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Editors:

R. Singh

A. Das

N.G. Goswami

Compilation: A.K. Sahu

INDIAN INSTITUTE OF MINERAL ENGINEERS

C/o Mineral Processing Division

CSIR-NATIONAL METALLURGICAL LABORATORY

JAMSHEDPUR 831 007, JHARKHAND WEBSITE: www.iimeindia.com

INDIAN INSTITUTE OF MINERAL ENGINEERS

C/o Mineral Processing Division

CSIR-National Metallurgical Laboratory

Jamshedpur 831 007, Jharkhand

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Microbial aspects of Environmentally Benign Iron Ore Beneficiation

Natarajan, KA
kan@materials.iisc.ernet.in

Iron Ore 2009 Proceedings, JUL 27-29, 2009, Perth, AUSTRALIA, AUSTRALASIAN INST MINING & METALLURGY, 2009, pp. 27-34.

Many types of micro-organisms inhabit iron ore deposits contributing to biogenic formation and conversion of iron oxides and associated minerals. Bacteria such as Paenibacillus polymyxa arc capable of significantly altering the surface chemical behaviour of iron ore minerals such as haematite, alumina, calcite and silica. Differing mineral surface affinities of bacterial cells and metabolic products such as proteins and polysaccharides can be utilised to induce their flotation or flocculation. Mineral-specific bioreagents such as proteins are generated when bacteria are grown in the presence of haematite, alumina, calcite and silica. Alumina-grown bacterial cells and proteins separated from such cells were found to be capable of separating alumina from haematite. Biodegradation of iron ore flotation collectors such as amines and oleates can be effectively utilised to achieve environmental control in iron ore processing mills.

Reuse of coal combustion ashes as dyes and heavy metal adsorbents: Effect of sieving and demineralization on waste properties and adsorption capacity

Montagnaro, F; Santoro, L
fabio.montagnaro@unina.it

Chemical Engineering Journal, Jul-15, 2009, Vol. 150(1), pp. 174-180.

Among the possibilities of limiting the disposal of coal combustion ashes (CCA), their reutilization as adsorbent materials is worthy of consideration. To this end, proper ashes beneficiation techniques can be put into practice. The

adsorption of toxic compounds from industrial wastewaters is an effective method for both treating these effluents and recycling CCA. The aim of this paper is to give a contribution for understanding the relationships among beneficiation treatments, adsorbent properties and adsorption mechanism/efficiency. In this context, as-received CCA together with mechanically sieved and demineralized ashes were employed as adsorbents of methylene blue and cadmium from aqueous solutions. The maximum values of the specific adsorbate quantity captured by the adsorbent were fairly good, ranging from 23 to 110 mg/g, with removal efficiency close to 1 for a pollutant/solid initial ratio ranging from 10 to 20mg/g. Moreover the influence of the beneficiation treatments on the adsorbent physico-chemical/microstructural properties was thoroughly discussed. These properties, in turn, affect the adsorption mechanism (either cooperative/multilayer or high-affinity monolayer) and the capture efficiency. In this respect. when the operating conditions are those of greater practical interest, the different adsorbents can be ranked in the order demineralized ashes > mechanically sieved ashes > CCA, in excellent agreement with previsions based on materials characterization.
10.1016/j.cej.2008.12.022

Application of liquid/solid fluidization technique in beneficiation of fines

Mukherjee, AK; Mishra, BK; Kumar, RV
akmukherjee@tatasteel.com
International Journal of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, Jul-01, 2009, Vol. 92, pp. 67-73.

Use of liquid/solid fluidization techniques for size classification is a common practice in mineral processing operations. Extending its application in gravity separation for finer feed particles (-0.5 mm) is not straightforward as these fine size particles tend to remain in a mixed state during fluidization. In this paper an effort is made to explore the possibilities of adopting liquid/solid fluidization technique to beneficiate fine-size feed. The study shows that separation is effective within a limited range of size (ratio) with proper control on superficial water velocity. This study is relevant to beneficiation of low-grade ore which typically liberates at finer size where beneficiation has been a challenge.
10.1016/j.minpro.2009.02.011

Mineralogical and Textural Characterisation of Iron Ore from a Peruvian Magnetite-Haematite Skarn Prospect

Hapugoda, S; Peterson, MJ; Manuel, JR
Sarath.Hapugoda@csiro.au; Michael.Peterson@csiro.au;
James.Manuel@csiro.au
Iron Ore 2009 Proceedings, JUL 27-29, 2009, Perth, AUSTRALIA,
AUSTRALASIAN INST MINING & METALLURGY, PARKVILLE VICTORIA, 2009,
pp. 105-112.

