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Effects of Temperature and Atmosphere on Sintering Process of Iron Ores

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JOURNAL OF IRON AND STEEL RESEARCH INTERNATIONAL Vol. 19(10), OCT 2012, pp. 1-6.

The relationship of time to minerals composition in sinters is investigated by mineragraphy are claritied observation and component analysis, and the effects of temperature and atmosphere on mineralization process. Results are obtained as follows. The initial melt forms below the eutectic temperature of CaO center dot Fe2O3 and CaO center dot 2Fe(2)O(3), which is complex substance containing Ca, Fe, Si and Al, rather than the binary calcium ferrite melt. Minerals composition of binding phase is related to local content of silica in melt, which is influenced by temperature. Appearance of the melt promotes the transition from hematite to magnetite. which then alters the mechanism of calcium ferrite formation. Before the formation of magnetite, the contents of Fe and Ca within the multiple calcium ferrite decrease with temperature, but in the case of magnetite presence, the content of Fe increases solely with increase of temperature and decrease of oxygen potential. Temperature and atmosphere determine minerals composition together. and bring influence on sintering process in different ways. It can be deduced that temperature affects kinetics of the mineralization process, but atmosphere just plays a role in thermodynamics.

Estimating error in measurements of mineral grain size distribution

C.L. Evans, T.J. Napier-Munn,
Minerals Engineering, Volume 52, October 2013, Pages 198-203, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.09.005.

When ore characteristics such as mineral grain size distributions are quantified using measurements on particulate samples there is an error associated with the measured values. The magnitude of this error is a function of the grade of mineral of interest, the texture of the ore and the number of ore particles measured in the analysis. In practice the desire to minimise the error due to sampling by increasing the number of particles measured must be balanced against the increase in time and cost of analysing this increased number of particles. A statistical method based on bootstrap resampling has been developed to estimate the error in measurements of textural characteristics which are quantified by automated mineralogy systems. An application of the method to estimate the error in measurements of mineral grain size distribution is presented; however, the method can equally be applied to estimate the error in other textural characteristics, for example mineral association. By estimating how the error in the characteristic of interest reduces as particle sample size increases, the bootstrap resampling approach assists mineralogists to identify how many particles must be analysed to achieve the desired variance in the measured value. Examples from a copper porphyry ore are presented to illustrate the practical applications of this methodology in quantitative mineralogy programmes.

Recycling ground granulated blast furnace slag as cold bonded artificial aggregate partially used in self-compacting concrete

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JOURNAL OF HAZARDOUS MATERIALS, Oct, 2012, Vol. 235, pp. 352-358

Ground granulated blast furnace slag (GGBFS), a by-product from iron industry, was recycled as artificial coarse aggregate through cold bonding pelletization process. The artificial slag aggregates (ASA) replaced partially the natural coarse aggregates in production of self-compacting concrete (SCC). Moreover, as being one of the most widely used mineral admixtures in concrete industry, fly ash (FA) was incorporated as a part of total binder content to impart desired fluidity to SCCs. A total of six concrete mixtures having various ASA replacement levels (0%, 20%, 40%, 60%, and 100%) were designed with a water-to-binder (w/b) ratio of 0.32. Fresh properties of self-compacting concretes (SCC) were observed through slump flow time, flow diameter, V-funnel flow time, and L-box filling height ratio. Compressive strength of hardened SCCs was also determined at 28 days of curing. It was observed that increasing the replacement level of ASA resulted in decrease in the amount of superplasticizer to achieve a constant slump flow diameter. Moreover, passing ability and viscosity of SCC's enhanced with increasing the amount of ASA in the concrete. The maximum compressive strength was achieved for the SCC having 60% ASA replacement. (C) 2012 Elsevier B.V. All rights reserved.
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Gem-Selektor Geochemical Modeling Package: Tsolmod Library and Data Interface For Multicomponent Phase Models

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CANADIAN MINERALOGIST, Oct, 2012, Vol. 50(5), pp. 1173-1195

The development of highly accurate and computationally efficient modeling software based on Gibbs energy minimization (GEM) makes it possible to thermodynamically simulate geochemically realistic subsurface fluid-rock interaction processes. This involves consideration of non-ideal multicomponent-multiphase systems that include dilute to concentrated aqueous electrolyte solutions, mineral solid solutions, supercritical fluids, silicate and metal melts, and sorption

and ion exchange phases. Predicting the stability and thermodynamic properties of non-ideal solution phases over wide ranges of pressures and temperatures requires that theoretically sound and sufficiently accurate equation of state and activity models are used within the GEM framework. The variety of such models calls for a novel, flexible, and computationally efficient code architecture that supports a wide range of models of non-ideal mixing with different mathematical structures and input data. Here, we introduce the TSolMod C++ class library for equation of state and activity models, implemented within the GEMS3K solver of geochemical equilibria as part of the GEM-Selektor code package (http://gems.web.psi.ch). Essential features of the TSolMod library include a generic and flexible model parameter setup, computationally efficient data exchange with the GEM algorithm, and a straightforward extensibility with any new models of mixing. The current version of TSolMod features a comprehensive selection of fluid, gas, liquid, and solid solution models of interest for geochemical, petrological, material science, and chemical engineering applications.
10.3749/canmin.50.5.1173

Classification of hematite types in iron ores through circularly polarized light microscopy and image analysis

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Minerals Engineering, Volume 52, October 2013, Pages 191-197, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.07.019.

Brazilian iron ores are predominantly hematitic and may have different textures. In the mining industry, their microstructural characterization is manually performed, by analyzing samples under an optical microscope to identify the hematite textures and estimate their fractions and crystal size. This procedure is subjective and consequently susceptible to random and systematic errors. The present paper proposes an automatic method for the identification, measurement and classification of hematite crystals in iron ore according to their textural types. The method exploits the use of circularly polarized light to amplify brightness and color differences among hematite crystals, allowing their individualization, and the subsequent morphological analysis and classification into granular, lamellar or lobular classes. The classifier was tested with more than 5400 crystals, reaching a global success rate close to 98%, and success rates per class above 96%.

Energy efficiency analysis of CO2 mineral sequestration in magnesium silicate rock using electrochemical steps

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CHEMICAL ENGINEERING RESEARCH & DESIGN, Oct, 2012, Vol. 90(10), pp. 1467-1472

A thermodynamic efficiency analysis using the exergy concept is used to assess CO2 mineral sequestration process routes where electrochemical steps (electrolysis and fuel cells) are used to produce aqueous hydrochloric acid and sodium hydroxide reactant solutions. Results from three recent publications on the subject that come to different conclusions are used for this case study. It is shown that including electrolysis as one of the steps of a magnesium silicate mineral carbonation process route results in input energy requirements that will exceed the output of a fossil fuel-fired power plant that produces the CO2 that is bound to (hydro-) carbonates. At the same time, fuel cells are not efficient enough to change this. 2012 The Institution of Chemical Engineers. Published by Elsevier B.V. All rights reserved.
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The use of X-ray computed tomography in the characterisation of coal and associated char reductants

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Minerals Engineering, Volume 52, October 2013, Pages 143-154, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.05.012.

