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Bacterial solubilisation of copper from a low grade sulphide mineral.

Mehta, KD; Anand Ram, S; Pal, SC; Abhilash; Pandey, B D and Mankhand, T R (2009)
kdmehta@nmlindia.org
In: Proc.BIOHYDROMET 2009, April 6, 2009.

The bio-dissolution of copper from a low grade ore containing chalcopyrite ore (0.3%Cu) from Malanjkhand Copper Mines, India was investigated using adapted pure species of Acidithiobacillus ferrooxidans (A.ferrooxidans) and also in association with Acidithiobacillus thiooxidans (A.thiooxidans) as consortia. Bench scale experiments for bioleaching of copper were carried out to investigate the effect of different parameters such as pulp density (PD), pH, particle size and temperature in presence of 10% (v/v) inoculum of A.ferrooxidans and a consortium (4:1 ratio) of A.ferrooxidans and A.thiooxidans. A maximum copper recovery of 75.3% was obtained in 35 days with the adapted A.ferrooxidans at 2.0 pH, 35oC temperature using <50μm size particles as compared to the copper recovery of 88% when a mixed culture of A.ferrooxidans and A.thiooxidans was employed. The paper highlights the mechanism of bioleaching with the single species (A.ferrooxidans) and the consortia, while correlating redox potential and iron level in solution with copper recovery.
http://eprints.nmlindia.org/391/

Hardgrove grindability index prediction using support vector regression

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International Journal of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, Apr-16, 2009, Vol. 91, pp. 55-59.

Hardgrove grindability index (HGI) measures the grindability of coal and is a qualitative measure of coal. it is referred to in mining. beneficiation and utilization of coal. HGI of coal depends on the coal composition and there is an interest to predict this property from proximate analysis of coal. In this paper, support vector regression (SVR), a potential machine learning technique is used to develop a non-linear relationship between input proximate analyses of coal with output HGI by

training the SVR model with limited measured data and to validate it with the rest of the untrained data. SVR is a promising method and suggests that a smaller data set can be used for training the model than what has been studied earlier using artificial neural network (ANN) techniques, so that the model still validates the remaining data. (c) 2008 Elsevier B.V. All rights reserved.
10.1016/j.minpro.2008.12.003

A simple heatsink for planetary mills

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Minerals Engineering, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, APR 2009, Vol. 22(5), pp. 516-518.

This paper proposes the use of a copper disk as a simple heatsink for planetary mills in order to limit or slow down the temperature increase during prolonged grinding. A series of grinding experiments have been performed in which the surface temperature of different parts of the grinding bowl has been determined as a function of grinding time. Three different experimental series were conducted: a reference series without the heatsink, and two series where the heatsink had been given the respective initial temperatures of 25 degrees C and -25 degrees C. As demonstrated in this paper, the proposed concept represents a cheap but effective way of limiting or slowing down the temperature increase occurring in the grinding bowl. The effect is of a magnitude that can be of considerable practical importance, and the concept can be employed on most planetary mills where the grinding bowl holder is designed to accommodate different bowl sizes. (C) 2009 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2009.01.003

Enhancement of flotation performance of oil shale cleaning by ultrasonic treatment

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International Journal Of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, Apr-16, 2009, Vol. 91, pp. 1-13.

In this study, it was attempted to enhance the performance of flotation cleaning of oil shales by use of ultrasound. The use of an excitation effect through ultrasonication was investigated towards inorganic particles that remain clogged in pores/voids or attached as surface coatings. Ultrasonic treatment was applied prior to flotation at different ultrasonic power levels and for different ultrasonication periods. Ultrasonic treatment proved to be useful in improving the extent of ash rejection. After ultrasonic treatment, the ash content of Himmetoglu oil shale decreased from 34.76% to 11.82% with 82.66% combustible recovery and the ash of Beypazari oil

shale decreased from 69.88% to 34.76% with 64.78% combustible recovery. Comparative XRD and SEM analyses showed that particulates clogged in the pores/voids or attached to the surfaces of larger particles were effectively removed after ultrasonic treatment and this condition significantly improved the liberation between organic and inorganic entities. (c) 2008 Elsevier B.V. All rights reserved.
10.1016/j.minpro.2008.10.003

Effect of sodium chloride on the selective removal of iron from chromite by carbochlorination

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International Journal Of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, May-16, 2009, Vol. 91, pp. 74-80.

