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Adsorption of herbicide paraquat by clay mineral regenerated from spent bleaching earth

Tsai, WT; Lai, CW
JOURNAL OF HAZARDOUS MATERIALS, Vol. 134, 2006, pp. 144-148.
10.1016/j.jhazmat.2005.10.045

The adsorption of herbicide paraquat (as model adsorbate) in aqueous solution onto regenerated clay mineral from bleaching earth waste has been studied in a batch reaction system. The adsorption rate has been investigated under the controlled process parameters including initial pH, salinity and temperature. Based on the high affinity between cationic paraquat and clay mineral, a pseudo-second order model has been developed using experimental data to predict the rate constant of adsorption, and equilibrium adsorption capacity. The results showed that the adsorption process could be satisfactorily described with the reaction model and were reasonably explained by assuming a competitive adsorption mechanism in the ion exchange process. Further, the fitted adsorption capacity at equilibrium decreased with increasing temperature. It implied that the strong interaction might play an important role in the paraquat-clay system. Overall, the results from this study demonstrated that the clay resource regenerated from bleaching earth waste could be used as a low-cost mineral adsorbent for the removal of environmental cationic organic pollutants from the aqueous solution. (c) 2005 Elsevier B.V. All rights reserved.

Adsorption of bisphenol-A from aqueous solution onto minerals and carbon adsorbents

Tsai, WT; Lai, CW; Su, TY
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The adsorption behaviors of bisphenol-A, which has been listed as one of endocrine disrupting chemicals, from aqueous solution onto four minerals including andesite, diatomaceous earth, titanium dioxide, and activated bleaching earth, and two activated carbons with coconut-based and coal-based virgins were examined in this work. Based on the adsorption results at the specified conditions, the adsorption capacities of activated carbons are significantly larger than those of mineral adsorbents; implying that the former is effective for removal of the highly hydrophobic adsorbate from the aqueous solution because of its high surface area and low surface polarity. The adsorption capacities of bisphenol-A onto these mineral adsorbents with different pore properties are almost similar in magnitude mainly due to the weakly electrostatic interaction between the mineral surface with negative charge and the target adsorbate with hydrophobic nature. Further, a simplified kinetic model, pseudo-second-order, was tested to investigate the adsorption behaviors of bisphenol-A onto the two common activated carbons at different solution conditions. It was found that the adsorption process could be well described with the pseudo-second-order model. The kinetic parameters of the model obtained in the present work are in line with the pore properties of the two adsorbents. (c) 2005 Elsevier B.V. All rights reserved.

Simultaneous optimization of the performance of flotation circuits and their simplification using the jumping gene adaptations of genetic algorithm-II: More complex problems

Guria, C; Varma, M; Mehrotra, SP; Gupta, SK
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10.1016/j.minpro.2006.01.008

The binary-coded elitist non-dominated sorting genetic algorithm with the modified jumping gene operator (NSGA-II-mJG) is used to obtain global optimal solutions of flotation circuits. Several single-objective and multi-objective optimization problems are solved using the interconnecting cell linkage parameters (fraction flow rates) and the mean cell residence times as the decision variables. In the single-objective problem, the overall recovery of the concentrate stream is maximized for a desired grade of the concentrate. Two two-objective optimization problems are then solved. In one, the number of non-linking streams and the overall recovery of the concentrate are maximized simultaneously. This gives several simple circuits in a systematic manner with only marginally lower recoveries. In the other two-objective optimization problem, the overall recovery of the concentrate is maximized while the total cell volume is minimized. A three-objective problem (maximization of the overall recovery of the concentrate, maximization of the number of non-linking streams and minimization of the total cell volume) is then solved. All the problems constrain the grade of the product to lie at a fixed value. Finally, a complex and computationally intensive four-objective optimization problem is solved. The solution of several practical optimization problems in this study helps develop useful insights into the optimal solutions. (c) 2006 Published by Elsevier B.V.

Studies on the interaction of some azo dyes (naphthol red-J and direct orange) with nontronite mineral

Gupta, VK; Mohan, D; Saini, VK
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10.1016/j.jcis.2005.11.041

The adsorption of two azo dyes, namely naphthol red-J and direct orange, on nontronite mineral was studied as a function of pH and temperature. All the sorption studies were conducted in batch mode. The Langmuir and Freundlich isotherm models were applied. The isotherms are Langmuirian in nature, while the Freundlich equation is only valid over the low concentration range. The adsorption of the two dyes increases with increased temperature and decreases with increased pH. The data have been explained in terms of the area of contact of the dye molecule on the clay platelet vis-a-vis the area per anion exchange site. Estimated area per anion exchange site of the mineral and area associated per anionic dye molecule at nontronite surface was 642 and 454 angstrom(2) for naphthol red-J and 642 and 440 angstrom(2) for direct orange respectively. This has been further supported by X-ray measurements. Thermodynamic parameters of the process were evaluated. (c) 2005 Elsevier Inc. All rights reserved.

Adsorption-induced fibronectin aggregation and fibrillogenesis

Pellenc, D; Berry, H; Gallet, O
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Fibronectin (Fn), a high molecular weight glycoprotein, is a central element of extracellular matrix architecture that is involved in several fundamental cell processes. In the context of bone biology, little is known about the influence of the mineral surface on fibronectin supramolecular assembly. We investigate fibronectin morphological properties induced by its adsorption onto a model mineral matrix of hydroxyapatite (HA). Fibronectin adsorption onto HA spontaneously induces its aggregation and fibrillation. In some cases. fibronectin fibrils are even found connected into a dense network that is close to the matrix synthesized by Cultured cells. Fibronectin adsorption-induced self-assembly is a time-dependant process that is sensitive to bulk concentration. The N-terminal domain of the protein, known to be implicated in its self-association, does not significantly inhibit the protein self-assembly while increasing ionic strength in the bulk alters both aggregation and fibrillation. The addition of a non-ionic surfactant during adsorption tends to promote aggregation with respect to fibrillation. Ultimately, fibronectin fibrils appear to be partially structured like amyloid fibrils as shown by thioflavine T staining. Taken together, our results suggest that there might be more than one single organization route involved in fibronectin self-assembly onto hydroxyapatite. The underlying mechanisms are discussed with respect to Fn conformation, Fn/surface and Fn/Fn interactions, and a model of fibronectin fibrillogenesis onto hydroxyapatite is proposed. (c) 2005 Elsevier Inc. All rights reserved.