High quality char, produced during the initial coal gasification process, is commonly utilised as a reductant during the smelting of chromite ores. The rate of the gasification reaction and gasification performance will depend on the relevant coal properties. These properties include organic and inorganic composition, coal porosity and pore size distribution, permeability, swelling index and intrinsic reactivity. Quantitative evaluation of these factors affecting the behaviour of coal during pyrolysis and the subsequent influence of those properties on the reactivity of the char product is of paramount significance to further our understanding of the natural differences inherent in coal. X-ray computed tomography allowed three-dimensional characterisation of pores, organic and inorganic constituents. Pyrolysis of coal resulted in increased pore volumes, and by extension, increased porosity. However, the percentage increase in porosity differs from sample to sample, which may be related to the volatile matter content of the coal. The widening and cleanup of pores during gasification result in a decrease in organic content. The organic phases will influence the behaviour of mineral matter during pyrolysis, since the former will fluidise and become devolatilised, while the mineral matter will not become fluid or volatilise, therefore the minerals will migrate and settle and, ultimately, form agglomerates. The lack of significant swelling in the TB1 sample may suggest that higher levels of inertinite were present in the sample, while increased amounts of swelling in the TB2 and TB3 samples may result from increased levels of vitrinite, with the TB3 sample possibly containing the largest percentage vitrinite. The proportion of porous chars will increase with increasing vitrinite content in the parent coal, and therefore, since the TB3 char is highly porous, the possibility that the TB3 sample contains a high proportion of vitrinite becomes highly probable. However, these results need to be verified by quantifying the maceral phases through petrographic analysis. Nevertheless, inherent differences in the nature of coal will result in differences in behaviour when subjected to gasification.

Although X-ray computed tomography could be used to successfully identify and quantify various properties within a sample, some limitations still remain. Further work utilising complementary techniques is required to positively identify the remaining unknown phases as well as quantify the organic components.

A review of copper–arsenic mineral removal from copper concentrates

Graham Long, Yongjun Peng, Dee Bradshaw

Minerals Engineering, *Vol. 36–38*, *October 2012*, *Pages 179-186*

Arsenic is a toxic and volatile element that has little commercial use. This is causing some concern to copper smelters as they are obliged to dispose of arsenic materials produced as a by-product to the smelting process in accordance with ever tightening environmental guidelines. The onus is to move back to concentrate producers to remove toxic elements, such as arsenic, earlier in the concentrate supply chain. The common copper–arsenic bearing minerals in copper ores, enargite (Cu_3AsS_4) and tennantite ($Cu_{12}As_4S_{13}$), contain significant amounts of copper; 48.4% and 51.6% respectively. Removal of these minerals from the concentrate removes valuable metal, hence income. There is a dearth of literature concerning the selective removal of enargite and tennantite from sulphide ores, but there are reports on some success using either chemical oxidation or potential control. These methodologies have been applied to ores from mines as they deepen where arsenic levels in concentrate are becoming prohibitive. In this paper copper–arsenic mineral removal from copper concentrates is reviewed.

Copper–molybdenum ores flotation in sea water: Floatability and frothability

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Minerals Engineering, Volume 53, Nov. 2013, Pages 108-112, http://dx.doi.org/10.1016/j.mineng.2013.07.009.

Laboratory rougher flotation tests were conducted with two samples of Cu–Mo ores in fresh water and in sea water as a function of pH. In both cases Cu recoveries were slightly lower in sea water than in fresh water for a wide range of pH (pH 7–12). Flotation of molybdenite was however strongly depressed in sea water at pH higher than 9.5. Frothers were characterized by measuring froth thickness in a modified laboratory flotation cell as a function of pH, salinity, frother type, and solids content (%). It was found that for all tested frothers, foamability in two-phase systems was better in sea water than in fresh water. However, froth layer thickness measurement showed that frothability also depends on solids content and increases with increasing pulp density. At high solids content (35%) the frothability depended strongly on pH. At pH of 9 it was similar for fresh water and sea water, however, once the pH is raised further frothability increases sharply when the tests are carried out in fresh water, but this was not observed in sea water. The froth in sea water is drier than in fresh water, and this probably also depends on solids content.

Pyrometallurgical upgrading of PGM-rich leach residues from the Western Platinum base metals refinery through roasting,

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Minerals Engineering, Volume 53, November 2013, Pages 228-240, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.04.002.

The production of Platinum Group Metals (PGMs) normally entails the smelting of PGM flotation concentrates, converting of the furnace matte and removal of the bulk of the Ni, Cu, Co, S and Fe through atmospheric and pressure leaching in a base metals refinery to produce a PGM-rich concentrate. A number of impurities, mostly Se, Te, As, Bi, Os and Pb, are not removed significantly during the oxidising leach process in sulphuric acid media. In addition slag inclusions in matte leads to contamination of the PGM residues with silica, fayalite, magnetite and trevorite phases. Furthermore some Cu, Ni, Fe and S also remain. For this reason a typical Precious Metal Refinery (PMR) feed material contains less than 65% PGMs. The PMR is based on a chloride process and requires contaminants to be within narrow specification limits to prevent the formation of PGM residues that must be reprocessed or tolled, leading to poor first pass metal efficiencies and extending the duration of the production pipeline for efficient recovery. A process has been developed to significantly upgrade the BMR leach residues through pyrometallurgical processing, which include a multistep process of roasting under oxidising atmospheres, a two-step smelting process of the roasted calcine (with engineered slag chemistry and slag-refractory interactions) and subsequent atomisation of the molten alloy which can be fed as a slurry into the HCl/Cl2 dissolution reactors in the precious metals refinery. These pyrometallurgical steps upgrade the BMR residue from a 45–50% grade up to an alloy grade of ca. 90% PGMs, whilst removing the most deleterious elements with major process impacts on the PMR. This paper will focus primarily on the roasting step and it will investigate the thermochemical and mineralogical changes occurring during roasting. These changes were evaluated through a combination of thermochemical modelling and experimental investigation. The roasting step needs to be in an oxidative environment in order to achieve the vapourisation of Se, Te, As, Os and S. The speciation of PGMs and their vapourisation behaviour are presented, as well as the sensitivity of precious metals deportment to changes in roast conditions.

The precious metals we prefer to ignore

Jannie S.J. van Deventer
Minerals Engineering, Volume 53, November 2013, Pages 266-275, ISSN 0892-6875, http://dx.doi.org/10.1016/j.mineng.2013.06.021.