Selected drill core samples from a Ferrobamba-limestone-hosted, magnetite-haematite skarn deposit, located in the Apurimac department of the Andahuaylas-Yauri skarn/porphyry belt of south-eastern Peru, were mineralogically and texturally characterised to gain a preliminary indication of the deposit's potential as an iron ore resource. Optical microscopy, X-ray diffraction (XRD) and scanning electron microscopy/electron probe microanalysis (SEM/EPMA) techniques were utilised to determine the characteristics of magnetite, haematite and/or goethite dominated ore types, including variations in the relative proportions and textural relationships of the ore and gangue minerals. The deportment of elements deleterious to processing performance (eg copper, sulfur and potassium) was determined and the beneficiation potential of the samples was briefly assessed. In drill core sections, the ores are grey to reddish in colour, massive and 'metallic' to dark brown and earthy in character, moderately hard and porous (macro and microporous), with variable gangue infill. Ores often appear weathered, typified by ochreous goethite staining and common minor goethite (except in dense core fragments), occasionally exhibiting a more friable texture with coarse magnetite/martite grains. Silicates and lesser carbonate gangue are visible as blue-green to beige to white scaly and/or shaly surface coatings, and finely particulate infill, often goethite stained. Sulfide-rich ore types also occur in part of the deposit, but are restricted to specific drill holes. Magnetite grain sire is relatively coarse, compared with magnetite from typical banded iron formations, whereas discrete silicate gangue is mainly bladed/fibrous and/or layered and micaceous in form. XRD analysis indicates the presence of vermiculite, serpentine, stilpnomelane, chlorite, actinolite and clays. There is a spectrum of ore types representing the gradation from 'fresh' (magnetite-dominated) to oxidised and weathered (martite/goethite-dominated). Martite-dominated samples are generally higher in grade, due to leaching and removal of silicate gangue, resulting in higher macroporosity. Where gangue has been leached out, partial replacement by vitreous goethite and/or hydrohaematite is typical, often preserving the fibrous/layered characteristics of the original silicates.

Evaluation of Gravity Spirals for Beneficiation of Banded Haematite Jasper Iron Ore of India

Sreedhar, GE; Venkatesulu, DR; Nanda, NK
gesreedhar@nmdc.co.in; drvenkatesulu@mndc.co.in; nknanda@nmdc.co.in
Iron Ore 2009 Proceedings, JUL 27-29, 2009, Perth, AUSTRALIA, AUSTRALASIAN INST MINING & METALLURGY, PARKVILLE VICTORIA, 2009, pp. 323-326.

Due to increased production of steel in India, the thrust is now on iron ore producers not only to enhance productivity from existing mines, but to look also into alternative resources, like lean grade iron ores such as banded haematite quartz (BHQ)/banded haematite jasper (BHJ), which are available in abundance but not yet utilised for want of suitable process technology. In this context, BHJ ore from the Bellary-Hospet sector was collected and subjected to detailed physical, chemical and mineralogical characterisation and beneficiation studies. The as-received sample was found to occur physically as alternating layers of haematite and jasper. The chemical analysis of the sample was 41.20 per cent Fe, 39.10 per cent SiO2 and 0.86 per cent Al2O3. Based on the mineralogical observation, haematite was found to be the lone ore mineral and jasper was the major gangue mineral. The microscopic observations revealed that the ore minerals liberate at a top size of 0.150 mm. Guided by the characterisation results, indicative tests were conducted using gravity and magnetic separation equipment, namely, Floatex (R), gravity slime table and wet high intensity magnetic separator (WHIMS). The results indicate that it is possible to upgrade the sample by both gravity and magnetic separation techniques. However, the WHIMS results indicate that jasper grains report to the concentrate at higher gauss intensities. Therefore, based on the encouraging gravity separation results and the availability of new design spirals for treating fine particles, the applicability of gravity spirals for beneficiating BHJ in the liberation size range of -0.150 mm was studied. The sample was ground to a top size of 0.150 mm and was subjected to preconcentration using wash waterless spirals. Tests were conducted at different feed rates, pulp densities and splitter positions. The results indicate that it is possible to upgrade the sample from a feed grade of 41.20 per cent Fe to a preconcentrate ranging from 46 per cent to 62 per cent Fe with a yield ranging from 19 per cent to 55 per cent. The obtained preconcentrate was then subjected to a cleaning stage by using a combination of wash water and wash waterless spirals. The test results indicate that it is possible to obtain a final concentrate assaying 65.75 per cent Fe and 4.75 per cent SiO2 with a yield of 25.9 per cent and an iron recovery of 41.31 per cent. It was concluded that further test work is necessary to increase the recovery and improve the product specification.

Alternative materials for dense medium separations
Honaker, R. Q.; Bimpong, C.
International Journal Of Coal Preparation And Utilization, Vol. 29(4), Jul-Aug, 2009, pp. 173-191

In response to concerns regarding cost and future supply of magnetite, a study has been performed to evaluate the potential of alternative materials that can be used to generate a dense medium for coal-cleaning applications. Alternative materials included waste steel slag, fine sand, and high-density material existing in run-of-mine feed. Under certain conditions, each of the materials tested provided separation efficiencies that meet industrial standards including probable error values of around 0.03. Dense medium derived from the non-magnetite sources achieved organic efficiency values exceeding the 95% level over a medium density range from 1.3 RD to 1.6 RD with lower than normal density offsets. Lower cost, coarse magnetite provided excellent separation efficiencies when medium density values above 1.6 RD are sufficient to meet product grade requirements.
10.1080/19392690903102329

Treatment of acid mine drainage (amd) from coal mines in south brazil
Silva, Renato; Rubio, Jorge
International Journal Of Coal Preparation And Utilization, Vol. 29(4), Jul-Aug, 2009, pp. 192-202

The Acid Mine Drainage (AMD) from an extinct coal mine was treated by the lamellar settler (LS) and the treated water was characterized for its quality in terms of inorganic or organic elements, suspended and dissolved solids, among others, to determine its usability for recycling. After neutralization of the AMD, flocs were formed using an anionic polymer flocculant in a specially designed flocculation reactor, patented by this research group (FGR (R)). The flocs settled at a rate of 5-6 m/h. The process showed a high efficiency (>90%) in removal of ions, low power requirement, and process simplicity. Operating costs for the AMD treatment at pH 9 was estimated to be about $0.3/m(3). The treated water was nearly free of heavy metals ions, low BOD and TOC, low solids content and no fecal coli forms, making it useable for irrigation, and other purposes. 10.1080/19392690903066045