The missing sulphur in mattheddleite, sulphur analysis of sulphates, and paragenetic relations at Leadhills, Scotland

Essene, EJ; Henderson, CE; Livingstone, A
Mineralogical Magazine, 70, 3, 2006, pp. 265-280.
10.1180/0026461067030330

Published electron microprobe analyses of mattheddleite, a lead sulpho-silicate apatite from Leadhills, Scotland, have 9-13% IV site deficiencies. However, galena was used as a standard for S, which suggested that low S resulted from a shift in the S-K alpha peak. Wavelength scans with a PET crystal show that the S-K alpha peak is shifted down by 0.0026 angstrom for sulphates relative to sulphides. Quantitative analyses show a similar to 30% increase of S in mattheddleite using a celestite standard, which fills the IV site, but with Si > S, on average Pb5S1.2Si1.8O11.7Cl0.6(OH)(0.4). Direct analysis of oxygen with the electron microprobe implies that the charge imbalance engendered from the inequality of Si and S is compensated with substitution of a vacancy (square), as in Pb5S1.2Si1.8[O-11.7 square(0.3)][Cl-0.6(OH)(0.4)] or Pb5S1.2Si1.8[O-11.7(Cl,OH)(0.3)][Cl,OH)(0.7)square(0.3)]. Calculation of OH as l-Cl suggests the presence of both OH- and Cl-dominant mattheddleite at Leadhills, but direct analysis of H is needed to confirm the dominance of OH in the channel site. Wavelength-dispersive analyses of S in apatite and other sulphates must be undertaken with sulphate standards: use of sulphide standards yields a negative error on the order of 10-20% in the resultant S concentration. Reactions of mattheddleite with other Pb minerals at Leadhills show that their stability depends on fluid composition as well as pressure and temperature. An X-ray map of Cl shows complex zoning between Cl-poor and Cl-rich mattheddleite, recording rapid changes in the fluid chemistry during late-stage hydrothermal processes at Leadhills.

The origin of the hydrous scandium phosphate, kolbeckite, from the Hagendorf-Pleystein pegmatite province, Germany

Dill, HG; Webber, B; Fussl, M; Melcher, F
Mineralogical Magazine, 70, 3, 2006, pp. 281-290.
10.1180/0026461067030331

The rare hydrous scandium phosphate, kolbeckite, [Sc(PO4).2H(2)O], has been recognized for the first time from the Hagendorf-Pleystein pegmatite province. The mineral was formed by the alteration of quartz-rich relict cores of pegmatites containing rutile, ilmenite, columbite, pyrochlore, wolframite, monazite and apatite. The alteration process involved acidic meteoric water and was not related to low-temperature hydrothermal fluids. Scandium and phosphorous for the formation of the kolbeckite were provided by the decomposition of the primary oxides and phosphates, respectively. Hydrous Sc phosphates are considered to form only during advanced stages of weathering in Al- and Fe-poor environments. In Al- and Fe-rich environments Sc is scavenged from solution as a trace component of Al- and Fe phosphates. A special type of leucoxene containing Fe, Al and P was formed during the process of formation of kolbeckite. In the absence of phosphate anions, Sc is removed in solution and 'normal' leucoxene is formed.

Ferrous iron sorption by hydrous metal oxides

Nano, GV; Strathmann, TJ
Journal of Colloid and Interface Science, Vol. 297, 2, 2006, pp. 443-454.
10.1016/j.jcis.2005.11.030

Ferrous iron is critical to a number of biogeochemical processes that occur in heterogenous aquatic environments, including the abiotic reductive transformation of subsurface contaminants. The sorption of Fe(II) to ubiquitous soil minerals, particularly iron-free mineral phases, is not well understood. Colloidal TiO(2), gamma-AlOOH, and gamma-Al(2)O(3) were used as model hydrous oxides to investigate Fe(II) sorption to iron-free mineral surfaces. Rapid Fe(II) sorption during the first few hours is followed by a much slower uptake process that continues for extended periods (at least 30 days). For equivalent solution conditions, the extent of Fe(II) sorption decreases, in the order

TiO(2) > gamma-Al(2)O(3) >> gamma-AlOOH. Short-term equilibrium sorption data measured over a wide range of conditions (pH. ionic strength, Fe(II)-to-sorbent ratio) are well described by the diffuse double layer model. Fe(II) sorption to TiO(2) is best described by a single-site model that considers formation of two surface complexes. equivalent to SOFe(+) and equivalent to SOFeOH(0). For gamma-AlOOH and gamma-Al(2)O(3), sorption data are best described by a two-site model that considers formation of equivalent to SOFe(+) complexes at weak- and strong-binding surface sites. Accurate description of sorption data for higher Fe(II) concentrations at alkaline pH conditions requires the inclusion of a Fe(II) surface precipitation reaction in the model formulation. The presence of common groundwater constituents (calcium, sulfate, bicarbonate, or fulvic acid) had no significant effect on Fe(II) sorption. These results demonstrate that iron-free soil minerals can exert a significant influence on Fe(II) sorption and speciation in heterogenous aquatic systems. (c) 2005 Published by Elsevier Inc.

Inner-sphere adsorption geometry of Se(IV) at the hematite (100)-water interface

Catalano, JG; Zhang, Z; Fenter, P; Bedzyk, MJ
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The 3-dimensional structure of adsorption complexes on mineral surfaces provides insight into the fundamental mechanisms controlling sorption processes. This is important to the development of a general understanding of the behavior of contaminants such as selenite in the environment. The adsorption of selenite (SeO32-) on the hematite (100) surface was studies using X-ray standing wave (XSW) measurements. Inner-sphere bidentate surface complexes bridging between adjacent singly-coordinated oxygen sites were identified as the primary adsorption site. The lack of binding to doubly-coordinated oxygen sites that were also exposed on the surface was likely due to differences in the reactivity or exchange kinetics of these sites or cation-cation repulsion, although the latter appears to be a secondary effect based on past observations. While these bridging bidentate geometries are similar to those inferred in past spectroscopic studies, the Se-Fe distances are such that these species might be misidentified as edge-sharing complexes if studied by EXAFS spectroscopy, highlighting the need for a fundamental understanding of mineral surface structure. (c) 2005 Elsevier Inc. All rights reserved.

On the mechanisms of dissolution of montroydite [HgO(s)]: Dependence of the dissolution rate on pH, temperature, and stirring rate

Hocsman, A; Di Nezo, S; Charlet, L; Avena, M
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10.1016/j.jcis.2005.11.020

The dissolution behavior of niontroyclite (Hg0) has been studied using a fully automated system. Dissolution data under equilibrium conditions are in agreement with previously published data and indicate that HgO solubility is relatively high and constant between pH 4 and 10.1 and increases markedly at pH < 4. The dissolution rate also has similar behavior it is relatively high and constant between pH 4 and 10.1 and increases sharply at pH < 4. The dissolution process obeys a three-dimensional contraction or attrition mechanism. The dissolution rate increases with increasing temperature and stirring rate and is the result of mixed transport and reaction control. The rate of HgO dissolution is considerably higher than that of other divalent metal oxides at low pH. This high rate is clue to the ability of Hg(II) to rapidly exchange its ligands. Data suggest that montroyclite will only occur in nature in highly contaminated sites and indicate that Ho oxidation products that are formed at the liquid ligo/water interface may dissolve rapidly. (c) 2005 Elsevier Inc. All rights reserved.