Based on publicly available information and the author's experience, there is reason to suspect that high levels of precious metals may be extracted economically from non-assayable materials. Such proprietary recovery methods have been demonstrated only at laboratory or pilot scale, so that the credibility associated with large scale production is still lacking. Precious metals not detected by spectroscopy and standard assay techniques are usually assumed not to exist, and hence present a technical and credibility challenge to metallurgists interested in these ‘abnormal’ ores. It is unlikely that this demanding field of metallurgy will be addressed by academic researchers or large companies, despite the substantial opportunity that it offers for breakthrough discovery. This paper reviews some of the pseudo-science surrounding this field, including: (a) the role of ‘intermolecular water’ in forming complex salts locking up precious metals, but which also presents a basis for extraction of precious metals from non-assayable ores; (b) accounts of ambient transmutation of elements, mainly using thermal methods; (c) Orbitally Rearranged Monoatomic Elements (ORMEs) which are virtually undetectable by conventional means and their conversion to normal metals; (d) the ‘high spin’ state of transition metals; and (e) the formation of microclusters altering the chemical behaviour of precious metals. It is hypothesised here that precious metals occur in nature across a spectrum of degrees of clustering, ranging from ‘normal’ gold amenable to conventional extraction methods, to the ORME state.

Modelling of an autoclave used for high pressure sulphuric acid/oxygen leaching of first stage leach residue. Part 1: Model development

C. Dorfling, G. Akdogan, S.M. Bradshaw, J.J. Eksteen,
Minerals Engineering, Volume 53, Nov. 2013, Pages 220-227, http://dx.doi.org/10.1016/j.mineng.2013.03.005.

Pressure leaching of the first stage leach residue in Base Metal Refinery (BMR) circuits aims to achieve high base metal dissolution with minimal precious metal leaching. Optimum autoclave operation is challenging because of the complex leaching chemistry, varying mineralogy of the feed material, and interaction between the different process variables. This research involved the modelling of the pressure leaching stages with flash recycle cooling at a typical BMR. The steady state solution employed the sequential modular approach in MATLAB, while the dynamic simulation involved the simultaneous solution of a set of differential equations, derived from mass and energy balances, in MATLAB. Part I of this communication presents a discussion of the Western Platinum Ltd. BMR process, an overview of relevant literature, and the strategies followed to develop both a steady state model and a dynamic model. Part II of this communication discusses the application of the models.

Synergetic effect during co-pyrolysis/gasification of biomass and sub-bituminous coal

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Fuel Processing Technology, Volume 115, November 2013, Pages 11-18, http://dx.doi.org/10.1016/j.fuproc.2013.03.044.

In this work, the co-pyrolysis of Indonesian coal (sub-bituminous) and two types of biomass, rice straw and Leucaena leucocepha wood, was studied using a drop tube fixed-bed reactor. The gasification reactivity of the obtained co-pyrolyzed char with steam was examined using a rapid heating thermobalance reactor. In the co-pyrolysis, a synergetic effect, in terms of higher gas yield and lower tar and char yields, was manifested especially at a biomass and coal ratio of 1:1. This synergetic effect could be explained by the transferring of active OH and H radicals from the biomass to the coal as well as the catalytic role of potassium (K) from the biomass. In the steam gasification, the in situ pyrolyzed char from the coal/biomass blend exhibited a higher reactivity than that from the coal or the biomass. This could be related to the increased surface area and pore volume of chars from the blend as well as the influence of volatile K released from the biomass. In addition, the biomass type appeared to have a significant influence not only on the magnitude of the synergetic effect during the co-pyrolysis but also on the reactivity of the resultant chars.

Nanobubble column flotation of fine coal particles and associated fundamentals

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International Journal of Mineral Processing, Volume 124, 14 Nov. 2013, Pp 109-116, http://dx.doi.org/10.1016/j.minpro.2013.04.016.

Froth flotation is a widely used, cost effective particle separation process. However, its high performance is limited to a narrow particle size range between approximately 50 to 600 μm for coal and 10 to 100 μm for minerals. Outside this range, the efficiency of froth flotation decreases significantly, especially for difficult-to-float particles of weak hydrophobicity (e.g., oxidized coal). This study was aimed at enhancing recovery of an Illinois fine coal sample using a specially designed flotation column featuring a hydrodynamic cavitation nanobubble generator. Nanobubbles that are mostly smaller than 1 μm can be formed selectively on hydrophobic coal particles from dissolved air in coal slurry. Results indicate that the combustible recovery of a − 150 μm coal increased by 5–50% in the presence of nanobubbles, depending on process operating conditions. Nanobubbles also significantly improved process separation efficiency. Other major advantages of the nanobubble flotation process include lower frother dosage and air consumption since nanobubbles are produced from air naturally dissolved in water, thereby resulting in considerably lower operating costs.

Pore structure in a gold mine cemented paste backfill

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Minerals Engineering, Volume 53, November 2013, Pages 144-151, http://dx.doi.org/10.1016/j.mineng.2013.07.017.

The evolving pore structure of cemented paste backfill (CPB), formed from plant tailings and sand mixtures, is critical to a more thorough and complete understanding of its functionality as a support structure during mining operations. Here we employ Nuclear Magnetic Resonance (NMR) signal relaxation measurements to provide a quantitative measurement of pore size distributions in CPB samples and monitor their progression as hydration of the CBP proceeds over 28 days. Three distinct, reproducible peaks are evident in the pore size distributions, which are consistent with cement regions, the bulk of the mixture and a macro-pore backbone. All peaks reduce to smaller pore sizes with hydration time and scale with sample permeability. A novel application of these scaling laws suggest that permeability is dominated by the network of macro-pores, which constitute only ~4% of the total porosity/moisture content of the samples.

Utilisation of ultrasonic treatment for upgrading of hematitic/goethitic iron ore fines

E. Donskoi, A.F. Collings, A. Poliakov, W.J. Bruckard

International Journal of Mineral Processing, *Vol. 114–117*, *Nov 2012*, *Pages 80-92*

Ultrasonic waves in pulps containing iron ore fines can start, or significantly intensify, particle cleaning, de-agglomeration or disintegration. Some softer minerals, often gangue minerals with lower iron contents such as kaolinite or ochreous goethite, disintegrate several orders of magnitude faster than the valuable iron-bearing minerals such as magnetite or hematite. This facilitates selective disintegration of the gangue minerals leaving the valuable minerals mostly unchanged. A set of experiments involving ultrasonic treatment of four Australian iron ore fine samples was undertaken using three different ultrasonic experimental setups. The effect of ultrasound duration, power and pulp density on the recoveries and grades of iron, alumina and silica was studied. The results showed that for hematitic/goethitic ores, the application of ultrasound enabled soft material of relatively low iron grade to de-agglomerate from the larger size fractions and report to the ultrafine size fractions. Modelled de-sliming of the ultrasonically treated ores showed that de-sliming following ultrasonic treatment could significantly improve the product iron grade, while de-sliming with a finer cut size could also improve the iron recovery compared with de-sliming identical ore that had not been pre-treated with ultrasound. It has been shown mathematically that in some scenarios it may be possible to simultaneously increase the iron grade and iron recovery in the de-slimed product if the ore has been treated with ultrasound before de-sliming.

