondary minerals result from the replacement of primary alummosilicates, rinkite, eudialyte and fluorapatite. The composition of apatite group minerals formed during these alteration processes reflects the Sr- and rare earth element (REE) content, Na/Cl ratio and pH of the deuteric fluids. Apatite-group minerals are observed to have formed in the following sequence: orthomagmatic fluorapatite; strontian britholite-(Ce); strontian fluorapatite; Sr-apatite; REE-rich Sr-apatite; Sr-Na-REE-rich minerals approaching the stoichiometry of belovite-(Ce) and deloneite-(Ce);britholite-(Ce). Increasing alkalinity of the deuteric fluids is reflected by increasing amounts of Sr replacing Ca in apatite and culminates in the formation of Sr apatite containing 62.1 wt.% SrO (similar to 4.17 a.p.f.u. Sr). Pilansberg apatite-group minerals form a near-complete solid solution between fluorapatite and a fluorine analogue of Sr apatite with limited solution towards belovite-(Ce), Si-rich belovite-(Ce) and strontian britholite-(Ce).