Characterization and adsorption properties of diatomaceous earth modified by hydrofluoric acid etching

Tsai, WT; Lai, CW; Hsien, KJ
Journal of Colloid and Interface Science, Vol. 297, 2, 2006, pp. 749-754.
10.1016/j.jcis.2005.10.058

This work was a study of the chemical modification of diatomaceous earth (DE) using hydrofluoric acid (HF) solution. Under the experimental conditions investigated, it was found that HF under controlled conditions significantly etched inward into the interior of the existing pore structure in the clay mineral due to its high content of silica, leaving a framework possessing a larger BET surface area (ca. 10 m(2) g(-1)) in comparison with that (ca. 4 m(2) g(-1)) of its precursor (i.e, DE). Further, the results indicated that the HF concentration is a more determining factor in creating more open pores than other process parameters (temperature, holding time, and solid/liquid ratio). This observation was also in close agreement with the examinations by the silicon analysis, scanning electron microscopy, X-ray diffraction, and Fourier transform infrared spectroscopy. The adsorption kinetics and the adsorption isotherm of methylane blue onto the resulting clay adsorbent can be well described by a pseudo-second-order reaction model and the Freundlich model, respectively. (c) 2005 Elsevier Inc. All rights reserved.

Modeling of cadmium(III) adsorption on kaolinite-based clays in the absence and presence of humic acid

Hizal, J; Apak, R
Applied Clay Science, Vol. 32, 2006, pp. 232-244.
10.1016/j.clay.2006.02.002

Cadmium adsorption on kaolinite-based clays in the absence and presence of humic acid was modeled with the aid of the FITEQL 3.2 computer program using a modified Langmuir approach for capacity calculations. Formation of surface-metal ion and surface-humate-metal ion complexes was assumed using the DLM approach. As Cd(H) adsorption was ionic strength-dependent, the adsorption experiments were carried out in solutions containing two different concentrations of an inert electrolyte (0.1 M and 0.005 M NaClO4). The surface sites responsible for the adsorption were assumed to be the permanent charges, =S1OH silanol groups and carboxyl groups having pK(a) values close to that of the silanol groups, and =S2OH aluminol groups and phenol groups with pKa values close to that of the aluminol groups, because the studied clays (partly composed of clay soil) contained organic carbon. Cd2+ ions were assumed to bind to the surface in the form of outer-sphere X-2(2-) Cd2+ and inner-sphere =SOCd+ monodentate complexes. When humic acid was added, Cd(II) adsorption was modeled using a multi-site binding model by the aid of FITEQL3.2. The fit between model and experimental values was excellent in each case. Since the stability of the ternary surface complexes in the presence of humic acid was higher than that of the corresponding binary surface-cadmium ion complexes, the adsorption vs. pH curves were much steeper (and distinctly S-shaped) compared to the tailed curves observed in binary clay-cadmium ion systems. The clay mineral in the presence of humic acid probably behaved more like a chelating ion-exchanger for heavy metal ions than as a simple inorganic ion exchanger. (C) 2006 Elsevier B.V. All rights reserved.

Removal of fulvic acid from aqueous media by adsorption onto modified vermiculite

Abate, G; dos Santos, LBO; Colombo, SM; Masini, JC
Applied Clay Science, 32, 2006, pp. 261-270.
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Clay minerals are low cost materials that can be structurally modified and exploited for removal of natural organic matter from freshwaters. The present study shows that vermiculites modified by ion exchange with hexadecyltrimethylammonium or intercalation with poly(hydroxy iron) cations are potential adsorbents for removal of fulvic acid, whereas the adsorption on the raw clay mineral is negligible. The efficiency of the modified vermiculite was evaluated by measuring adsorption isotherms by the batch technique using initial fulvic acid concentrations between 2.5 and 50.0 mg L-1, with one hour of contact time. At least 94% of the fulvic acid initially present in a 20 mg L-1 solution was sorbed onto either the intercalated poly (hydroxy iron) cations or the organically modified vermiculite. Up to an initial concentration of 5.0 mg L-1 the adsorption is irreversible, and no quantifiable fulvic acid was measured in the desorption experiments. For initial fulvic acid concentrations between 10.0 and 50.0 mg L-1, desorption was between 2.3% and 4.9% for Fe(III) intercalated vermiculite, and between 1.4% and 9.2% for the organoclay. The adsorption percentages on intercalated poly(hydroxy iron) cations increased upon lowering pH and increasing the ionic strength, indicating the occurrence of strong binding mechanisms such as ligand exchange. Adsorption percentage of fulvic acid onto the organoclay also increased with lowering of pH, but in this case the adsorption percentages showed a small decrease at high ionic strength, suggesting that electrostatic attraction plays an important role in the adsorption process. (C) 2006 Elsevier B.V. All rights reserved.

Structural characterisation of a sol-gel copolymer synthesised from aliphatic and aromatic alkoxysilanes using Si-29-NMR spectroscopy

Oubaha, M; Dubois, M; Murphy, B; Etienne, P
Journal of Sol-Gel Science and Technology, Vol. 38, 2, 2006, pp. 111-119.
10.1007/s10971-006-7114-7
A hybrid organic-inorganic material was prepared from the hydrolytic co-condensation of 3-trimethoxysilylpropylmethacrylate (MAPTMS) and diphenyldiethoxysilane (DPHDES). The synthesis was performed in three steps: (1) MAPTMS pre-hydrolysis, (2) addition of

DPHDES, and (3) further hydrolysis of the obtained mixture. Si-29 nuclear magnetic resonance spectroscopy was used to characterise the structural evolution of the mineral network during the synthesis. It revealed the catalytic effect of DPHDES on the condensation reaction of silanol groups, initially observed for pre-hydrolysed MAPTMS. In addition, it was clearly demonstrated that the formation of the highest condensed species of the aromatic oligomers (D-2 species) occurred only in the presence of aliphatic oligomers, which decrease the sterical hindrance about the silicon nuclei.

Spectroelectrochemical investigations of flotation reagent-surface interaction

Hope, GA; Woods, R; Parker, GK; Watling, KM; Buckley, FM
Minerals Engineering, 19, 2006, pp. 561-570.
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Surface enhanced Raman scattering (SERS) spectroscopy at surfaces under electrochemical control has been applied to elucidate the adsorption of thiol collectors. SERS spectroelectrochemical studies at coinage metal electrodes have been carried out on ethyl xanthate, and three isoxanthates, O-isopropyl-N-ethylthionocarbamate, 2-mercaptobenzothiazole, diisobutyldithiophosphinate and butylethoxycarbonylthiourea. For each collector, adsorption occurs via charge transfer to form a metal-sulfur bond and, in situations for which the reversible potential of the formation of the bulk phase is known, at underpotentials. Mercaptobenzothioazole was detected on chalcopyrite after immersion in a solution of the collector after the deposition of gold to induce SERS. (C) 2005 Elsevier Ltd. All rights reserved.