Coal ash transportation as paste-like, highly loaded pulps in brazil: characterization and main features
Braganca, S. R.; Goncalves, M. R. F.; Bergmann, C. P.; Rubio, J.
International Journal Of Coal Preparation And Utilization, Vol. 29(4), Jul-Aug, 2009, pp. 203-215

The transportation of mineral coal ash in trucks with open top load compartments is inefficient, harmful to the environment, and costly. One solution to this problem is to utilize highly concentrated aqueous suspensions (paste) transportation systems, through steel pipes assisted by hydraulic pumping. In this study, coal ash (both fly ash and bottom ash), produced at a typical coal power plant (South Brazil), was utilized at different formulations, with mixtures of fly ash, bottom ash, and water (65%-70% solids content). These ash-bearing pulps were characterized in terms of their chemical and mineralogical composition, suspension pH that varied with the presence of Ca-bearing minerals, particle size distribution, and rheological behavior. Ash samples were distributed in fine, mean, and coarse sizes, facilitating the particles packing, diminishing voids, and contributing to the formation of paste with good consistency. The ash suspensions (32% water content) did not show compression strength and were plastically deformed after 48 hours of water addition. This behavior indicates that there were no chemical reactions, or pozzolanic activity, and that the particle interactions were mainly due to electrostatic forces and dispersions forces.
10.1080/19392690903066052

Development of air dense medium fluidized bed technology for dry beneficiation of coal - a review

Sahu, A. K.; Biswal, S. K.; Parida, A.

International Journal Of Coal Preparation And Utilization, Vol. 29(4), Jul-Aug, 2009, pp. 216-241

Wet processing of coal requires a large quantity of water. Waste generated from wet process ties up a significant amount of water and land. The slurry ponds also pose serious problems in case of dam breakage. Dry beneficiation of coal offers a better alternative approach for cleaning coal. An overview on the development of separation technology for beneficiation of coal using dense medium fluidized bed system is described. A theory of the dry separation relevant to coal beneficiation by density difference has been highlighted. This paper summarizes past and present development of different designs and operational features of a countercurrent cascade fluidization (CCFC) system and air dense medium fluidized bed separator (ADMFBS) based on their separation efficiency for different sizes of coal at different scales of operation. For fine coal beneficiation, magnetically stabilized bed improves the separation efficiency by preventing the back mixing of the separated solids. 10.1080/19392690903113847

Design Variables of Pilot Scale Electrostatic Separator for Removing Unburned Carbon from Coal Fly Ash

Kim, JK; Lee, HD
jkkim@kepri.re.kr
Journal of Chemical Engineering of Japan, SOC CHEMICAL ENG JAPAN, BUNKYO KU TOKYO, 2009, Vol. 42(7), pp. 471-477.

A pilot scale beneficiation system for removing unburned carbon from coal fly ash was developed and has tested using a continuous triboelectrostatic separator composed of two vertical electrodes and an ejector tribocharger. Tests were conducted to evaluate the charge density and the separation efficiency at various operating conditions. With a stainless steel tribocharger, the optimum conditions for achieving maximum charge density were as follows: air flow rate, 3.4 m(3)/min; feed rate, <300 kg/h; relative humidity, <30%. Under these optimum conditions, clean ash with an LOI (loss on ignition) of less than 4.5% could be recovered (yield: >70%). The electrostatic separator was operated under the following conditions: width of the diffuser slit, 4 mm; air velocity at the diffuser outlet, 16.7 m/s; distance between the diffuser slit and the splitter, 15 cm. The optimum feed rate was found to be 830 kg/h per square meters of the electrode surface area, which can be used as the scale-up factor for the electroseparator.

Application of liquid/solid fluidization technique in beneficiation of fines

Mukherjee, AK; Mishra, BK; Kumar, RV
akmukherjee@tatasteel.com
International Journal of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, Jul-01, 2009, Vol. 92, pp. 67-73.

Use of liquid/solid fluidization techniques for size classification is a common practice in mineral processing operations. Extending its application in gravity separation for finer feed particles (-0.5 mm) is not straightforward as these fine size particles tend to remain in a mixed state during fluidization. In this paper an effort is made to explore the possibilities of adopting liquid/solid fluidization technique to beneficiate fine-size feed. The study shows that separation is effective within a limited range of size (ratio) with proper control on superficial water velocity. This study is relevant to beneficiation of low-grade ore which typically liberates at finer size where beneficiation has been a challenge. (C) 2009 Published by Elsevier B.V.
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Thermal-hydrologic-mechanical-chemical processes in the evolution of engineered geothermal reservoirs

Taron, J; Elsworth, D
jmt269@psu..edu
International Journal of Rock Mechanics and Mining Sciences, JUL, 2009, Vol. 46(5), pp. 855-864.

In a companion paper [Taron J, Elsworth D, Min K-B. Numerical simulation of thermal-hydrologic-mechanical-chemical processes in deformable, fractured porous media. Int J Rock Mech Min Sci 2009; we introduced a new methodology and numerical simulator for the modeling of thermal-hydrologic-mechanical-chemical processes in dual-porosity media. In this paper we utilize the model to examine some of the dominant behaviors and permeability-altering mechanisms that may operate in naturally fractured media. Permeability and porosity are modified as fracture apertures dilate or contract under the influence of pressure solution, thermo-hydromechanical-compaction/ dilation, and mineral precipitation/dissolution. We examine a prototypical enhanced geothermal system(EGS) for the relative, temporal arrival of hydro-mechanical vs. thermomechanical vs. chemical changes influid transmission as cold (70 degrees C) water is injected at geochemical disequilibrium within a heated reservoir (275 degrees C).