The addition of some salts such as sodium chloride and potassium chloride to the chromites were found to be able to significantly improve selective removal of iron from chromites by carbochlorination by using Cl(2) + CO or Cl(2) + petroleum coke. A systematic study of the effect of sodium chloride was performed in this study. The removal percentage of iron increased with increasing NaCl content at the range of 5-15% (w/w) NaCl. It was found that after 2.5 h of carbochlorination, the weight loss percentages of chromite were raised by 79% and 45%, the iron removal percentage were raised by 49% and 36% and the Cr/Fe molar ratios were raised by 27% and 127%. at 626 degrees C and 679 degrees C, respectively, due to the addition of 5% (w/w) NaCl. An appreciable loss in chromium content was found at 720 degrees C in the presence of 5% (w/w) NaCl when Cl(2) and petroleum coke were used. The chlorinated chromite residues were leached with hydrochloric acid. It was found that acid concentration has no remarkable effect on the iron removal by leaching and water is preferred to use in the leaching process. The weight of chlorinated chromite residue was reduced by about 40% after the leaching. Two processes are suggested for beneficiation of chromite by carbochlorination in the presence of NaG. (C) 2009 Elsevier B.V. All rights reserved.
10.1016/j.minpro.2008.12.005

Approaches for the treatment of waste streams of the aluminium anodising industry

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Journal of Hazardous Materials, ELSEVIER SCIENCE BV, AMSTERDAM, May-30, 2009, Vol 164, pp. 409-414.

The aluminium anodising industry is an important industrial sector that invariably generates great amounts of different waste streams. Classical and especially new-developing technologies dealing with them are reviewed. Innovative methods are

mainly based on engineering geochemical processes, looking for the recovery of resource materials and the reduction of emissions to the environment. These represent a promising alternative to the classical method (neutralisation process and anodising mud disposal) which is an end-of-pipe solution. Among the treatments recently proposed, there are the use of anodising mud in the manufacture of refractory bodies, and the synthesis of useful minerals from the wastewaters arising from the etching, anodising and brightening processes. The viability of the application of such methods in the treatment of waste streams of the aluminium anodising industry is discussed, pointing out the main shortcomings and benefits of each of them. For those methods appearing environmentally friendly the process cost and the actual marketability of the final products should be determinant on their near future applicability. (C) 2008 Elsevier B.V. All rights reserved.
10.1016/j.jhazmat.2008.08.054

Characterisation of particle tribo-charging and electron transfer with reference to electrostatic dry coal cleaning

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International Journal of Mineral Processing, ELSEVIER SCIENCE BV, AMSTERDAM, May-16, 2009, Vol. 91, pp. 100-110.

The electrostatic beneficiation of coal is based on different tribo-charging characteristics of ash forming minerals and coal particles. In this work the tribo-charging of quartz and coal particles contacted with various metals and polymer materials have been measured and the charge acquisition was examined through surface energy calculations from liquid contact angle data. The contacts angles, before and after tribo-charging of solids, were measured with Kruss tensiometer using Washburn's equation where the sample holders in tensiometer are specially constructed with tribo-charger materials. The polarity and amount of charge acquired by quartz and carbon powders with metal tribo-chargers were found to be in good agreement with the reported work functions of the contacting surfaces. The results for the charge with polymer materials differed from the work function values, presumably due to surface contamination. The surface energy of quartz particles calculated from the measured contact angle data showed that the tribo-charging increases the surface energy. Both polar and non-polar components computed using Fowkes and Owens-Wendt approaches showed that these components increase after tribo-electrification. However, the polar component divided into acid and base parts, as in van Oss approach, manifest decreasing acid part and increasing base part. Since quartz charged negatively during tribo-charging with metal surfaces and therefore suggests acceptance of electrons, the determined acid-base surface energy components are consistent with the charge transfer process. The results also elucidate an explicit correlation between the charge generated by powders and the surface acceptor (acid) and donor (base) electronic state and thereby the work functions. Thus a method for characterising the changes in surface energetic

structure of solids during tribo-electrification in terms of acid-base parameters of electron transfer between the contacting surfaces has been described for the first time. (C) 2009 Elsevier B.V. All rights reserved.
10.1016/j.minpro.2009.02.006

Recycling of coal combustion wastes

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Waste Management & Research, MAY, 2009, Vol. 27(3), pp. 267-273.