CFD modelling of bubble-particle attachments in flotation cells

Koh, PTL; Schwarz, MP
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In recent years, computational fluid dynamic (CFD) modelling of mechanically stirred flotation cells has been used to study the complexity of the flow within the cells. In CFD modelling, the flotation cell is discretized into individual finite volumes where local values of flow properties are calculated. The flotation effect is studied as three sub-processes including collision, attachment and detachment. In the present work, these sub-processes are modelled in a laboratory flotation cell. The flotation kinetics involving a population balance for particles in a semi-batch process has been developed. From turbulent collision models, the local rates of bubble-particle encounters have been estimated from the local turbulent velocities. The probabilities of collision, adhesion and stabilization have been calculated at each location in the flotation cell. The net rate of attachment. after accounting for detachments, has been used in the kinetic model involving transient CFD simulations with removal of bubble-particle aggregates to the froth layer. Comparison of the predicted fraction of particles remaining in the cell and the fraction of free particles to the total number of particles remaining in the cell indicates that the particle recovery rate to the pulp-froth interface is much slower than the net attachment rates. For the case studied, the results indicate that the bubbles are loaded with particles quite quickly, and that the bubble surface area flux is the limiting factor in the recovery rate at the froth interface. This explains why the relationship between flotation rate and bubble surface area flux is generally used as a criterion for designing flotation cells. The predicted flotation rate constants also indicate that fine and large particles do not float as well as intermediate sized particles of 120-240 mu m range. This is consistent with the flotation recovery generally observed in flotation practice. The magnitude of the flotation rate constants obtained by CFD modelling indicates that transport rates of the bubble-particle aggregates to the froth layer contribute quite significantly to the overall flotation rate and this is likely to be the case especially in plant-scale equipment. (C) 2005 Elsevier Ltd. All rights reserved.

Flotation process diagnostics and modelling by coal grain analysis

Ofori, P; O'Brien, G; Firth, B; Jenkins, B
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In coal flotation, particles of different components of the coal such as maceral groups and mineral matter and their associations have different hydrophobicities and therefore different flotation responses. By using a new coal grain analysis method for characterising individual grains, more detailed flotation performance analysis and modelling approaches have been developed. The method involves the use of microscopic imaging techniques to obtain estimates of size, compositional and density information on individual grains of fine coal. The density and composition partitioning of coal processed through different flotation systems provides an avenue to pinpoint the actual cause of poor process performance so that corrective action may be initiated. The information on grain size, density and composition is being used as input data to develop more detailed flotation process models to provide better predictions of process performance for both mechanical and column flotation devices. A number of approaches may be taken to flotation modelling such as the probability approach and the kinetic model approach or a combination of the two. In the work reported here, a simple probability approach has been taken, which will be further refined in due course. The use of grain data to map the responses of different types of coal grains through various fine coal cleaning processes provided a more advanced diagnostic capability for fine coal cleaning circuits. This enabled flotation performance curves analogous to partition curves for density separators to be produced for flotation devices. Crown Copyright (C) 2005 Published by Elsevier Ltd. All rights reserved.

Liberated 0-10 mu m particles from sulphide ores, their production and separation - Recent developments and future needs

Johnson, NW
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The general types of industrial behaviour of liberated valuable sulphide minerals in the 0-10 mu m size fraction are described and tests to explore on-site at a concentrator the general nature of any deficient behaviour are discussed. In addition, the general types of behaviour of the gangue minerals in this size fraction are also described in terms of their mechanisms for recovery. These behaviours are also discussed in terms of the type of grinding device and grinding environment in which they were produced and the target grinding product size. Major recent improvements in the industrial capabilities of grinding devices are discussed. Present difficulties in characterization of particles in the 0-10 mu m range are described and desirable improvements for the future are outlined. Further, desirable improvements for industrial processing of valuable minerals in this size range are discussed along with some remedial actions. (C) 2005 Elsevier Ltd. All rights reserved.

The effect of heavy oxidation upon flotation and potential remedies for Merensky type sulfides

Newell, AJH; Bradshaw, DJ; Harris, PJ
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Surface oxidation of sulfide minerals, such as that found in the regions of a sulfide ore body near the water table, can have a significant impact upon flotation. This theme has been explored for Merensky ore type sulfides where an ore containing pyrrhotite, pentlandite and chalcopyrite was thermally oxidised and the role of potential remedies investigated. Back-scattered scanning electron microscope images are presented showing the oxidation layer which formed in the mineral surfaces. These oxidation layers were depleted in both sulfur and iron with incorporated oxygen. Flotation recovery rapidly decreased with increasing oxidation, particularly after 27 days and reached a plateau after 50 days. Up to 27 days, this effect could be partially overcome with higher collector additions. Oxidation had more impact upon the finer size fractions, particularly for pyrrhotite. For more heavily surface oxidised samples, ultrasonic treatment prior to collector conditioning was found to improve flotation recoveries. This treatment had the greatest effect upon chalcopyrite particles. Sulfidisation was successful in restoring the flotation recovery of the heavily oxidised sulfide minerals. Longer sulfidisation conditioning times were not conducive to good flotation recoveries of both oxidised pyrrhotite and pentlandite due to oxidation of the freshly formed sulfide surfaces. For maximum flotation recoveries of oxidised pyrrhotite, pentlandite and chalcopyrite, different sulfidisation conditions are indicated. It appears likely that in a mineral processing operation treating oxidised Merensky type ores, two stages of sulfidisation employing different conditions would be required. (C) 2005 Elsevier Ltd. All rights reserved.

The froth stability column: Measuring froth stability at an industrial scale

Barbian, N; Hadler, K; Cilliers, JJ
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Froth structure and stability are known to play important roles in determining mineral flotation recovery and selectivity. However, measuring froth stability in a consistent manner remains a significant challenge, especially at an industrial scale. Following preliminary tests on a copper concentration plant, a quantitative dynamic stability measure is investigated in this study in order to extend the results over a wider range of conditions and on a different ore body. The technique is based on the Bikerman foam test and uses a non-overflowing froth column to quantify froth stability. Experiments were carried out using an automated version of the froth stability column under different operating conditions. Air flowrate was the key operating variable. Tests were reproduced on a single flotation cell of a Platinum Group Metals concentrator. The froth stability factor, beta, was measured for each operating condition, and compared with the air recovery in the cell, alpha, which was measured using image analysis. The froth stability column results gave the same trends as image analysis. In particular the froth stability factor was found to be linearly related to the actual fraction of air overflowing the cell. The metallurgical results clearly indicated that changes in air flowrate result in variations in flotation performance that can be attributed to changes in froth stability. The results showed that high froth stability conditions occur at intermediate air flowrates, and result in improved flotation performance. It is found that the froth stability column is a simple, cost-effective and reliable method for quantifying froth stability, and for indicating changes in flotation performance. (C) 2005 Elsevier Ltd. All rights reserved.