For an injection-withdrawal doublet separated by similar to 670 m, the results demonstrate the strong influence of mechanical effects in the short-term (several days), the influence of thermal effects in the intermediate term (<1 month at injection), and the prolonged and long-term (>1 year) influence of chemical effects, especially close to injection. In most of the reservoir, cooling enhances permeability and increases fluid circulation under pressure-drive. We observe thermo-mechanical driven permeability enhancement in front of the advancing thermal sweep, counter acted by the re-precipitation of minerals previously dissolved into the cool injection water. Near injection, calcite dissolution is capable of increasing permeability by nearly an order of magnitude, while precipitation of amorphous silica onsets more slowly and can completely counteract this increase over the very long-term (410 years). For the reinjection of highly-silica-saturated water, amorphous silica is capable of drastic reduction in permeability close to the injection well. With combined action from all mechanisms, permeability change varies by two orders of magnitude between injection and withdrawal.
10.1016/j.ijrmms.2009.01.007

Trends in Magnetite Ore Processing and Test Work

Dowson, N; Connelly, D; Yan, D
neville.dowson@mets.net.au; damian.connelly@mets.net.au;
denis.yan@mets.net.au
Iron Ore 2009 Proceedings, JUL 27-29, 2009, Perth, AUSTRALIA, AUSTRALASIAN INST MINING & METALLURGY, PARKVILLE VICTORIA, 2009, pp. 231-241.

Beneficiation of magnetite is an integral part of the future of iron ore processing. Historically, the focus of Western Australian producers has been on exporting direct shipping ore (DSO) namely haematite. The future for new DSO resources is limited so companies are changing their emphasis into processing the very large, undeveloped magnetite ores in Western Australia (WA), using beneficiation to produce shippable magnetite concentrates. These magnetite resources require higher cost processing techniques such as fine grinding and beneficiation to produce saleable concentrates. This distinct difference, from the DSO ores, has lead to the development of a number of new technologies. This paper reviews: the different techniques used for magnetite beneficiation and provides some case studies in the WA industry; the use of mineral liberation analysis (MLA) to describe the nature, grain size, occurrence and associations of the mineralisation; the consideration of coarse cobbing as a critical upgrading; the application of high pressure grinding rolls (HPGR) to save energy; how the field of magnetic separation has resulted in new machines with higher field strength (SLon Separators); ultra fine grinding requirements of magnetite concentrates; and the application of reverse flotation to reduce silica in the concentrates.

The dissolution of scorodite in gypsum-saturated waters: Evidence of Ca-Fe-AsO4 mineral formation and its impact on arsenic retention

Bluteau, MC; Becze, L; Demopoulos, GP
george.demopoulos@mcgill.ca
Hydrometallurgy, JUL, 2009, Vol. 97, pp. 221-227

This paper reports the results of an investigation on scorodite behavior in a gypsum-saturated aqueous environment in terms of arsenic release and solid phase transformation. The experiments were conducted at fixed pH (5-9) and temperature (22 degrees C and 75 degrees C). The apparent equilibrium arsenic concentrations obtained in a gypsum-saturated system were lower than in a pure (gypsum-free) system. At pH 7 and 22 degrees C, the apparent equilibrium arsenic concentration was 3.6 mg/L in the presence of gypsum compared to 5.9 mg/L in a pure system. At higher temperatures and pH

values, this effect was even more significant. One possible explanation for this reduced arsenic concentration level in the presence of gypsum may be the formation of calcium-iron(III)-arsenate compounds. Experimental evidence for this was obtained at 75 degrees C and pH 7 and 9 where scorodite was found to partly transform to yukonite (Ca2Fe3(ASO(4))(4)(OH)center dot 12H(2)O).
10.1016/j.hydromet.2009.03.009

Present Situation and Future Trends in the Chinese Steel Industry and Utilisation of Low-Grade Iron Ore Resources

Zhu, D; Qiu, G; Pan, J
dqzhu@mail.csu.edu.cn; qgz@mail.csu.edu.cn; pjcsu@mail.csu.edu.cn
Iron Ore 2009 Proceedings, JUL 27-29, 2009, Perth, AUSTRALIA, AUSTRALASIAN INST MINING & METALLURGY, PARKVILLE VICTORIA, 2009, pp. 35-39.

In this paper, an analysis is made of the present situation in the Chinese steel industry and its demand for iron ores. It is shown that the demand for iron ores has been growing substantially with the rapid development of the steel industry all over the world, especially in China. However, the iron ore market is currently in the situation where supply exceeds demand due to the economic crisis, with more investment in mines and less output of steel for several years ahead all over the world. Gigantic pressure is confronting the Chinese steel mills due to the too high and irrational price of iron ores. It is time to return the price of iron ores to a normal position much closer to their value. More attention has therefore been paid to developing low-grade and complex iron ore resources in China due to the irrational price of imported iron ores. More innovative mineral processing processes have been developed to tackle these complex resources. A systematic introduction to the development of beneficiation processes for low-grade iron ores is provided, including upgrading low-grade siderite, limonite, micron sized haematite and magnetite resources.

Studies on the Production of Ultra-clean Coal by Alkali-acid Leaching of Low-grade Coals

Nabeel, A; Khan, TA; Sharma, DK
takhan501@yahoo.com
Energy Sources Part A-Recovery Utilization And Environmental Effects, 2009, Vol. 31(7), pp. 594-601.