The separation of unburned carbon from coal-fired power plant bottom ashes was conducted in order to increase the possibility of the recycling of coal combustion wastes. A two-stage flotation technique was used for this study. In the rougher flotation experiments the amounts of collector, dispersant and frother, pulp density, pH, particle size distribution, flotation time and flotation temperature were tested as variables. After rougher flotation experiments, at optimum conditions, the carbon content of the concentrate increased from 13.85 to 51.54% at a carbon recovery of 54.54%. Under the same conditions, the carbon content was reduced to 4.54% at a weight yield of over 80% in the tailings fraction. This fraction meets the industrial specifications and can be utilized as a cement additive. After the cleaner flotation experiment the carbon content of the product was enhanced to 64.81% with a 52.16% carbon recovery. This fraction can be blended back into the coal feed to the power plant boilers.
10.1177/0734242X08089314

Pilot-Scale Baum Jig Washing For Beneficiation of a High-Ash Indian Noncoking Coal

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International Journal Of Coal Preparation And Utilization, MAY-JUN, 2009, Vol. 29(3), pp. 130-139.

Coal will continue to play an important role in overall energy scenario in India. Despite its high-ash content, the run-of-mine (ROM) Indian coals are used directly for thermal power generation. There is an urgent need to improve quality of coal by reducing ash so that a consistent supply of quality coal can be supplied to the power plants. Pilot-scale studies were conducted on beneficiation of High Ash Indian Non Coking Coal obtained from the Samleshwari mines using a 20-t/h Baum Jig Washer. The results of the pilot-scale studies revealed that the ROM coal, containing 50% ash content, could be cleaned with the Baum jig providing a clean coal containing 36% ash at a yield of 52%.
10.1080/19392690902936396

Predicting the overall specific energy requirement of crushing, high pressure grinding roll and tumbling mill circuits

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Minerals Engineering, MAY, 2009, Vol. 22(6), pp. 544-549.

In a previous paper [Morrell, S. 2008a. A method for predicting the specific energy requirement of comminution circuits and assessing their energy utilisation efficiency. Minerals Engineering 21(3), 5-9] an approach was described which enabled the specific energy of tumbling mills such as Autogenous (AG), Semi-autogenous (SAG) and ball mills to be estimated from laboratory-derived ore characterisation data. The following paper extends this approach to encompass jaw, gyratory and cone crushers as well as High Pressure Grinding Rolls (HPGR). The technique is applied to three different comminution circuits and their overall specific energies are compared. All of the calculations involved are described in detail in an appendix. (C) 2009 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2009.01.005

The role of weathering on fly ash charge distribution during triboelectrostatic beneficiation

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Journal Of Hazardous Materials, May-30, 2009, Vol. 164, pp. 683-688.

Triboelectrostatic beneficiation of coal combustion fly ashes with high-unburned carbon contents can produce low-carbon ash products having value as mineral admixtures and meeting technical requirements for replacing cement in concrete. This capability is a result of establishing bipolar charge on mineral ash versus carbon particles where, typically, unburned carbon attains positive surface charge and ash attains negative surface charge under the tribocharging conditions employed in triboelectrostatic technologies. However, long-term exposure of fly ash to weathering conditions, such as moisture or high humidity, before beneficiation is known to dramatically diminish carbon-ash separation efficiencies. Although experimentation has shown that water soluble surface species can be redistributed on fly ash particles after exposure to moisture, which could affect the extent of charging and polarities, measurement of the actual amount of charge and polarity on particles after weathering exposure versus after removal of surface moisture has not been accomplished. Hence, a new experimental methodology was developed and applied to measure charge distributions on tribocharged ash and carbon particles in a fly ash that had been exposed to weathering conditions for 6 months before and after removal of the surface moisture. Weathered ash particles were found to have an average zero charge, whereas carbon particles attained an average negative charge, opposite of the normal polarity for carbon. Although the extent of uncharged particles decreased and ash particles attained an average negative charge after

drying, carbon particles attained only an average zero charge. These changes were reflected in very small increases in carbon-ash separation efficiency, in contrast to previous beneficiation tests in which fly ash drying led to significant increases in carbon-ash separation efficiency. It is suggested that removal of surface moisture in the absence of other processes like surface ion redistribution would beneficially impact carbon-ash triboelectrostatic beneficiation. (c) 2008 Elsevier B.V. All rights reserved.
10.1016/j.jhazmat.2008.08.050