Frother-related research at McGill University

Finch, JA; Gelinas, S; Moyo, P
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Over the past ten years the Mineral Processing group at McGill University has developed techniques to determine gas dispersion properties (gas superficial velocity, gas holdup, bubble size and bubble surface area flux) in flotation machines. This work is finding application in metallurgical diagnostics and cell characterization. The picture, however, will remain incomplete until the impact of chemistry on bubble production, and hence on gas dispersion, is understood. This has prompted investigations into frothers. There are two areas addressed in this communication: frother analysis and frother characterization. Coincident with the centenary, for 100 years there was no convenient frother analysis procedure. A colorimetric technique originally developed for alcohols had been applied to MIBC (Parkhomovski, V.L., Petrunyak, D.G., Paas, L., 1976. Determination of methylisobutylcarbinol in waste waters of concentration plants. Obogashchenie Rud 21 (2), 44-45). Using this as a starting point, the technique was successfully extended to a wide range of commercial frothers and shown to be robust against most common 'contaminants'. The technique is readily used on-site and some observations from plant surveys are described. Characterization of frothers has taken two routes, determining water carrying rate and investigating properties of thin bubble films. Second only to transporting particles the recovery of water by bubbles has the most influence on metallurgy. The question posed was whether this 'water carrying' property could be related to frother type. In a specially designed column the volume rate of water to the overflow per unit cross-sectional area ('carrying rate', J(wo)) and gas holdup (epsilon(g)) at controlled froth depths were measured. The J(wo)-epsilon(g) relationship proved approximately linear and dependent on frother type, with four frother 'families' being identified. Bubble thin films have been studied for soaps and the techniques were adapted for frothers. From infrared analysis it became apparent that the frother molecule, while itself not seen, had an impact on organizing water molecules, apparently forming a film of bound water on the bubble surface. Exploiting the interference pattern generated in UV/Vis the film thickness (d) was determined; for MIBC d was less than 160 nm while for DF250 d was similar to 600 nm. Taking a representative frother from the four families identified above, the water carrying rate at a given gas holdup increased with film thickness. Possible implications of the findings on the role of frother in bubble production are explored. (C) 2005 Elsevier Ltd. All rights reserved.

Application of numerical image analysis to process diagnosis and physical parameter measurement in mineral processes - Part I: Flotation control based on froth textural characteristics

Bartolacci, G; Pelletier, P; Tessier, J; Duchesne, C; Bosse, PA; Fournier, J
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10.1016/mineng.2005.09.041

This paper summarizes research into the study of the control of flotation processes based on froth images. A review of the froth flotation operation background and the re relevance and role of the froth phase are presented. The use of numerical image analysis techniques for the extraction of significant patterns from industrial flotation froths is discussed. First, the froth was analysed by the use of the Multivariate Image Analysis (MIA) method to extract the spectral variation contained in a RBG image. The Partial Least Squares (PLS) method was applied to develop an empirical model for the prediction of froth grade. The results of this application are illustrated using an industrial case study. Second, the froth was also analysed by Grey-Level Co-occurrence Matrix (GLCM) and Wavelet Transform Analysis (WTA) to extract features related more to morphological aspects. Since there is useful information hidden in froth texture, these methods are used as texture descriptor to classify different types of froths. They also provide qualitative information on the changes in the visual appearance of the froth. The pros and the cons of those methods are highlighted. Third, a control strategy based on a froth structure indicator was developed and implemented on an industrial zinc flotation circuit. The feedback controller uses the reagent flow-rate in order to maintain the froth structure at its set point. Process improvements obtained from the implemented control strategy are highlighted. Finally, the feasibility of implementing a hybrid control strategy consisting in a froth structure supervision controller based on the froth concentrate grade estimated by MIA and recovery inferred by image analysis is discussed. (C) 2005 Elsevier Ltd. All rights reserved.

Evaluation of a Microcel (TM) sparger in the Red Dog column flotation cells

Pyecha, J; Lacouture, B; Sims, S; Hope, G; Stradling, A
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Column flotation cells have been installed in numerous base metal operations around the world. The majority of these cells utilize conventional air-only spargers to introduce air into the bottom of the column. The recent development of instruments to measure the bubble characteristics in these columns has provided a renewed understanding of column behaviour. These new tools provided insight into why the columns at Red Dog

Mine had never performed up to expectations. After efforts to optimise the spargers failed to substantially change the bubble size and air efficiency, alternate sparger systems were investigated. The Metso Minerals CISA Microcel sparger system appeared promising and was selected for a full-scale plant trial. The Microcel sparger system was originally developed for the coal industry at the Virginia Centre for Coal and Minerals Processing. In October 2003, a Microcel was retrofitted into one of two 3.66 m diameter flotation columns in the zinc retreat circuit at Red Dog Mine. The operation of the two different sparger systems in parallel allowed a detailed comparison. This paper discusses the performance of the Microcel based on the data collected during several detailed surveys. Bubble size measurements carried out in the pulp zone using the McGill University bubble viewer showed a significant difference in bubble size. The mean Sauter diameter of the bubbles decreased from 3.4 mm for the jetting-type sparger to 1.9 mm for the Microcel sparger. The overall recovery and the recovery by size fraction for both valuable and gangue minerals were compared. Paired t-tests demonstrated that the Microcel column produced a higher concentrate grade (0.6% zinc absolute) and a higher unit recovery (2.8% zinc absolute) than the existing Canadian Process Technologies Inc (CPT) SlamJet column. These improvements provided a payback period of 1.5 months for the $109,000 investment. (C) 2005 Elsevier Ltd. All rights reserved.

Creating value through application of flotation science and technology

Clark, ME; Brake, I; Huls, BJ; Smith, BE; Yu, M
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10.1016/j.mineng.2005.09.030

A brief outline of some of the pioneering events in the development of flotation technology, which originated in Broken Hill at the start of the 1900s, is presented. The development of the original Potter-Delprat process, the introduction of oils to generate froth flotation and the achievement of selective flotation processing are described, all focussed on solving challenges with the Broken Hill Pb-Ag-Zn ores. Some recent initiatives in flotation at BHP Billiton operations are also outlined, covering coal, copper, lead-silver-zinc and diamonds. Some views are offered on the characteristics of innovation in flotation and on possible trends into the future. (C) 2005 Elsevier Ltd. All rights reserved.

Tracking of particles in the froth phase: An experimental technique

Ata, S; Pigram, S; Jameson, GJ
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This paper is concerned with the tracking of particles in the froth phase of an aerated water/glycerol mixture. Experiments have been carried out in a specially designed laboratory flotation cell that allows formation of a deep froth. Phosphorescent tracer particles of various sizes were injected into the centre of a froth column where they were excited by ultraviolet lights. The motion of particles was captured on a digital camera with a green filter. The images from the digital camera were then transferred to a computer and an image analysis program was used to convert the color intensity to the concentration of particles at each location within the froth. The tracer technique was used to determine the dispersion of hydrophilic particles and the variation of the concentration of solids with axial and radial positions. (C) 2005 Elsevier Ltd. All rights reserved.

The Sullivan concentrator - the last (and best) 30 years

Fairweather, MJ
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The optimal production of the metals needed by society is best achieved by a close synergy between concentrate production and smelting. For over 75 years commencing in 1923, such a close relationship was enjoyed between the Sullivan Mine in Kimberley, BC and the Trail zinc lead complex. An effective program of continual change and improvement at the Sullivan concentrator was achieved through a strong entrepreneurial spirit. This spirit was in part maintained through a favourable location in southeastern British Columbia that resulted in a dynamic local community that has survived the closure of the mine. Innovations to be reviewed include feed forward reagent control, the use of column flotation to zinc and lead cleaning and the application of ultrafine grinding coupled with concentrate dewatering using hyperbaric filter technology. (C) 2005 Elsevier Ltd. All rights reserved.