The use of low-grade coal in thermal power stations is leading to environmental pollution due to the generation of large amounts of fly ash, bottom ash, and CO2 besides other pollutants. It is therefore important to clean the coal before using it in thermal power stations, steel plants, or cement industries etc. Physical beneficiation of coal results in only limited cleaning of coal. The increasing environmental pollution problems from the use of coal have led to the development of clean coal technologies. In fact, the clean use of coal requires the cleaning of coal to ultra low ash contents, keeping environmental norms and problems in view and the ever-growing need to increase the efficiency of coal-based power generation. Therefore this requires the adaptation of chemical cleaning techniques for cleaning the coal to obtain ultra clean coal having ultra low ash contents. Presently the reaction conditions for chemical demineralization of low-grade coal using 20% aq NaOH treatment followed by 10% H2SO4 leaching under reflux conditions have been optimized. In order to reduce the concentration of alkali and acid used in this process of chemical demineralization of low-grade coals, stepwise, i.e., three step process of chemical demineralization of coal using 1% or 5% aq NaOH treatment followed by 1% or 5% H2SO4 leaching has been developed, which has shown good results in demineralization of low-grade coals. In order to conserve energy, the alkali-acid leaching of coal was also carried out at room temperature, which gave good results.
10.1080/15567030701743684

Leaching of a low-grade, copper-nickel sulfide ore 2. Impact of aeration and pH on Cu recovery during abiotic leaching

Maley, M; van Bronswijk, W; Watling, HR
Helen.Watling@csiro.au
Hydrometallurgy, AUG, 2009, Vol. 98, pp. 66-72

The conditions under which copper was retained and re-distributed in a test heap of pyrrhotite-rich, copper-nickel sulfide ore were investigated in abiotic column leaching tests. It was determined that acidity plays a key role in maximising copper recovery. During passage through the ore bed, when the leachate pH rose to > 23, copper ions previously released to solution through the oxidation of chalcopyrite were retained by adsorption on, or reaction with, ore minerals. Lack of aeration (limited oxygen) had only a small impact on copper recovery, in association with a favourable pH environment. Possible reaction mechanisms are discussed. The results indicated the need for careful acid management in the operation of heaps of pyrrhotite-rich ores such as complex copper-nickel sulfide ores. 10.1016/j.hydromet.2009.03.016

Leaching of a low-grade, copper-nickel sulfide ore. 3. Interactions of Cu with selected sulfide minerals

Maley, M; van Bronswijk, W; Watling, HR
Helen.Watling@csiro.au
Hydrometallurgy, AUG, 2009, Vol. 98, pp. 73-80

Interactions between copper ions and selected sulfide mineral concentrates were investigated in flask and column tests under conditions relevant to heap leaching in order to understand why copper recovery from a copper-nickel complex sulfide ore was significantly less than nickel recovery. Both pyrrhotite and pyrite were found to play roles in copper deposition from sulfate solutions in the range pH 1-5. The non-oxidative dissolution of pyrrhotite, previously reported to occur under acidic conditions of low oxygen availability, was also found to occur in a well-aerated system. Soluble copper reacted with the generated hydrogen sulfide to form copper sulfide, mainly covellite at pH >23 and its re-dissolution required acid, oxygen and a strong oxidant such as ferric ion. While significant copper also precipitated from copper sulfate solutions pH >3 in the presence of pyrite, the brochantite which was formed was readily re-dissolved at pH <3. The poor recovery of copper experienced in a test heap of copper-nickel sulfide ore was attributed to the presence of pyrrhotite and the rise in pH as the leachate percolated through the heap bed. The copper would only be recovered if acidic. oxidising conditions were restored in the heap.
10.1016/j.hydromet.2009.03.015

Optimum water pulsation of jig separation for crushed plastic particles

Hori, K; Tsunekawa, M; Hiroyoshi, N; Ito, M
hoycun@eng.hokudai.ac.jp
International Journal Of Mineral Processing, Aug, 2009, Vol. 92, pp. 103-108.

Mechanical separation of different plastics should be established in planning and constructing a recycling plant for scrapped office and home appliances. The authors studied jig separation of small plastic particles (two types of burn-resistant polyethylene (PE) and polyvinyl chloride (PVC)) using a TACUB jig. The size of the particles was 0.5-3 mm and the specific gravities of the two PEs and PVC were about 1.1, 1.3 and 1.4, respectively. The jig separation experiments were carried out under various water pulsations, at which the amplitude, frequency, and pattern of pulsation were varied. Based on the observation of separation progress and water pulsation, it was found that the upstream velocity of the pulsation is a very important factor to form high grade PE and PVC product layers with high efficiency. Moderate fluidization

of particle bed caused high separation performance. High-grade PE and PVC products over 99.8% were recovered under pulsations of small frequency and amplitude. The optimum separation condition was determined easily by measuring the fluidity of the plastic beds in the separation chamber. (C) 2009 Published by Elsevier B.V.
10.1016/j.minpro.2009.01.001

Control of Particulate Triboelectrification of Coal and Minerals by Chemical Pretreatment

Wang, HF; Chen, QR; Zhang, XX; Tan, ZH; Wang, SA; Zhou, NX
whfcumt@126.com
8th International Conference on Measurement and Control of Granular Materials, Proceedings, 8th International Conference on Measurement and Control of Granular Materials, Aug 27-29, 2009, Shenyang, PEOPLES R CHINA, NORTHEASTERN UNIV SHENGYANG, SHENGYANG, 2009, pp. 528-532.