Integrated piloting of a thermophilic bioleaching process for the treatment of a low-grade nickel-copper sulphide concentrate

Neale, JW; Robertson, SW; Muller, HH; Gericke, M
Journal Of The South African Institute Of Mining And Metallurgy, MAY, 2009, Vol. 109(5), pp. 273-293.

Mintek was a leading participant in the BiominE project between 2004 and 2008. This project, which was funded in part by the European Commission, was aimed at the development of biotechnology for the minerals industry in Europe. Mintek's research programme focused mainly on the development of integrated bioleach-based processes for the recovery of base metals from complex, low-grade sulphide concentrates. Specific European mineral resources were targeted and used in integrated piloting campaigns involving bioleaching, solution purification, and metals recovery. This paper describes the use of thermophilic bioleaching for the recovery of nickel and copper from a low-grade nickel-copper concentrate produced at the Aguablanca Mine in southern Spain. Currently, the Aguablanca Mine produces a bulk nickel-copper concentrate for sale to a smelter, and the proposition is to increase the profitability of the operation by the on-site production of metal or metal intermediate. Initially, bench-scale bioleach tests were conducted to determine the bioleach operating conditions. These tests included an evaluation of mesophilic, moderately thermophilic and thermophilic microorganisms. in order to achieve sufficiently high levels of both copper and nickel extraction, a thermophilic process was selected-this was necessary for leaching of the refractory chalcopyrite that occurs in this concentrate. Additional bench-scale test work was carried out to derive a conceptual process flowsheet for the solution purification and metals recovery circuit. The results of the bench-scale tests were used to design, construct and commission an integrated pilot plant, which was subsequently operated at Mintek for over seven months. During this time, the solution purification and metals recovery processes were optimized, and all recycle loops were closed. The final process flowsheet included the following unit operations: concentrate regrinding, thermophilic bioleaching at 70 degrees C, primary iron removal using limestone, copper solvent extraction and electrowinning, secondary iron removal, nickel hydroxide precipitation using magnesia, and final solution purification using lime. Where applicable, process solutions were recycled to preserve water. The process design data derived from this pilot-plant campaign formed the basis for a

conceptual engineering study for the developed process. in the study, mass and energy balances were derived, and a process flowsheet was developed and used as the basis for estimating the capital and operating costs of the process. This enabled a preliminary economic analysis of the process to be undertaken. The findings of this study are discussed.

SELECTIVE ABSTRACTS

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

Processing of copper electrorefining anode slime: a review.
Hait, Jhumki and Jana, R K and Sanyal, S K (2009)
jhumki@nmlindia.org
Mineral Processing and Extractive Metallurgy (Trans. IMM C), 118 (4). pp. 240-252.

Anode slime is the insoluble product deposited at the bottom of the electrorefining tank during electrorefining of copper. It generally contains Cu, Ni, Se, Te, Ag, Au, platinum group metals (PGM), Pb, Ba, Fe, etc. Owing to the presence of valuable metals and metalloids in the anode slime, numerous approaches have been made by the researchers to extract them following pyro-, pyrohydro-, hydropyro-, hydrometallurgical, etc. routes. In the present paper the various processing routes with the special emphasis on plant practice and precious metals recovery from anode slime have been described systematically. Since the understanding of the process chemistry is considerably aided by the formation and characterisation studies of the slime, these aspects have also been included.
http://eprints.nmlindia.org/3230/

Using DEM to compare the energy efficiency of pilot scale ball and tower mills
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Minerals Engineering, JUN-JUL, 2009, Vol. 22, pp. 665-672.

Tower mills are considered to be appreciably more energy efficient than ball mills. Why this should be so is a question which can be explored by using DEM to simulate one machine of each type with similar breakage capabilities. This paper reports on a comparison between a pilot scale tower mill and a small ball mill in terms of the power required to produce reasonably similar distributions of normal and tangential impacts. While the tower mill produces quite a narrow spectrum of normal energies, the ball mill produces a wide distribution. Hence, the ball mill can be expected to be Much more "forgiving" of variable feed conditions but much less efficient in terms of utilization of the energy from media interactions. (C) 2009 Published by Elsevier Ltd.