The oxidation of copper sulfide minerals during grinding and their interactions with clay particles

Shengli Zhao, Yongjun Peng

Powder Technology, *Volume 230*, *November 2012*, *Pages 112-117*

In this study, the mechanism which underpins the different interactions of chalcopyrite, a primary copper sulfide mineral, and chalcocite, a secondary copper sulfide mineral, with bentonite, a clay mineral, during the grinding with stainless steel media was investigated by a range of techniques including XPS (X-ray Photoelectron Spectroscopy) analysis, electrokinetic studies and Cryo-SEM (Scanning Electron Microscope) measurements. It was found that during grinding chalcocite was heavily oxidized but chalcopyrite was slightly oxidized. As a result of the different extent of mineral surface oxidation, chalcopyrite remained negatively charged but chalcocite became positively charged after grinding leading to the different interactions with bentonite particles. This study provides a guideline to improve the extraction of copper sulfide minerals in the presence of clay minerals, an important issue in mineral processing.

Mechanism of phosphorus removal in beneficiation of high phosphorous oolitic hematite by direct reduction roasting with dephosphorization agent

Xu Cheng-yan; Sun Ti-chang; Kou Jue; et al.

TRANSACTIONS OF NONFERROUS METALS SOCIETY OF CHINA Vol. 22(11), NOV 2012, pp. 2806-2812 DOI: 10.1016/S1003-6326(11)61536-7

High phosphorous oolitic hematite ore is one of typical intractable iron ores in China, and the conventional beneficiation methods are found to be impracticable to remove phosphorus from the ore effectively. Better beneficiation index were gotten by direct reduction roasting with dephosphorization agent followed by two stages of grinding and magnetic separation. P content decreases from 0.82% in the raw ore to 0.06% in the magnetic concentrate, and the total iron grade increases from 43.65% to 90.23%, the recovery of iron can reach 87%. Mechanisms of phosphorus removal in the beneficiation of high phosphorous oolitic hematite ore by direct reduction roasting with dephosphorization agent were studied using XRD, SEM and EPMA. The results showed that about 20% of the apatite in the raw ore transferred into phosphorus and volatilized with the gas in the process of reduction roasting, while the rest 80% apatite was not involved in the reaction of generation of phosphorus, and remained as apatite in the roasted products, which was removed to tailings by grinding and magnetic separation. A small amount of phosphorus existed in the magnetic concentrate as apatite. The oolitic texture of raw ore was partly changed during roasting, resulting in the formation of nepheline in the reaction between the dephosphorization agent, SiO2 and Al2O3 in the raw ore, which greatly improved the liberation degree of minerals in the roasted products, and it was beneficial to the subsequent grinding and magnetic separation.

Reaction path modeling of enhanced in situ CO2 mineralization for carbon sequestration in the peridotite of the Samail Ophiolite, Sultanate of Oman

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CHEMICAL GEOLOGY, Nov, 2012, Vol. 330, pp. 86-100

The peridotite section of the Samail Ophiolite in the Sultanate of Oman offers insight into the feasibility of mineral carbonation for engineered, in situ geological CO2 storage in mantle peridotites. Naturally occurring CO2 sequestration via mineral carbonation is well-developed in the peridotite; however, the natural process captures and sequesters CO2 too slowly to significantly impact the concentration of CO2 in the atmosphere. A reaction path model was developed to simulate in situ

CO2 mineralization through carbonation of fresh peridotite, with its composition based on that of mantle peridotite in the Samail Ophiolite and including dissolution kinetics for primary minerals. The model employs a two-stage technique, beginning with an open system and progressing to three different closed system scenarios- a natural system at 30 degrees C, an engineered CO2 injection scenario at 30 degrees C, and an engineered CO2 injection scenario at 90 degrees C. The natural system model reproduces measured aqueous solute concentrations in the target water, signifying the model is a close approximation of the natural process. Natural system model results suggest that the open system achieves steady state within a few decades, while the closed system may take up to 6,500 years to reach observed fluid compositions. The model also identifies the supply of dissolved inorganic carbon as the limiting factor for natural CO2 mineralization in the deep subsurface. Engineered system models indicate that injecting CO2 at depth could enhance the rate of CO2 mineralization by a factor of over 16,000. CO2 injection could also increase mineralization efficiency - kilograms of CO2 sequestered per kilogram of peridotite - by a factor of over 350. These model estimates do not include the effects of precipitation kinetics or changes in permeability and reactive surface area due to secondary mineral precipitation. Nonetheless, the faster rate of mineralization in the CO2 injection models implies that enhanced in situ peridotite carbonation could be a significant sink for atmospheric CO2. (C) 2012 Elsevier ay. All rights reserved.
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Utilisation of ultrasonic treatment for upgrading of hematitic/goethitic iron ore fines

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INTERNATIONAL JOURNAL OF MINERAL PROCESSING, Nov, 2012, Vol. 114, pp. 80-92

Ultrasonic waves in pulps containing iron ore fines can start, or significantly intensify, particle cleaning, de-agglomeration or disintegration. Some softer minerals, often gangue minerals with lower iron contents such as kaolinite or ochreous goethite, disintegrate several orders of magnitude faster than the valuable iron-bearing minerals such as magnetite or hematite. This facilitates selective disintegration of the gangue minerals leaving the valuable minerals mostly unchanged. A set of experiments involving ultrasonic treatment of four Australian iron ore fine samples was undertaken using three different ultrasonic experimental setups. The effect of ultrasound duration, power and pulp density on the recoveries and grades of iron, alumina and silica was studied. The results showed that for hematitic/goethitic ores, the application of ultrasound enabled soft material of relatively low iron grade to de-agglomerate from the larger size fractions and report to the ultrafine size fractions. Modelled de-sliming of the ultrasonically treated ores showed that de-sliming following ultrasonic treatment could significantly improve the product iron grade, while de-sliming with a finer cut size could also improve the iron recovery compared with de-sliming identical ore that had not been pre-treated

with ultrasound. It has been shown mathematically that in some scenarios it may be possible to simultaneously increase the iron grade and iron recovery in the de-slimed product if the ore has been treated with ultrasound before de-sliming. Crown Copyright (C) 2012 Published by Elsevier B.V. All rights reserved.
10.1016/j.minpro.2012.10.005

Beneficiation of coal fly ashes by oxygen chemisorption

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EXPERIMENTAL THERMAL AND FLUID SCIENCE, Nov, 2012, Vol. 43, pp. 76-81