In order to improve the efficiency of dry coal triboelectrostatic beneficiation, chemical surface modification was used to control the triboelectrification performance of coal and mineral particulates. The results indicate that the charge-to-mass of coal positively is increased after surface modification with absorption of kerosene and changed to negative directions with absorption of cation chemical respectively. After chemical conditioning, on the whole, the characteristics of the main ash forming minerals show the charge magnitude increased negatively with absorption of organic additives, and positively with absorption of cation additives respectively. The variation directions of dielectric constant agree with the change trend of charge-to-mass for most conditions. The changes of triboelectrification mainly due to the particles adsorbing additives or encapsulated by additives, and then the surface electrical properties of coal are changed.

Hematite and iron carbonate precipitation-coexistence at the iron-montmorillonite-salt solution-CO2 interfaces under high gas pressure at 150 degrees C

Montes-Hernandez, G; Pironon, J
german_montes@hotmail.com
Applied Clay Science, AUG, 2009, Vol. 45(4), pp. 194-200.

The hydrothermal reactivity of swelling clays has relevant implications on the geological storage of radioactive waste and greenhouse gases because the clay geo-materials have been proposed as engineered or natural barriers due

to their low permeability in confined systems and their high capacity to sequester ions. In the present study, the iron-montmorillonite-salt solution-CO2 interactions were investigated under high gas pressure (200 bar) at 150 degrees C. Various chemical processes were characterized at the solid-fluid interfaces such as the dissolution of montmorillonite fine particles and oxidative-dissolution of elemental iron. The ionic supersaturation of solution and possibly the surface complexation in the system produced the precipitation of hematite nanoparticles (<200 nm) after 15 days of solid-fluid contact. The hematite nanoparticles dispersed and/or coagulated on the clay matrix caused a stable red coloration of the montmorillonite composite. We assume that initial dissolved oxygen was progressively consumed in this closed-stirred system favouring the presence of divalent iron (in-situ change of redox conditions) and then leading the surface precipitation of iron carbonate nanocrystals (<500 nm) after 60 days of solid-fluid contact. Thus, an atypical mineral coexistence of hematite-iron carbonate was observed in our system. A qualitative comparison with the blank experiment, i.e. at the same P-T conditions, but without CO2 injection, suggested that the carbon dioxide increased the hydrothermal reactivity of montmorillonite because the hematite and iron carbonate formation were not observed after the same reaction time.
10.1016/j.clay.2009.06.004

The processing of high silica bauxites - Review of existing and potential processes

Smith, P
Peter.Smith@csiro.au
Hydrometallurgy, AUG, 2009, Vol. 98, pp. 162-176.

World reserves of bauxite include vast quantities of ore which at present are sub-economic due to high levels of reactive silica that cause expensive loss of caustic soda during Bayer processing. As the economic reserves of high grade ores diminish, attention is turning to how these lower grade ores may be processed at reasonable cost. This paper presents a review of existing and potential processes from the open literature that have been proposed for high silica bauxites. The processes have been divided into three strategies for reducing soda loss. These are (i) reduce the input of reactive silica into the process (ii) modify the process to produce a low soda residue and (iii) recover caustic soda by re-processing residue. For each of the processes considered, a description of the principle is given along with the current status and any hurdles (economic, environmental etc) to implementation. For each strategy the review identifies the most promising processes for future

consideration. Crown Copyright (C) 2009 Published by Elsevier B.V. All rights reserved. 10.1016/j.hydromet.2009.04.015

Innovative surge bin design for mineral sands processing plant

Lyons, J; Hill, G; Vadeikis, C; Wiche, S

Recent Advances In Mineral Processing Plant Design, Conference on Mineral Processing Plant Design,
SEP 30-OCT 03, 2009, Tucson, AZ, SOC MINING METALLURGY & EXPLORATION INC, LITTLETON, 2009, pp. 520-526.

Mineral Technologies carried out the mineral processing test work and developed the flow sheets for a mineral sands project in the Murray Basin, Australia. Mineral Technologies then completed the detailed engineering design for the project. The ore body required a processing plant that could operate efficiently over a wide range of conditions: Slimes up to 30% Feed Rate from 500 to 750tph Heavy Mineral in situ from 12 to 19% w/w The mined ore was to be stockpiled and blended to achieve this operating range. The material was to be screened and scrubbed to liberate the HM from the clays. The feed was then pumped to the Feed Preparation area of the Concentrator. The concentrator utilised gravity separation and wet magnetic separation to produce a Heavy Mineral Concentrate. The separation can cater for some slimes but anything more than about 3% will affect mineral recovery. The feed preparation utilised a set of cyclones to remove the majority of the clays and presented the upgraded feed to the surge bin. The cyclone overflow was then treated in thickeners for disposal with the tailings. The Surge Bin was designed to have mass flow characteristics allowing material to be stored for up to an hour with a consolidation in excess of 80%w/w. The material is withdrawn using slurry pumps to feed to the spiral separators. Various forms of dilution water are injected into the bin to assist in the density control of the slurry. The bin has a storage capacity of 350 tonnes and delivers the slurry to the spirals at a constant density. This bin design utilises the work of Jenike and the University of Newcastle, Australia to determine the critical dimensions of the Surge Bin to ensure that there is mass flow. This work has been applied to particulate dry solids in silos previously but not to slurries. However, in fact, the slurry acts more like a solid in this situation rather than a liquid.