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Reformation and Practice in Mineral Separation Teaching Courses
Pan, LY; Ma, J
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Proceedings Of 2009 International Conference On Education Management And Engineering, International Seminar on Education Management and Engineering, 25-Jun-09, Henan Province, PEOPLES R CHINA, M D FORUM, ALLAWAH NSW, 2009, pp. 571-574.

Mineral separation is a primary specialized course for the major of Mineral Processing Engineering. The problem is that mineral separation contains too much knowledge but there is relatively less time on the education schedule for it. Teaching quality is ensured by constructing a complete system of teaching course, improving the methods of class teaching, and using modern tools in the class.

Surface area production during grinding
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Minerals Engineering, JUN-JUL, 2009, Vol. 22, pp. 587-592.

During grinding, in cascading mills, the mass distribution of the material moves continuously to finer sizes. Grinding models are usually designed to predict the size distribution of the mill products either as a function of effective breakage events and the time or the energy consumed by the mill. Mill products are always tested for their size analysis and their fineness is usually expressed as the size d through which a certain amount of material passes, i.e. d(80). However, particulate materials have some supplementary properties that a grinding model should predict as well. The specific surface area is such an important supplementary property. Initially, the present work examines the relationship between mass distribution and the surface area of ground materials and determines the conditions under which, mass distribution can be used to determine the surface area. Based on these findings the work further examines the operating conditions of a cascading mill under which the surface area of the material increases at the highest rate. The operating parameter examined is the mill load ratio expressed as the mass ratio of mill grinding media and the material present in the mill. (C) 2008 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2008.12.001

Mineralogy and geochemistry of banded iron formation and iron ores from eastern India with implications on their genesis.
Roy, Subrata and Venkatesh, A S (2009)
Journal of Earth System Science, 118 (6). pp. 619-641.

The geological complexities of banded iron formation (BIF) and associated iron ores of Jilling-Langalata iron ore deposits, Singhbhum-North Orissa Craton, belonging to Iron Ore Group (IOG) eastern India have been studied in detail along with the geochemical evaluation of different iron ores. The geochemical and mineralogical characterization suggests that the massive, hard laminated, soft laminated ore and blue dust had a genetic lineage from BIFs aided with certain input from hydrothermal activity. The PAAS normalized REE pattern of Jilling BIF striking positive Eu anomaly, resembling those of modern hydrothermal solutions from mid-oceanic ridge (MOR). Major part of the iron could have been added to the bottom sea water by hydrothermal solutions derived from hydrothermally active anoxic marine environments. The ubiquitous presence of intercalated tuffaceous shales indicates the volcanic signature in BIF. Mineralogical studies reveal that magnetite was the principal iron oxide mineral, whose depositional history is preserved in BHJ, where it remains in the form of martite and the platy hematite is mainly the product of martite. The different types of iron ores are intricately related with the BHJ. Removal of silica from BIF and successive precipitation of iron by hydrothermal fluids of possible meteoric origin resulted in the formation of martite-goethite ore. The hard laminated ore has been formed in the second phase of supergene processes, where the deep burial upgrades the hydrous iron oxides to hematite. The massive ore is syngenetic in origin with BHJ. Soft laminated ores and biscuity ores were formed where further precipitation of iron was partial or absent.
http://eprints.nmlindia.org/828/

Special issue: Comminution Foreword
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Minerals Engineering, JUN-JUL, 2009, Vol. 22, pp. 575-575.
10.1016/j.mineng.2009.04.006

Strategies for processing low-grade iron ore minerals
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Mineral Processing And Extractive Metallurgy Review, 2009, Vol. 30(4), pp. 361-371.