This paper addresses the issue of unburnt carbon in fly ashes from coal-fired power stations. It has been shown that carbon-in-ash has much lower combustion reactivity than the original coal, because of the extensive thermal annealing experienced in the boiler. Thermal annealing reduces the rate of the first reaction step of which carbon combustion is composed, namely oxygen chemisorption. In the present work experiments have been carried out in order to verify if a preconditioning stage consisting of mild pre-oxidation with air is able to promote oxygen chemisorption thus increasing the combustion reactivity of ashes. Fly ashes with high LOI have been exposed to air at temperature <400 degrees C for times up to 300 min. Results show that a satisfactory extent of oxygen chemisorption can be attained at 300-400 degrees C with 1-2 h holding time. After this conditioning, samples have been tested to check their combustion reactivity by means of non isothermal thermogravimetric analysis. Additionally, combustion experiments have been carried in a purposely designed suspension reactor at temperatures up to 1000 degrees C. Results confirm that ash pre-conditioning reduces the burn-out time of carbon in ash. The concept has been finalized into an international patent application. (c) 2012 Elsevier Inc. All rights reserved. 10.1016/j.expthermflusci.2012.03.022

Stepwise carbothermal reduction of bauxite ores

Chun Hung Yeh, Guangqing Zhang
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The commercial technologies for aluminium production include production of alumina from bauxite and smelting of alumina to produce aluminium. The current technology is energy intensive, and a major source of greenhouse gas emissions and harmful fluoride emissions. Carbothermal reduction of bauxite is a promising alternative technology for aluminium and aluminoalloy production. Western Australia and Queensland bauxite ores were carbothermally reduced in steps in argon. Experiments were performed in a high temperature vertical tube furnace, and the off-gas composition was monitored using an infra-red gas analyser. The phase composition of reduced samples was characterised by XRD. Oxygen and carbon contents in reduced samples were determined by LECO analysers. The morphology of the surface and intersections was observed by SEM. The chemical compositions of the phases in the reduced samples were detected by EDS. The results of this study have proved the concept of stepwise reduction of bauxite ores in solid state by appropriate control of reduction temperature. Below 1100 °C, only iron oxides were reduced to metallic iron. A ferroalloy phase was formed at 1200 °C and above. The products in the bauxites reduced to 1600 °C include a ferroalloy of silicon and aluminium, carbides of titanium, silicon and aluminium, and unreacted alumina.

Mechanism of phosphorus removal in beneficiation of high phosphorous oolitic hematite by direct reduction roasting with dephosphorization agent

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TRANSACTIONS OF NONFERROUS METALS SOCIETY OF CHINA, Nov, 2012, Vol. 22(11), pp. 2806-2812

High phosphorous oolitic hematite ore is one of typical intractable iron ores in China, and the conventional beneficiation methods are found to be impracticable to remove phosphorus from the ore effectively. Better beneficiation index were gotten by direct reduction roasting with dephosphorization agent followed by two stages of grinding and magnetic separation. P content decreases from 0.82% in the raw ore to 0.06% in the magnetic concentrate, and the total iron grade increases from 43.65% to 90.23%, the recovery of iron can reach 87%. Mechanisms of phosphorus removal in the beneficiation of high phosphorous oolitic hematite ore by direct reduction roasting with dephosphorization agent were studied using XRD, SEM and EPMA. The results showed that about 20% of the apatite in the raw ore transferred into phosphorus and volatilized with the gas in the process of reduction roasting, while the rest 80% apatite was not involved in the reaction of generation of phosphorus, and remained as apatite in the roasted products, which was removed to tailings by grinding and magnetic separation. A small amount of phosphorus existed in the magnetic concentrate as apatite. The oolitic texture of raw ore was partly changed during roasting, resulting in the formation of nepheline in the reaction between the dephosphorization agent, SiO2 and Al2O3 in the raw ore, which greatly improved the liberation degree of minerals in the roasted products, and it was beneficial to the subsequent grinding and magnetic separation. 10.1016/S1003-6326(11)61536-7

Speciation of chromium in Australian coals and combustion products

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FUEL, Dec, 2012, Vol.102, pp. 1-8

Trace elements in coal combustion ash products are potentially hazardous to the environment and some of them have high carcinogenic potency. They also have the potential to bioaccumulate providing the major limiting factor for safe disposal or beneficiation of the coal combustion ash products. The various forms and oxidation states of the trace elements may determine the ultimate environmental fate and health impacts. For example, in case of chromium, the trivalent Cr(III) is an essential

nutrient while Cr(VI) is strongly carcinogenic. Moreover, Cr(VI) originates mostly from anthropogenic industrial sources and is classified as a Group A inhalation carcinogen by the US environmental protection agency (EPA), and is also classified as one of the 'priority pollutants' in the national pollutant inventory (NPI) in Australia. Knowledge of the chromium species in coals and ash by-products becomes important for conducting comprehensive risk assessment of their emissions from coal-based power plants. This study focuses on chromium speciation analysis of coals and ash by-products. US EPA methods 3060A and 7199 were used for Cr(VI) determination in samples. To quantify Cr(VI) and total chromium in the samples, Ion Chromatography with Post Column Derivatisation & Colorimetric Detection and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) were used, respectively. The more toxic hexavalent chromium was detected in most of the fly ash samples with concentrations up to 1.38 ppm. Enrichment of concentration of total Cr and Cr(VI) was found with respect to decreasing particle size range of fly ash particles. The bottom ash samples contained primarily the trivalent form of chromium. Laboratory ash and char were also produced by carrying out combustion and pyrolysis experiments on two different types of coal in a laboratory-based drop tube furnace. Chromium in laboratory-produced char and ash was mainly in trivalent form. Possible gas phase chromium reactions likely to occur in the combustion zone are also discussed. (C) 2008 Elsevier Ltd. All rights reserved.
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Desliming of dense minerals in fluidized beds

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Minerals Engineering, *Volume 39*, *December 2012*, *Pages 9-18*

This paper applies Drift Flux theory for the first time to explore the relationship between the liquid and solids flow through fluidized beds in the context of desliming of dense minerals. At low solids fluxes the process is not flux curve constrained. Here continuity considerations indicate the net liquid flux through the lower bed is upwards, ideal for the removal of slimes from the underflow product. Moreover, the liquid split to the underflow is also lower, further reducing the slimes content of the underflow. At higher solids fluxes the net liquid flux becomes downwards and eventually the system becomes flux curve constrained. Under these circumstances slimes entrainment to the underflow increases significantly. In order to operate at these higher solids fluxes, and achieve efficient desliming, Split Fluidization should be used. Here additional fluidization liquid is added at a higher elevation, producing a net liquid flux in the upwards direction through the zone above the Split Fluidization entrance level. Desliming experiments covering a range of solids fluxes were conducted to investigate the effects of increasing solids flux and Split Fluidization. This study shows that a system of parallel inclined channels, a key feature of the Reflux Classifier, permits the introduction of this additional liquid while preventing the ultra fine product from being entrained to the overflow reject stream,

thus permitting the efficient removal of slimes. Experiments were conducted using an iron ore feed with particles smaller than 0.50 mm in diameter. Efficient desliming at a relatively high solids feed flux of 20 t/m^2 h was achieved, but to efficiently deslime at 40 t/m^2 h significant Split Fluidization was found to be essential.