Technologies for laboratory generation of dust from geological materials

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Journal of Hazardous Materials, Vol. 132, 1, 2006, pp. 1-13.
10.1016/j.jhazmat.2005.11.083

Dusts generated in the laboratory from soils and sediments are used to evaluate the emission intensities, composition, and environmental and health impacts of mineral aerosols. Laboratory dust generation is also utilized in other disciplines including process control and occupational hygiene in manufacturing, inhalation toxicology, environmental health and epidemiology, and pharmaceutics. Many widely available and/or easily obtainable laboratory or commercial appliances can be used to generate mineral aerosols, and several distinct classes of dust generators (fluidization devices, dustfall chambers, rotating drums/tubes) are used for geological particulate studies. Dozens of different devices designed to create dust from soils and sediments under controlled laboratory conditions are documented and described in this paper. When choosing a specific instrument, investigators must consider some important caveats: different classes of dust generators characterize different properties (complete collection of a small puff of aerosol versus sampling of a representative portion of a large aerosol cloud) and physical processes (resuspension of deposited dust versus in situ production of dust). The quantity "dustiness" has been used in industrial and environmental health research; though it has been quantified in different ways by different investigators, it should also be applicable to studies of geological aerosol production. Using standardized dust-production devices and definitions of dustiness will improve comparisons between laboratories and instruments: lessons learned from other disciplines can be used to improve laboratory research on the generation of atmospheric dusts from geological sources. (c) 2005 Elsevier B.V. All rights reserved.

Chemical and structural variability of illitic phases formed from kaolinite in hydrothermal conditions

Bentabol, M; Cruz, MDR; Huertas, FJ; Linares, J
Applied Clay Science, Vol. 32, 2006, pp. 111-124. 10.1016/j.clay.2005.12.003

The transformations of kaolinite in the system Na2O-K2O-MgO-Al2O3-SiO2-H2O-HCl at 200 degrees C, with different MgCl2 contents, have been investigated by X-ray diffraction and transmission/analytical electron microscopy. Two contrasting mechanisms of illite formation were identified: 1) direct precipitation of illite from dissolution of zeolites, which occurs at high pH and low Mg contents; and 2) formation of illitic phases from recrystallized kaolinite, either through dissolution-precipitation processes or by topotactic replacement. The second mechanism occurs at higher Mg contents and almost neutral conditions. Under these later conditions, kaolinite dissolution-precipitation processes occur at the earliest stages of reaction, which lead to the formation of Mg-rich kaolinite. The illitic phases formed through both mechanisms have different structural and chemical characteristics. Direct precipitation from solution produces well-ordered illites with scarce phengitic substitution and high Na contents. Illitic phases formed from kaolinite show an evolution from illite/smectite mixed-layers to illite, at increasing run times. These phases are characterized by high octahedral Mg content (in the order of 0.8 apfu, for O-10(OH)(2)), and lack of Na. The activity diagrams constructed from the data of solutions confirm the data obtained from the study of. the solid products. (C) 2006 Elsevier B.V. All rights reserved.

Microcalorimetric studies of the effects of MgCl2 concentrations and pH on the adsorption of DNA on montmorillonite, kaolinite and goethite

Cai, P; Huang, QY; Zhang, XW
Applied Clay Science, Vol. 32, 2006, pp. 147-152. 10.1016/j.clay.2005.11.004

This study attempted to comprehend the interaction mechanisms between DNA and the common minerals in soil such as montmorillonite, kaolinite and goethite at various environmental conditions. The effects of MgCl2 concentrations (0, 1, 10 and 60 mM) and pH (3.0, 5.0, 7.0 and 9.0) on the adsorption of DNA on the examined minerals were investigated by the equilibrium adsorption and direct measurement of adsorption enthalpies. The adsorption isotherms fitted by the Langmuirian model revealed that the maximum capacities and affinities of DNA adsorption on minerals increased with MgCl2 concentrations and decrease of pH. No DNA was adsorbed on montmorillonite at pH 9.0. The values of DNA adsorption enthalpies (Delta H-ads) ranged from -0.3 to 4.9 kJ g(-1) at different systems. The Delta H-ads values decreased with increasing MgCl2 concentrations and decreasing pH. The adsorption of DNA on montmorillonite, kaolinite and goethite was an exothermic reaction (-0.3<Delta H-ads<-0.1 kJ g(-1)) at 60 mM MgCl2 and pH 3.0, suggesting a more significant electrostatic attraction in the adsorption process. In contrast, DNA adsorption on minerals became endothermic (0.1

< Delta H-ads<4.9 kJ g(-1)) at 0-10 mM MgCl2 and pH 5.0-9.0 and dehydration effects were considered as the dominant driving forces for DNA adsorption on minerals. The thermodynamic parameters presented in this study have important implications for clarifying the binding mechanisms between DNA and mineral particles in soil and associated environments. (C) 2005 Elsevier B.V. All rights reserved.

Dissolved gas flotation in mineral processing

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Mineral Processing and Extractive Metallurgy Review, Vol. 27, 2, 2006, pp. 87-97.
10.1080/08827500500339331

Potential use of dissolved gas bubbles in mineral flotation processes was investigated by conducting tests on the copper-nickel ore of Inco Ltd. in Sudbury, Ontario, Canada. Such bubbles were generated by pressurizing the ore pulp in an air or argon atmosphere at a 276 kPa gauge (40 psig) for a period of about 1 min and then releasing the pressure by discharging the pressurized pulp into a column where flotation took place. Based on the conclusions of an earlier work, dissolved gas bubbles were employed together with conventional bubbles, the latter produced by a gas sparger located inside the flotation column. The presence of dissolved gas bubbles in the flotation pulp was found to have a significant impact, particularly when argon was used as the flotation gas, resulting in substantially higher grades and recoveries in the concentrate. At the same time, mass recoveries by size showed a 20% increase across all sizes when air was used as the flotation gas and a 40-100% increase in the case of argon.

Influence of applied mineralogy in developing an optimal hydrometallurgical processing route for complex sulphide ores

Olubambi, PA; Ndlovu, S; Potgieter, JH; Borode, JO
Mineral Processing and Extractive Metallurgy Review, Vol. 27, 2, 2006, pp. 143-158.
10.1080/08827500600563350

The selection of an optimum technical and economic processing and extraction route for minerals and metals requires complete knowledge of the ore, especially its chemical and mineralogical compositions, relative amounts, and grain size distribution. Thus, to obtain optimum results during base metals recovery from complex sulphide ore, processing must start from a sound and complete mineralogical study. This work therefore investigates the influence of applied mineralogy in the selection of the optimal route for processing and extracting base metals from complex sulphides, by studying the size, mineralogy, and elemental distribution of Ishiagu bulk complex sulphide ore. Bulk complex sulphide ore from Ishiagu, in Eboyin State, in the southeastern part of Nigeria, was sequentially crushed in a jaw crusher and a cone crusher, and ground in a rod mill. The results obtained during laboratory sieve analysis were used to evaluate its size distribution. Identification of mineral phases distributed within the sizes was determined by microscopy, using a scanning electron microscope coupled with energy dispersed x-ray analyzer to produce backscattered images. The elemental distribution was determined by the optical emission spectrometry using x-ray fluorescence and inductively coupled plasma-optical emission spectrometer. Results obtained showed variations in elemental and mineralogical composition within the different sizes. The concentrations of zinc, copper, and iron reduce as particle size decreases, while silicon, sulphur, and lead contents increase. The overall results obtained were used as a basis for predicting parameters for which optimal hydrometallurgical recovery of the constituent's metals could be achieved.