Identification of concrete deteriorating minerals by polarizing and scanning electron microscopy

Gregerova, M; Vsiansky, D

mirka@sci.muni.cz; daliborv@centrum.cz

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The deterioration of concrete represents one of the most serious problems of civil engineering worldwide. Besides other processes, deterioration of concrete consists of sulfate attack and carbonation. Sulfate attack results in the formation of gypsum, ettringite and thaumasite in hardened concrete. Products of sulfate attack may cause a loss of material strength and a risk of collapse of the concrete constructions. The authors focused especially on the microscopical research of sulfate attack. Concrete samples were taken from the Charles Bridge in Prague, Czech Republic. A succession of degrading mineral formation was suggested. Microscope methods represent a new approach to solving the deterioration problems. They enable evaluation of the state of concrete constructions and in cooperation with hydro-geochemistry, mathematics and statistics permit prediction of the durability of a structure. Considering the number of concrete constructions and their age, research of concrete deterioration has an increasing importance. The results obtained can also be useful for future construction, because they identify the risk factors associated with formation of minerals known to degrade structures. 10.1016/j.matchar.2009.01.018

Biohydrometallurgy: what is its future?

Brierley, CL
clbrierley@msn.com

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Bioleaching/minerals biooxidation and bioremediation have been widely used commercially for heap/dump bioleaching of secondary copper sulfide ores, sulfidic-refractory gold concentrates and treatment of acid rock drainage. Technical and commercial challenges, identified in this paper, remain for bioleaching of primary sulfides and complex ores. New frontiers for the technology exist in processing massive Sulfides, silicate-locked minerals and in the more distant future in-situ leaching. Decommissioning of cyanide heap leach operations and stabilizing mine wastes using biotechnology are opportunities requiring intensive and focused research, development and engineering efforts.

SELECTIVE ABSTRACTS

Full-text Papers available in NML Eprints (http://eprints.nmlindia.org)

Mineralogical and flotation characteristics of lead-zinc ore with a particular reference to effects of oxidation.

Singh, Ratnakar; Rao, D S; Sinha, N; Banerjee, B and Bhattacharyya, K K
rs@nmlindia.org

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The present paper deals with the mineralogical and flotation characteristics of two lead-zinc ore samples (S1 and S2) from Ganesh-Himal region of Nepal. The two samples assayed 2.47% & 3.53% Pb and 13.6 & 13.45% Zn respectively. The ore was predominantly made up of spahlerite and pyrite in association with subordinate amounts of galena, minor amounts of pyrrhotite and chalcopyrite. Dolomite was the main gangue. The modal analysis showed the probability of fair liberation of sulphides from gangues around 210 micron but the locking of galena with sphalerite and other sulphides continued to finer sizes. However, sample S2 showed the presence high content of mineral fines and oxidised mineral phases. Detailed flotation studies carried out on the samples under varying process conditions resulted in reasonably high recovery of lead and zinc bearing minerals for sulphidic sample (S1) but recovery from oxidised sample (S2) was not satisfactory. Use of new alkyl quinoline based chelating type collector found helpful in improving flotation results. http://eprints.nmlindia.org/1208/

Comparative leaching of minerals by sulphuric acid in a Chinese ferruginous nickel laterite ore

Liu, K; Chen, QY; Hu, HP
cqy@mail.csu.edu.cn

Hydrometallurgy, SEP, 2009, Vol. 98, pp. 281-286

The Yuanjiang nickel laterite ore containing mainly maghemite, goethite and lizardite was leached by sulphuric acid at atmospheric pressure and the residues were characterized using X-ray diffraction and scanning electron microscopy/X-ray energy dispersive spectroscopy. The relationship was

discussed between the extraction of nickel, cobalt, iron, magnesium, aluminum, and the dissolution behaviour of the laterite minerals; as well as the extent of congruency of nickel, cobalt and iron extraction. The results show that the solubility of the laterite minerals in sulphuric acid decreases in the following order: lizardite > goethite > maghemite > magnetite approximate to hematite > chromite approximate to ringwoodite. Lizardite dissolved rapidly in 0.6 mol/L sulphuric acid at 60 degrees C whilst goethite dissolved completely in 2.5 mol/L sulphuric acid at 80 degrees C. The dissolution of the primary mineral maghemite was slow, but increased with increasing acid concentration and leaching temperature. Magnetite dissolved more slowly than maghemite; and hematite was only dissolved in > 6.2 mol/L sulphuric acid at 105 degrees C. Chromite and ringwoodite were not dissolved. The leaching behaviour of the laterite minerals may be explained by the bond strength differences of Me-O and the substitution of metal cations in the mineral structure.
10.1016/j.hydromet.2009.05.015

Rheology in mineral processing

Klein, B; Hallbom, D
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406-418.

Concentrated suspensions of fine minerals often exhibit behavior that is markedly different from that of common Newtonian fluids, such as water. Failure to allow for this non-Newtonian behavior may cause problems in the design and operation of process units. Failure to recognize the causes and effects of non-Newtonian behavior may make it difficult to troubleshoot problems. Therefore, it is important that mineral process engineers understand the behavior of non-Newtonian fluids, which is to say "rheology." This paper reviews the fundamentals of rheology, its application in mineral processing and the chemistry of additives that can be used to modify the rheology of mineral suspensions. Rheological measurement methods are described; without proper measurement the effects of rheology and opportunities to modify the rheology for improved processing cannot be determined.

Recovery Improvement of Fine Iron Ore Particles by Multi Gravity Separation.

Roy, Subrata (2009)
adas@nmlindia.org

Open Mineral Processing Journal, 2 (14). pp. 17-30.