Floatability studies of wavellite and preliminary results on phosphorus removal from a Brazilian iron ore by froth flotation

Minerals Engineering, *Volume 39*, *December 2012*, *Pages 206-212*

Along with other deleterious elements, phosphorus is an extremely harmful element found in iron ores used as a raw material in the steel making process. It is responsible for increasing its hardness and brittleness while decreasing its ductility. Reducing the phosphorus content in ores when the apatite is the main phosphorous mineral can be easily achieved through reverse flotation making use of anionic collectors to float the apatite and sodium silicate to depress the iron oxides. However, the phosphorus removal from iron ores other than igneous formations has been a challenge for most of the iron ore operations. This research aims to make a preliminary study of wavellite's floatability and to evaluate the reduction of phosphorus content by froth flotation from a Brazilian iron ore with a P content of 0.82%. Microflotation experiments of wavellite using anionic, cationic and amphoteric collectors were carried out in the basic pH range. Sodium silicate was evaluated as a depressant, and the presence of this reagent did not change significantly the wavellite's floatability. Dodecylamine showed the best floatability results, which were around 100% above pH 8. Bench flotation experiments confirmed the results of the microflotation experiments. During the bench experiments, flotation with amine as collector gave the lowest phosphorus content at the final iron concentrate. A concentrate containing 0.201% P with a mass recovery of 62.31% was achieved when a 150 g/t dosage of Flotigam EDA (an amine type collector) was used. In a bench experiment with Flotigam 2835 2L as collector led to a concentrate containing 0.312% P with a mass recovery of 90.24%. The collector Flotigam 2835 2L appeared to be more selective onto phosphates and aluminum silicates than the other amine.

Fine coal dry beneficiation using autogenous medium in a vibrated fluidized bed

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Dry beneficiation of fine coal (− 6 mm) using autogenous medium in a vibrated fluidized bed has been studied. The results show that in the particulate bed of fine coal, most of − 1 + 0.5 mm size fractions of coal and a small portion of − 0.5 mm size fraction of coal having high ash content contribute to the formation of an autogenous medium bed. This provides a favorable fluidization environment for the stratification process of fine coal particles depending on their density difference. The main operational parameters including superficial air velocity, vibration frequency and amplitude, initial bed height and separating time all have significant influences on the stratification performance of the particulate bed of fine coal. The batch separation results of Wuhai fine coal in an autogenous medium vibrated fluidized bed show that the separation efficiency, i.e. the probable error *E*, is 0.14, indicating that dry beneficiation of fine coal using an autogenous medium vibrated fluidized bed is a promising technique for coal cleaning in dry regions.

Rank-dependent formation enthalpy of coal

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In the study, the enthalpy of formation of a complex chemical compound, such as coal, was defined as the difference between the experimentally determined heat of combustion and the thermodynamically calculated heat of combustion of the elementary reactants. The boundary conditions for the approach were defined by the enthalpy of formation of graphite; thus, the aforementioned method should produce a value of zero for graphite. Using the developed correlation for the enthalpy of formation, a model of coal classification was developed based on this thermodynamic quantity, which reflects the structure and technological suitability of coal. According to the analysis of the enthalpy of formation with respect to the composition of coal, the enthalpy of formation may have negative or positive values, depending on the type of fuel. Furthermore, changes in the formation enthalpy are continuous but correspond to different chemical structures. The following values for the enthalpy of formation were obtained: anthracite = +250 kJ/kg, peat < −3200 kJ/kg and medium volatile bituminous coal ~zero.

Mechanism and performance of a dry particle separator using an elastic drum

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International Journal of Mineral Processing, Volume 125, 10 December 2013, Pages 34-38, ISSN 0301-7516, http://dx.doi.org/10.1016/j.minpro.2013.09.006.

In order to develop a dry separation tool for low-grade middling ores with high economic feasibility, a novel rotating drum separator covered with an elastic material was designed. The operational principle was based on the simple notion that the differences in the physical properties of ores, such as their shape and chemical composition, should result in different rebounding distances. When ores slide down the drum and rebound from the drum surface, the friction coefficient and repulsion coefficient of the ores affect their collisions with the drum surface, and thus determine their rebounding distances. The basic performance of the elastic drum separator was examined for selected sample ores, including coal, shale, talc, and dolomite. The calculated and experimentally determined rebounding distances were found to be in good agreement for all of the ores. Tests on a 1:1 talc/dolomite mixture showed good performance for the separation of talc from dolomite. It was also found that the shape anisotropy of the ores played an important factor in determining the rebounding distance. The separation of low-grade coal middling dumped at a mine confirmed the performance of the elastic drum. A total of 46.5 wt.% of coal ore with a calorie content of 4991 cal/g was recovered from 45 to 65 mm sized coal ores with an average calorie content of 3576 cal/g. In addition, 35.4 wt.% of coal ore with a calorie content of 3105 cal/g was recovered from 25 to 45 mm-sized ore that had an average calorie content of 1554 cal/g. It was thus verified that the drum separator was useful for sorting relatively high calorie coal ores from abandoned coal wastes.

Effects of Grain Scale Heterogeneity on Rock Strength and the Chipping Process

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INTERNATIONAL JOURNAL OF GEOMECHANICS, Dec, 2012, Vol.12(6), pp. 632-647

Heterogeneity is an important factor controlling fracture initiation, accumulation, and propagation within polycrystalline rock. Internal spatial variability in terms of mineralogy, grain size, and anisotropy affect the yielding process. To investigate these factors, a texture-generating algorithm integrated within a numerical model was developed to create realistic rock analogs and provide user control over geological characteristics including mineral type, grain size, and anisotropic crystal shape. A mineral-specific constitutive model was created and calibrated using published values and real laboratory strength values. Brazilian tensile strength and unconfined compressive strength (UCS) model tests were developed using the finite-difference modeling software FLAC to perform parametric analysis of a series of geological characteristics. The results show that the methodology is capable of realistically reproducing damage propagation and failure behavior similar to that observed during laboratory testing. The strength results show trends similar to those found during laboratory testing. This methodology was applied to the simulation of tunnel-boring machine (TBM) cutter excavation to investigate the effect of geomechanical characteristics on the chipping process. (C) 2012 American Society of Civil Engineers. 10.1061/(ASCE)GM.1943-5622.0000194

Effect of regrinding conditions on pyrite flotation in the presence of copper ions

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In this study, the effect of regrinding conditions on copper activation on the pyrite surface and subsequent pyrite flotation in the cleaner stage was investigated. Pyrite was activated by copper ions during primary grinding, and the rougher flotation concentrate was reground in a tumbling mill prior to the cleaner flotation. The regrinding condition was manipulated by two types of grinding media, stainless steel and mild steel. It was found that pyrite flotation in the cleaner stage was depressed especially when mild steel media was used during regrinding. An additional amount of collector improved pyrite flotation especially when stainless steel media was used during regrinding. An additional amount of copper ions further increased pyrite flotation after regrinding with mild steel media but decreased pyrite flotation after regrinding with stainless steel media. XPS (X-ray photoelectron spectroscopy) analyses and EDTA (ethylene diamine tetraacetic acid) extraction revealed that the different response of pyrite flotation in the cleaner stage to stainless steel and mild steel media used during regrinding was associated with the modified property of the Cu-activated pyrite surface carried from the rougher flotation concentrate and the new pyrite surface created during regrinding.