Biological, chemical and electromagnetic treatment of three types of feldspar raw materials

Styriakova, I; Styriak, I; Malachovsky, P; Lovas, M
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Bioleaching processes in combination with electromagnetic separation can substantially improve the quality of feldspar raw materials. Bacterial destruction of silicates is necessary for releasing intergranular spaces of silicate grains. These are often impregnated with iron minerals which can be subsequently removed by electromagnetic separation. Bioleaching is also effective for the removal of surface layers of fine iron minerals. After the bioleaching, a new mineral, weddellite (calcium oxalate dihydrate), was identified in the fine grain fraction in samples. Weddellite is formed upon the destruction of Ca-plagioclase and its formation indicates that oxalic acid was one of the metabolites involved in the bioleaching process. Bioleaching resulted in a 35-41% decrease in Fe content of raw material from Strazov and the subsequent electromagnetic separation decreased the Fe content up to 69-74% of Fe. The second raw material was granite from Poproc and bioleaching removed 60% of Fe in spite of a high content of Fe2O3. The removal was increased up to 75% of Fe in combination with electromagnetic separation. Iron removal by biological leaching and electromagnetic separation ensures high quality and white color of raw material. (c) 2005 Elsevier Ltd. All rights reserved.

Product quality improvement of Brazilian impure marble

Varela, JJ; Petter, CO; Wotruba, H
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Natural carbonates have an enormous importance in the world's economy due to their numerous applications. According to their different uses, such as calcium carbonate in the paper and paint industries, the final products have rigorous quality specifications which are currently difficult to meet for local producers in Brazil. Therefore, large quantities of high-grade carbonates are transported long distances inside the country to supply the different industrial plants. In southern Brazil, carbonate ores are used mainly for agricultural purposes. In Cacapava do Sul, the selectively mined ore is currently hand-picked at low throughputs to produce high-grade (white) carbonate. This paper present applied research work to improve the product quality and gives an overview of the market situation for the regional producers. The aim of the work is threefold: - to characterize the raw ore and determine the potential for production of the required quality and quantity for the Brazilian market; - to develop an industrial process incorporating optical sorting and comminution (high intensity magnetic separation was tested too); - to control the quality of the products by application tests, including the measurement of brightness. (c) 2005 Elsevier Ltd. All rights reserved.

Beneficiation of colemanite tailings by attrition and flotation

Gul, A; Kaytaz, Y; Onal, G
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Boron minerals are generally concentrated using attrition methods followed by screening and classification to remove clay minerals in industrial scale. Physical concentration methods are used in Kestelek Boron Mine for the concentration of colemanite. Because of the inefficient process operation, the tailings containing about 20% B2O3 are discarded into the tailings pond. In this study, colemanite tailings sample taken from tailings pond was treated using scrubbing + screening followed by flotation to recover the lost boron. As a result of the experimental studies, a concentrate containing 44.5% B2O3 was produced with 68.4% B2O3 recovery. (c) 2005 Elsevier Ltd. All rights reserved.

Application of sugar foam to a pyrite-contaminated soil

Moraza, CJ; Iglesias, N; Palencia, I
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Mining and mineral processing of sulphide ore deposits produce large quantities of wastes, most of which are characterised as toxic or hazardous, due to the formation of acid drainage, and to their heavy metal content. Samples of pyrite-contaminated soil from a former flotation plant were studied in this work to obtain environmental characterization and rehabilitation. Acid mine drainage prediction by the standard acid base accounting method (ABA) together with speciation techniques, were used in order to determine the potential pollution of the area. The effectiveness of sugar foam as an amendment in preventing acid drainage and metal dissolution was tested in this work. The application of sugar foam results in a neutralizing action, due to the contained calcium carbonate, and in pyrite oxidation inhibition, significantly reducing acid generation and metals release. (C) 2005 Elsevier Ltd. All rights reserved.

Fundamental limits for the recycling of end-of-life vehicles

Reuter, MA; van Schaik, A; Ignatenko, O; de Haan, GJ
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This paper explores the limits of recycling on a fundamental basis. This fundamental basis suggests that the high recycling quotas for end-of-life vehicles (ELVs) as required by EU legislation could be totally erroneous since it is based on poor first principles argumentation. If this conjecture is true then the monitoring of recycling quotas by legislation could be the incorrect manner of controlling environmental performance.

Rather, it is suggested that a market driven approach is required to ensure optimal performance of the recycling system in which each actor in the system optimises its activity within the boundaries of its relevant environmental legislation, physics, chemistry, which all dictate the limits of recycling. In order to illustrate this industry/market driven approach, a system model was developed, conjecturing that the intrinsic property determining the recyclability and recoverability of a product respectively, is not just determined by the different materials and alloys used, but primarily by the mineral or joint classes (combination of materials due to design), particle size distribution and degree of liberation (multi-material particles). These all affect the physical separation efficiency, metallurgical and energy recovery, which all in turn determine the quality and economic value of the recycling (intermediate) products in the recycling system. The summation of these aspects determines the economics and hence the recyclability and recoverability of the product and therefore the recycling and recoverability rate. Note that each system activity as always run within the boundaries of normal environmental legislation for process industries. Based on these intrinsic properties, a fundamental framework is developed as a common language to harmonise recycling legislation with industrial practice, separation physics and thermodynamics, quality of recycling (intermediate) products, plant statistics and if required, product design. This recycling optimisation model, building on previous work by the authors, not only describes physical separation and metallurgical processing, but also covers the physical separation of shredder residue in close connection to the thermal treatment of these materials. This model therefore adds significant detail and novel aspects to a previous model by the authors. In order to illustrate the mentioned conjecture, it is shown how the optimisation model can be applied by the recycling industry (for process optimization purposes) and legislator (for demonstrating the arguments in favour of more flexibility and less regulations) to build and evaluate recycling scenarios as a function of (future) car design, evaluate future market directions (i.e., what effect EU legislation has on the treatment of material in China), find the balance between dismantling, post-shredding technology (PST) and thermal processing, as a function of the calorific input constraints of different thermal treatment options, to name a few. An important fundamental conclusion is that recycling quotas of above 85% (Plus standard deviation) will probably be difficult to reach in future under current EU legislation. The preferred process route by the car industry with minimum dismantling (just de-pollution), but including PST is feasible to reach presently ca. 85% (plus a standard deviation). However, new novel and innovative, lightweight car designs, beneficial for less impact during use phase, could encounter problems in future to reach the required recycling quota of 85%, not to mention and a recovery quota of 95% by 2015. This paper suggests that recycling should accommodate flexibility within its structure, i.e., feedstock, mechanical recycling and energy recovery should together reach as high as possible value within the constraints of the market, technology and natural laws; matching changing innovative new car designs. This would help much to stimulate creative future design developments and at the same time provide a basis to run recycling and recovery technology at its fundamental maximum. A rigid quota driven legislation is too inflexible to meet these requirements and should be dropped for a market driven approach that optimises the recycling system in its totality. (C) 2005 Elsevier Ltd. All rights reserved.