The conventional routes for making iron and steel require that the ore be upgraded through a series of physical separation processes in sequence. The unit operations involved include crushing, grinding, separation, dewatering, pelletization, blast furnace processing, and basic oxygen furnace processing. This complex sequence is not cost effective for many low-grade ores that are resistant to physical concentration. For example, many ores contain iron oxide in a nonmagnetic form and are so fine-grained that it is uneconomical to grind them to a fine enough size to separate the iron oxides from the gangue. Exploitation of these iron minerals needs to take a different approach, using fewer process steps than are required for

conventional ironmaking. Results are presented showing that it is possible to produce metallic iron directly from low-grade ores. The metal is in a form that can be easily separated to produce a high-grade iron product, and the iron recovery is greater than can be achieved from difficult-to-process ores by conventional means.
10.1080/08827500903185208

On the potential of biological treatment for arsenic contaminated soils and groundwater

Wang, SL; Zhao, XY
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Journal Of Environmental Management, JUN, 2009, Vol. 90(8), pp. 2367-2376.

Bioremediation of arsenic contaminated soils and groundwater shows a great potential for future development due to its environmental compatibility and possible cost-effectiveness. It relies on microbial activity to remove, mobilize, and contain arsenic through sorption, biomethylation-demethylation, complexation, coprecipitation, and oxidation-reduction processes. This paper gives an evaluation on the feasibility of using biological methods for the remediation of arsenic contaminated soils and groundwater. Ex-situ bioleaching can effectively remove bulk arsenic from contaminated soils. Biostimulation such as addition of carbon sources and mineral nutrients can be applied to promote the leaching rate. Biosorption can be used either ex-situ or in-situ to remove arsenic from groundwater by sorption to biomass and/or coprecipitation with biogenic solids or sulfides. Introduction of proper biosorbents or microorganisms to produce active biosorbents in-situ is the key to the success of this method. Phytoremediation depends on arsenic-hyperaccumulating plants to remove arsenic from soils and shallow groundwater by translocating it into plant tissues. Engineering generic strategies can be employed to increase the arsenic-hyperaccumulating capacity of the plants. Biovolatilization may be developed potentially as an ex-situ treatment technology. Further efforts are needed to focus on increasing the volatilization rate and the post-treatment of volatilization products. (C) 2009 Elsevier Ltd. All rights reserved.
10.1016/j.jenvman.2009.02.001

Modeling the contribution of specific grinding pressure for the calculation of HPGR product size distribution

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Minerals Engineering, JUN-JUL, 2009, Vol. 22, pp. 642-649.

Vale, one of the largest mining companies in the world, has prioritized the development of HPGR technology for practical application in its current projects. An existing model for the HPGR, capable of predicting product size distributions, has been evaluated under distinct grinding conditions for one feed material. The effect of grinding pressure and feed size distribution were investigated. The model

response showed a clear dependency of product size distribution with specific grinding pressure. As a result, specific grinding pressure was incorporated into the model. allowing for predicting product size distribution at practical values of this important process parameter. Based on this result, a characterization procedure was envisaged so as to produce parameters for the model. The procedure does not require complex experimental procedures, and all of the testing can be carried out in an expedited form in an instrumented bench-scale HPGR, using small samples of about 10 kg. The only analyses required are size distributions. The model was implemented in the Modsim (TM) plant-wide simulator, with facilities to predict product size distribution for any roll diameter, length and speed of an HPGR machine. (C) 2009 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2009.03.006

Development of a rapid particle breakage characterisation device - The JKRBT

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Minerals Engineering, 5th MEI Conference on Communication, 2008, Cornwall, ENGLAND, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, JUN-JUL, 2009, Vol. 22, pp. 602-612.

Ore breakage characterisation plays an essential role in the design and optimization of comminution circuits. Recently, the JKMRC comminution research team has developed a Rotary Breakage Tester (JKRBT) for rapid particle breakage characterisation tests. The JKRBT uses a rotor-stator impacting system, in which particles gain a controlled kinetic energy while they are spun in the rotor and are then ejected and impacted against the stator, causing particle breakage. The first industrialised JKRBT was installed at Anglo Research in Johannesburg in March 2007, and six more JKRBTs were deployed in 2008 around the world. This paper discusses the major design and calibration issues encountered in the JKRBT development and findings from detailed experimental studies. (C) 2009 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2009.05.001

The release of mineral matter and associated phosphorus as a function of the particle size coal

Claassens, V.
International Journal Of Coal Preparation And Utilization, Vol. 29(3), MAY-JUN 2009, pp. 99-111