Experimental and simulative study on phase transformation in Bayer red mud soda-lime roasting system and recovery of Al, Na and Fe

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Red mud, or bauxite residue, is the largest environmental concern of alumina refineries, mainly because of the size of this waste stream and its caustic characteristics. This paper reports part of a research effort aimed at developing an economically feasible zero waste process for the treatment of red mud. Soda-lime roasting was carried out on fine red mud, which was separated from raw red mud physically with particle size below 75 gm, under reductive atmosphere prior to leaching and magnetic separation. The aim was to recover valuable components such as Al, Na and Fe from the fine red mud. This study found that, the recovery of Al and Na after the water leaching was about 75.7% and 80.7%, respectively. The recovery of iron depended on the type of reduction products. Under the roasting conditions applied in this study, spinet, sodium aluminosilicate, and larnite are dominant mineral phases in the roasted samples, with calcium aluminoferrite, melilite and wustite being minor phases. The effect of Ca content and of reaction atmosphere on the equilibrium phases was studied by experiments and thermodynamic modeling, and the dependence of the recovery of Al and Na on these factors was demonstrated. (C) 2012 Elsevier Ltd. All rights reserved.
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Selective sulphidation and flotation of nickel from a nickeliferous laterite ore

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Minerals Engineering, Volume 54, December 2013, Pages 21-31, http://dx.doi.org/10.1016/j.mineng.2013.02.016.

The sulphidation of a nickeliferous lateritic ore was studied at temperatures between 450 and 1100 °C and for sulphur additions of 25–1000 kg of sulphur per tonne of ore. The experiments demonstrated that the nickel could be selectively sulphidized to form a nickel–iron sulphide. It was found that both the grade and the sulphidation degree largely depended upon the temperature and the sulphur additions, with temperatures above 550 °C exhibiting the highest nickel sulphidation degrees and grades. A DTA/TGA with mass spectrometer was used to further elucidate the nature of the phase transformations that occurred upon heating of the ore in the presence of sulphur. It was found that at low temperatures, the Fe–Ni–S phase was submicron in nature and heating to temperatures between 1050 and 1100 °C allowed for the growth of the particles, due to the increased sulphide mobility associated with the formation of a liquid sulphide matte phase, containing dissolved oxygen. Flotation studies conducted on 60 g samples showed that the sulphides responded to flotation with maximum grades of up to 6–7 wt.% nickel being achieved. Recoveries were approximately 50% on a sulphide basis and it was determined that the low nickel grades were due to the entrainment of magnetite fines.

Influence of charge type on measurements with an in-mill sensor

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The process of grinding is complex with many factors affecting the result. As the composition of the ore fed to the concentrator varies, implying changes in grindability, the optimal operation conditions for a pebble mill will also vary. In an attempt to increase the understanding of charge dynamics, a series of statistically planned experiments were done in a pilot-scale pebble mill with differing charge types. This pebble mill is equipped with an in-mill sensor, which measures the deflection of a single lifter as it passes through the mill charge. The experimental setup was a factorial design with two factors; two levels of magnetite pebbles content and three different size distributions. The experiments show that there is an advantage to keep the magnetite pebbles proportion as high as possible. This will increase the power consumption and maximum deflection of the lifters, but at the same time increase the production of <45 mu m material, the grindability and the pebbles consumption. A pebble size fraction 10-35 mm improves the grindability the most and the amount of <45 mu m material. It is strongly suggested that the 10-35 mm and 100% magnetite pebbles fraction should be tested in a larger scale pebble mill to confirm these findings. (C) 2012 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2012.07.009

Microbial colonisation in heaps for mineral bioleaching and the influence of irrigation rate

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Microbial colonisation is important for mineral dissolution in heap bioleaching of low grade ore. Colonisation studies to date have focused on the microbial attachment of single species to mineral concentrates in batch and flow systems. Hydrology and soil engineering studies suggest interaction between microbial colonisation and fluid flow in porous systems that result from solution-ore and microbe-mineral contacting (Wan et al., 1994: Yarwood et al., 2006). The effect of the irrigation rate on microbial colonisation was assessed using columns packed with acid agglomerated low grade copper-containing ore. Continuous flow, unsaturated, aerated bed reactors were inoculated by pulse irrigation with iron and sulphur oxidising mesophilic microorganisms (10(12) cells/ton ore), followed by operation at irrigation rates of 2, 6 and 18 l/m(2)/h. A novel in-bed sampling technique allowed the extraction of ore samples from the bed during the leaching process. Novel insights regarding microbial growth, interstitial and weakly and strongly attached microbial populations were obtained. Bacterial adherence and cell number retained in the ore bed increased over the 32 day leaching period. Average specific growth rates of ore-associated micro-organisms of 0.161 +/- 0.0045, 0.155 +/- 0.026 and 0.120 (+/- 0.00) 1/h were obtained at 2.6 and 18 L/m(2)/h respectively. Faster colonisation occurred at lower irrigation rates. At higher irrigation rates, higher detachment and cell removal were apparent, based on PLS cell numbers. The interstitial cells from the stagnant fluid in the ore bed formed the dominant contribution to the microbial population within all the heap systems. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2012.07.002

Optimization of in-mill ball loading and slurry solids concentration in grinding of UG-2 ores: A statistical experimental design approach

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The in-mill load volume and slurry solids concentration have significant influence on the ball mill product size and energy expenditure. Hence, better energy efficiency and quality grind can only be achieved with correct tuning of these influential operational factors to the desired optimum point. In view of the deficiencies of the classical "one-factor-at-a-time" methodology, statistical experimental design methodologies were applied in this study to optimize the slurry % solids and ball load volume during a batch ball milling process of UG-2 ore. The response surface methodology and central composite design were used to determine the best possible combination of ball load volume and slurry % solids for maximum size reduction index and minimum specific energy consumption (kW h/t). Second order response surface models were built to describe the relationship between the input factors and the response variables. Analysis of variance (ANOVA) tests and response surface plots were used to set the optimal level for each input factor. With compromise optimized values of 29% ball load volume and 75% slurry solids, the response surface models yielded specific energy consumption of 10.54 kW h/t and size reduction index of 3.93. Confirmatory experiments carried out in these optimized conditions resulted in specific energy consumption of 10.72 kW h/t and size reduction index of 3.91 thus corroborating the validity of the response surface models. (C) 2012 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2012.05.020.