Processing contaminated soils and sediments by high power ultrasound

Collings, AF; Farmer, AD; Gwan, PB; Pintos, APS; Leo, CJ
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Following the successful application of high power ultrasound to some areas of mineral processing, attention was directed towards the remediation of contaminated soils and sediments. Laboratory experiments have produced high contaminant destruction rates with surprisingly low energy costs and work at pilot plant scale is under way. The process relies on the phenomenon of cavitation to destroy contaminants Such as PCBs, polycyclic aromatic hydrocarbons and organochlorides which adsorb to the surface of soil particles because of their inherent hydrophobicity. Such chemicals persist in the environment because of their chemical stability and they bioaccumulate, posing a serious health threat to animals and humans. High power ultrasound allows low-cost, on-site remediation and circumvents many of the shortcomings posed by conventional remediation technologies. Results are presented for a range of contaminants and the underlying physics of the technology is explained. Crown Copyright (C) 2005 Published by Elsevier Ltd. All rights reserved.

Heavy metals removal from solution by palygorskite clay

Potgieter, JH; Potgieter-Vermaak, SS; Kalibantonga, PD
Minerals Engineering, Vol. 19, 5, 2006, pp. 463-470. 10.1016/j.mineng.2005.07.004

The possible use of palygorskite clay, mined in the Dwaalboom area of the Northern Province of South Africa, as an adsorbent for the removal of metal ions such as lead, nickel, chromium and copper from aqueous solution, was investigated. In this work, adsorption of these metals onto palygorskite has been studied by using a batch method at room temperature. The results of adsorption were fitted to both the Langmuir and Freundlich models. Satisfactory agreement between experimental data and the model-predicted values was expressed by the correlation coefficient (R-2). The Langmuir model represented the sorption process better than the Freundlich one, with correlation coefficient (R-2) values ranging from 0.953 to 0.994. The adsorption capacity (Q(0)) calculated from the Langmuir isotherm was 62.1 mg Pb(II) g(-1), 33.4 mg Ni(II) g(-1), 58.5 mg Cr(VI) g(-1) and 30.7 mg Cu(II) g(-1) at a pH of 7.0 at 25 +/- 1 degrees C for a clay particle size of 125 mu m. Kinetic investigations were performed to investigate the rate of adsorption of metal ions. The Lagergren's first-order rate constants were calculated for different initial concentrations of metal ions. In batch mode adsorption studies, removal increased with an increase of contact time, adsorbent amount and solution pH. Adsorption of metals from the single-metal solutions was in the order: Pb>Cr>Ni>Cu. Data from this study proved that metal cations from aqueous Solution can be adsorbed successfully in significant amounts by palygorskite. This opens up new possibilities and potential commercial uses in the palygorskite market. (C) 2005 Elsevier Ltd. All rights reserved.

Application of electric spark generated high power ultrasound to recover ferrous and non-ferrous metals from slag waste

Wilson, MP; Balmer, L; Given, MJ; MacGregor, SJ; Mackersie, JW; Timoshkin, IV
Minerals Engineering, Vol. 19, 5, 2006, pp. 491-499. 10.1016/j.mineng.2005.08.017

On a worldwide basis there exist large stocks of by-products from the production of ferrous and non-ferrous metals. For example, in Scandinavia there is a site which currently has 60000 tons of stainless steel trapped in slag waste. Even at current market prices this is a valuable resource. However, current technological approaches, such as ball milling, are uneconomic. High power ultrasound (HPU) is a novel approach to this problem to allow recovery of the stainless steel and a recycling path for the silicate slag as a building material. At the University of Strathclyde, pulsed power (the compression of electrical energy with time) has been used to generate HPU shock waves from spark discharges in water. Trials using a prototype HPU system have demonstrated that stainless steel metal can be separated from the slag waste by-product rapidly and with low power consumption. Glass may also be comminuted for recycling using the HPU system. The results of the trials are presented and proposed methods for industrial scale-up are discussed. (C) 2005 Elsevier Ltd. All rights reserved.

Extraction of lithium from boron clays by using natural and waste materials and statistical modelling to achieve cost reduction

Buyukburc, A; Marasliolglu, D; Bilici, MSU; Koksal, G
Minerals Engineering, Vol. 19, 5, 2006, pp. 515-517. 10.1016/j.mineng.2005.11.003

Lithium has found widespread application areas; from glass and ceramics to pharmaceutics. Moreover, last decade has witnessed a significant increase in the demand for lithium batteries. The Studies made in Turkey showed that about 2000 ppm lithium occur in boron clays. Extraction of lithium from clays was the subject of many researchers, but all concluded that it was not economical when compared to extraction from minerals and brines. A major source of the cost is the raw materials used in such an extraction process. This study aims to achieve cost reduction by extracting lithium from boron clays using natural (limestone-clay) materials and waste of boric acid production as a source of gypsum. Statistical modelling of the extraction process has enabled 18% increase in the extraction yield even under these circumstances. This study demonstrates that it is possible to design more economical processes through use of appropriate statistical modelling while using low quality materials. (C) 2005 Elsevier Ltd. All rights reserved.

Thermal expansion of slate wastes

Silva, MEMC; Peres, AEC
Minerals Engineering, Vol. 19, 5, 2006, pp. 518-520. 10.1016/j.mineng.2005.10.008
Among the technological routes for recycling mining and beneficiation slate wastes, thermal expansion seems particularly attractive, yielding products adequate for use in civil construction, especially as pozzolanic material for cement manufacture. The present investigation aims at analysing the properties of slate before and after the thermal expansion, searching for the reasons of expansion and the variables that affect the characteristics and properties of the products. Results of standard test procedures

recommended by the construction industry are presented and discussed. (C) 2005 Elsevier Ltd. All rights reserved.

Study of pore size distribution of slate ceramic pieces produced by slip casting of waste powders

Mansur, AAP; Peres, AEC; Palhares, L; Mansur, HS
Minerals Engineering, Vol. 19, 5, 2006, pp. 525-527. 10.1016/j.mineng.2005.10.001

One crucial problem in quarries associated with mining dimension stories is the generation of enormous amounts of waste, which strongly impacts on the environment. Slate mining and processing generate large amounts of fine powder during extraction, cutting and polishing procedures. In the present work, suspensions were produced by mixing slate powder with different solid fractions in water, and then casting into plaster moulds ("slip casting process"). The "green samples" ("as cast") were characterised according to density and pore size distribution by mercury porosity and X-ray diffraction techniques. Ceramic pieces from slate powder, produced through slip casting were fired at 1000 degrees C/4 h. The results show that slate powder waste has a potential use in the manufacturing of ceramic pieces by the slip casting process. (C) 2005 Elsevier Ltd. All rights reserved.