The presence of phosphorus in carbon reductants is a major concern in the metallurgical industry. The behavior of the phosphorus and mineral matter content (reported as ash) as a function of particle size was investigated. The primary aim of this study was to determine the reduction in phosphorus and mineral matter that occurred as the particle size decreased. A secondary aim was to determine how the

phosphorus was distributed in the feed coal and to where it reported during floc-flotation. Results showed that the ash content decreased more rapidly than the phosphorus content as the mean particle size was reduced. It remains unclear why P-rejection is only half as effective as mineral matter rejection. Detailed liberation analysis of P-containing minerals is required to possibly explain this phenomenon.
10.1080/19392690902936370

Dense medium cyclone control - a reconsideration

Firth, B. A.

International Journal Of Coal Preparation And Utilization, Vol. 29(3), MAY-JUN 2009, pp. 112-129

The current process management and control of dense medium cyclones is based on the measurement of feed medium density and pressure. This paper considers the relationships between the controlling factors and the relative density of separation and Ep. These relationships have been developed from the analysis of over 20 data sets on modern large cyclones in which important factors such as overflow and underflow densities, feed solids flow rate, medium to coal ratio, and loading to the spigot were recorded. 10.1080/19392690902936388

Applying grindcurves to mill operation and optimisation

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Minerals Engineering, 5th MEI Conference on Communication, 2008, Cornwall, ENGLAND, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, JUN-JUL, 2009, Vol. 22, pp. 625-632.

The operation of AG/SAG mills is sensitive to mill filling, therefore developing grindcurves to relate mill filling to performance indicators such as throughput, power draw, and product size can assist in achieving optimal mill operations. The throughput, power draw, and product size have been shown to peak at different mill filling levels. Establishing grindcurves can assist operators to decide on the best set point for operating their mill. Factors such as mill speed, mill inlet water, feed size distribution, and ore hardness all have an influence on the grindcurve, and form an integral part of the optimisation process. Test work has been conducted at a number of sites to develop grindcurves for different mills treating a range of ores. The results show great promise for use in optimising the operating set points for use in mill control. The methodology for developing grindcurves is described and the results from the case studies performed on fixed and variable speed mills are discussed. (C) 2009 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2009.01.008

A more sustainable approach to assessing Comminution efficiency

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Minerals Engineering, JUN-JUL, 2009, Vol. 22, pp. 593-601

The Bond operating work index is in common use for assessment of Comminution efficiency. This method was developed for rod and grinding ball mill circuits and is not well suited to AG/SAG mills or the wide range of Comminution devices now in common use. Traditional measures of efficiency only consider the net motor power of the drive unit. However, ancillary processes such as materials handling and classification can consume a substantial fraction of motor power. Wear resistant liners and grinding media are also consumed by the Comminution process. These consumables themselves require substantial energy to mine, refine and to manufacture. This embedded (or indirect) energy can be of similar order to motor power. This paper outlines several ways to estimate of Comminution efficiency. These methods can be applied to a wide range of equipment. The paper also describes how to estimate indirect energy consumption. (C) 2009 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2009.04.004

A theoretical approach to coal flotation washability correlation

Mondal, Kanchan; Mohanty, Manoj K.
International Journal Of Coal Preparation And Utilization, Vol. 29(3), MAY-JUN 2009, pp. 140-151

This research paper presents a theoretical derivation for analyzing and extracting the coal floatability information. The relationship between combustible recovery and ash recovery was derived. The basic assumptions and the theoretical approach based on statistical distributions are discussed. In addition, the significance of various parameters to describe the floatability, cleanability, and performance of a separation device have also been discussed. Potential uses of this approach have been suggested. 10.1080/19392690903035198

Kinetics of coal desulfurization in an oxidative acid media

Davalos, A.; Pecina, E. T.; Soria, M.; Carrillo, F. R.
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Tests were carried out for determining pyrite dissolution present in carbon in an aqueous media by using sulfuric acid and hydrogen peroxide as oxidant. The main objective is the evaluation of an oxidative treatment in acid media focused on the elimination of pyrite from coal. The influence of several parameters such as temperature, acid, and hydrogen peroxide concentrations were investigated. It was found that the dissolution curves for pyritic sulfur follow the kinetic model of the shrinking core model, with diffusion through the solid product of the reaction as the

controlling stage. Additional tests show the preferential release of iron from pyrite leaving a reacted "polysulfide" or "metal deficient" layer. Results also indicate that, in aqueous solutions of 0.5 M of H(2)SO(4) at 60 degrees C and with an increase in hydrogen peroxide concentration, pyrite dissolution increases around 50%. The results also show the peroxide degradation due to the presence of iron ions and the coal matrix. 10.1080/19392690903035206