SELECTIVE ABSTRACTS

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

Panda, Rekha and Kumari, Archana and Hait, Jhumki and Sahu, S K and Jha, Manis K and Kumar, Vinay and Kumar, J Rajesh and Lee, Jin-Young (2012) *Leaching of Korean monazite for the recovery of rare earth metals.* In: NMD-ATM 2012, 16-19th November, 2012, Jamshedpur.

The technological innovations resulted in various applications using rare earth metals (REM), which lead to a steep increase in their demand. Monazite is the second most essential naturally occurring phosphate mineral containing REM. The present work reports the recovery of REM from Korean monazite which contained mainly 50.12% rare earth oxide and 29.4% phosphate. For the recovery of REM from monazite, the hydrometallurgical process consisting of alkaline leaching of phosphate followed by acid dissolution of REM has been reported. As the presence of phosphate decreases the leaching efficiency of REM from monazite, the studies were carried out initially for hot digestion of phosphate present in the monazite in an autoclave using sodium hydroxide, which resulted in the formation of RE oxide and soluble sodium phosphate. To get the optimum condition for phosphate decomposition by alkaline leaching, the various process parameters such as concentration of sodium hydroxide, temperature, mixing time and pulp density were studied. The obtained slurry was washed with hot water and filtered to get sodium phosphate in the solution. A maximum of 99% phosphate was removed from monazite concentrate using 50% sodium hydroxide solutions (wt./vol.) at 170oC in 4 h mixing time maintaining the pulp density of 100 g/L. From the phosphate free monazite sample, REM was leached out using hydrochloric acid. More than 95% of REM was found to be leached out using 6M HCl at constant pulp density 100 g/L, temperature 90oC and mixing time 2 h. Further studies are in progress to obtain pure solution and salts of REM from chloride leach liquor using recipitation/ solvent extraction/ ion-exchange techniques. http://eprints.nmlindia.org/6542/

Joshi, Ritika Sadanand and Choubey, Pankaj K and Jha, Manis K and Kumar, Vinay and Jeong, Jinki and Lee, Jae-chun (2012) *Extraction and recovery of nitric acid and copper from leach liquor of waste PCBs.* In: NMD-ATM 2012, 16-19th November, 2012, Jamshedpur.

The disposal of large quantities of electronic scrap worldwide is causing an enormous harm to environment as well as to mankind. Therefore, efforts have been

made to develop a suitable hydrometallurgical process for the extraction of metals from electronic scraps. The leach liquor of waste PCBs was generated containing 18.78g/LCu, 0.38g/LFe, 0.13g/LNi, 1.34g/L Pb and 6.3 M HNO3. Initially, HNO3 was extracted from the leach liquor using TBP as an extractant. Various process parameters such as time, concentration of extractant, O/A ratio etc were studied for the extraction of HNO3. It was observed that the extraction of HNO3 increased from 8.1–39.6% with increase in TBP concentration from 10 to 100%. The plot of log D vs. log[TBP] gives a straight line with slope ~ 1indicated that the 1 mole of TBP used for the extraction of 1mole of HNO3. The McCabe – Thiele Plot was drawn to investigate the stage required for maximum acid extraction. After extraction of HNO3 from leach liquor, extraction of copper was investigated using LIX84IC. Various parameters such as effect of pH, phase ratio, stripping, etc. Were studied to investigate the optimum experimental condition for the extraction of copper. The extraction of Cu increased from 37 to 88% with the increase in the Ph range from 0.7 to 2.0. The optimum equilibrium pH for Cu extraction was found to be ~2.0. The McCabe–Thiele Plot for Cu extraction indicated that 2 counter current stages is enough for its complete removal from acid free leach liquor at O/A=1.2/1 maintaining equilibrium pH~2.0. The present study reports removal of acid and Cu from the leach liquor of waste PCBs in an eco-friendly manner.
http://eprints.nmlindia.org/6543/

Jha, Amrita kumari and Jha, Manis K and Kumar, Vinay and Jeong, Jinki and Lee, Jae-chun (2012) *Review on e-waste recycling scenario and development of eco-friendly processes at CSIR-NML.* In: NMD-ATM 2012, 16-19th November, 2012, Jamshedpur.

Electrical and electronic devices applications in consumer products are growing enormously, resulting in increasing resources demand due to the replacement of old/ obsolete by advanced and new products. It is estimated that the total amount of e-wastes generation in European Union (EU) ranges from 5 to 7 million tons per annum or about 14 to 15 kg per capita with the growth rate 3% to 5% yearly. CSIR-NML (India) is pioneer in the field of development of e-waste recycling processes and also recognized by several national and international recognitions. Present paper focused on a detailed analysis of global e-waste recycling scenario and contribution of CSIR-NML for developing the e-waste recycling processes with several national and international collaborations. Recently, CSIR-NML has developed a process for the removal of hazardous metal elements from leach liquor of electronic scraps following solvent extraction and recovery of valuables. A novel process has been developed for the recovery of lead and tin from liberated resin of printed circuit boards (PCBs) swelled by organic. The processes meet the strict environmental regulations. In the area of rare earth processing, a process for the recovery of neodymium has been developed on laboratory scale by hydrometallurgical route from discarded hard-disk of personal computer. The laboratory scale processes are also developed for the recovery of indium, lithium, cobalt, zinc, chromium, lead, tin etc from secondary resources. Developments of several eco – friendly and energy-saving processes for e-waste recycling are underway to meet the stringent environmental regulations. http://eprints.nmlindia.org/6535/

Jha, Manis K (2012) *Status of E-waste Recycling in India and Developing Recycling Processes at CSIR-NML, India.* In: Electronics Recycling Asia-2012, November 13 - 16, 2012, Guangzhou, China.

Generation of E-waste is increasing globally due to the fast economical growth, technological advancement and availability of advanced electronic equipments in the market. E-waste means the discarded electrical or electronic devices i.e. obsolete computers, mobile phones, televisions, microwave ovens and other such appliances that had past their useful lives. These wastes contain hazardous but also valuable and scarce materials. Due to the supremacy of e-waste management, countries are being enforced to establish new models for the collection and environmentally sound disposal of these wastes. E-waste recycling is essential due to the national and international reports, which cautioned on the global generation, treatment and accumulation of e-waste. Global data indicate that total e-waste generation including imports is around 20-50 million tones per year. In India, 332,979 tones of e-waste were generated and 50,000 tones imported in 2007. The yearly growth rate of total E-waste in India is ~10%. Among these, recycling by non-formal and formal sectors are 95% and 5%, respectively. Present lecture describes the current scenario of E-waste recycling in India and developing recycling processes at CSIR-NML, India with joint collaborations and sponsorship from national and international agencies. At NML, the mineral beneficiation and hydrometallurgical processes are developed to recover valuable, precious and hazardous metals from E-waste. The varieties of metals have been recovered from E-wastes using individual or combined processes in an organized and safe manner.
http://eprints.nmlindia.org/6244/