Conventional gravity separation process of iron mineral fines is not very effective. In present work Multi Gravity Separation (MGS) process has been studied. This study was performed on a low-grade iron ore namely goethiticlateritic ore (GLO) from Eastern India. Detailed mineralogical, physical and chemical characteristics of a goethiticlateritic iron ore showed that the sample contained porous and friable oxides and hydroxides of iron. The ore sample had a feed grade of 54.43% total Fe, 9.27% SiO2 and 8.02% Al2O3. Hematite and goethite are main iron-bearing minerals while kaolinite and gibbsite are the major gangue mineral constituents. Considering the characterization data, these ores were ground separately to three size fractions, namely -300 μm, -250 μm and -150 μm sizes and subjected to flowing film concentration in Wilfley Table. As revealed by the liberation study, higher concentration was obtained by the processing of -150 μm crushed sample. The grade of the ore was improved from 54.43% Fe to 65.71% Fe. However, significant amount of fine iron ore particles were lost during the processing of -150 μm size ore, because it is not very effective for particles less than 15 μm. Thus, fine hematite and goethite particles are usually not recovered resulting in the loss of valuable iron ore fines. To recover this fine, Multi Gravity Separator was used in place of Wilfley Table and was found to be effective in reducing loss of fine iron particles and increasing the grade of the concentrate. The MGS process improved the Fe from 54.43% to 66.5% along with decreasing the alumina from 8.02% to 1.17%.
http://eprints.nmlindia.org/4/

Early-stage risk minimization in process flowsheet design

Goodall, WR; Adams, MD

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Of increasing importance in the design of extractive metallurgical process flowsheets is the early identification of techno-economic, occupational safety and environmental risks potentially associated with the project. This is particularly the case for semi-refractory low-grade, high-volume mineral

resources, where it is essential to constrain both capital and operating expenses to the minimum. An approach is presented that serves to minimize the upfront costs of project assessment, allowing the stakeholders either an early exit or decision to proceed to the next level. This is achieved via the integration of several modern tools available to the process engineer, including historical data mining and analysis, quantitative mineralogy techniques such as QEMSCAN (R) or MLA, `sighter level physico-chemical testwork and short-form process and economic modelling. The current global economic position is limiting access to mineral process development funding; hence, the ability to produce meaningful process development decisions on a limited budget is of great value.

Fresh Water Leaching of Alkaline Bauxite Residue after Sea Water Neutralization

Menzies, NW; Fulton, IM; Kopittke, RA; Kopittke, PM
p.kopittke@uq.edu.au
Journal Of Environmental Quality, AMER SOC AGRONOMY, MADISON, SEP-OCT, 2009, Vol. 38(5), pp. 2050-2057.
Processing of bauxite to extract alumina produces a strongly alkaline waste, bauxite refining residue, which is commonly stored in engineered structures. Once full, these waste dumps must: be revegetated. In many alumina refineries, the waste is separated into fine-textured red mud and coarse-textured residue sand (RS). The sand component has physical characteristics that make it a Suitable plant growth medium, provided the adverse chemical characteristics can be addressed. Neutralization of the highly saline-sodic RS with sea water lowers pH, reduces Na saturation, and adds plant nutrients. However, sea water-neutralized RS remains saline sodic and needs fresh water leaching before use as a plant growth medium. Columns containing sea water-neutralized RS were leached with 30 to depth-equivalent of fresh water to evaluate the effects of rainfall on the RS and its leachate. Entrained cations were rapidly displaced by the fresh water, lowering salinity to non-plant-limiting levels (<= 0.3 dS m(-1)). The percentage of the effective cation exchange capacity (ECEC) saturated by Na decreased from 71 to 62% due to a reduction in soil solution ionic strength (causing a decrease in the ECEC) and the preferential displacement of Na(+) (and K(+)) from the exchange. Fresh water leaching increased pH (leachate pH increased front 8.0 to 10.1). This pH increase is attributed to the slow dissolution of the Na-containing mineral sodalite. Under the current experimental conditions, the application of 30 m depth-equivalent of leaching reduced the total RS sodalite content by <10%. 10.2134/jeq2008.0511

A novel flowsheet for the recovery of metal values from waste printed circuit boards.

Das, Avimanyu and Vidyadhar, A and Mehrotra, S P (2009)
adas@nmlindia.org

Resources, Conservation and Recycling, 53 (8). pp. 464-469.

Recovery of metal values from waste printed circuit boards using physical beneficiation techniques was studied. A novel flowsheet using a combination of wet and dry unit operations was developed to achieve the separation of metals from non-metallic constituents. The wet concentration circuit consisted of flowing film concentration in tabling, flotation of plastics and enhanced gravity separation in multi-gravity separator. The dry purification circuit consisted of electrodynamic and electrostatic separation. Substantial enrichment of the ground powder with good recovery of metals was achieved using the flowsheet. The starting PCB powder, ground to −0.5 mm size, had about 23% total metal. Complete liberation of metals from plastics was achieved below 100 μm size. Metal values were found to be more abundant in the coarser sizes. A concentrate grade of over 93% total metal at a recovery of over 54% or a grade of 66% total metal at 95% recovery could be achieved using this flowsheet. Recovery of small and flat metal pieces was problematic in conventional gravity separation. Using gravity separation as a pre-concentration operation followed by flotation and enhanced gravity separation, these problems could be solved to a great extent and good recoveries could be achieved. The circuit has great potential to recover metal values from waste printed circuit boards in an industrial scale.