Comparison of energy efficiency between ball mills and stirred mills in coarse grinding

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Minerals Engineering, 5th MEI Conference on Communication, 2008, Cornwall, ENGLAND, PERGAMON-ELSEVIER SCIENCE LTD, OXFORD, JUN-JUL, 2009, Vol. 22, pp. 673-680.

Stirred mills are primarily used for fine and ultra-fine grinding. They dominate these grinding applications because greater stress intensity can be delivered in stirred mills and they can achieve better energy efficiency than ball mills in fine and ultra-fine grinding. Investigations were conducted on whether the greater performance of stirred mills over ball mills in fine grinding can be extended to coarse grinding applications. Four different laboratory ball mills and stirred mills have been tested to grind seven ore samples with feed sizes ranging from 3.35 mm to 150 mu m. A case study on full scale operations of a 2.6 MW IsaMill replacing the existing 4 MW regrind ball mill at Kumtor Gold Mine in Kyrgyzstan is also included. This paper Summarizes the major findings from these investigations. (C) 2008 Elsevier Ltd. All rights reserved. 10.1016/j.mineng.2008.12.002

New developments in cone crusher performance optimization

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This paper shall review Metso Minerals' current 3D Discrete Element Method (DEM) modeling techniques, developed to allow a detailed study of the interactions of crushing design variables with actual rock mechanics. A standard DEM approach cannot be applied to systems where size reduction is an important element in the flow of particles, such as industrial crushers. In these systems, it is necessary to physically decrease the particle sizes in a realistic way, as they are transported through the device. Metso Minerals has therefore developed a breakage model that incorporates elements of Population Balance Modeling (PBM) techniques to describe breakage as a function of the loads on the individual rocks. The combination of this breakage model with DEM has therefore allowed the development of a multi physics based comminution model that can be applied to crusher development. This model is sensitive to all aspects of crusher design including crusher machine parameters and the ore characteristics. This physics based virtual comminution model will

enable engineers to optimize the design development of future crushers by allowing a wider range of values for the crusher variables to be investigated in a rapid, yet more detailed manner, without the need for the traditional expensive and lengthy prototype testing. (C) 2009 Elsevier Ltd. All rights reserved.
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Optimization of comminution circuit simulations based on genetic algorithms search method

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Comminution simulators are extensively used by mineral processing engineers for plant design and optimization purposes. Recently, there had been a great progress in developing new and more powerful optimization methods such as Genetic Algorithms (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Tabu Search Algorithm (TSA). Simulation optimization is required if one wants to find the best steady-state values of important process variables. In this paper, the authors investigated the integration of GA optimization algorithm with a pre-existing grinding circuit simulator called Ball Milling Circuits Simulator (BMCS) in MATLAB (TM) environment. The BMCS code has been written in ANSI C language and has been validated against real industrial grinding circuit data sets. Various C modules of the BMCS grinding software were restructured under a new single source code file so that it can be imported into MATIAB. Then, a number of input simulation data were identified and selected as possible process variables (e.g., solids flow rate, water addition rate, and number of operating cyclones) which Must be optimized in order to achieve a pre-defined process objective (e.g., a specific d(80) of circuit output). The obtained results show that BMCS simulation trials can be successfully optimized by applying evolutionary algorithms via MATLAB toolboxes. This allows the mineral processor to perform automatic repetitive simulations to find the possible solutions of the problem at hand quickly. (C) 2009 Elsevier Ltd. All rights reserved.
10.1016/j.mineng.2009.02.009

Beneficiation of siliceous limestone sample.

Rao, D S and Bhaskar Raju, G and Prabhakar, S and Vijaya Kumar, T V (2009)
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Mineral Processing, 50 (6). pp. 36-47.

White colored low grade siliceous limestone sample containing 45.10 % CaO and 15.60 % SiO2 from the Jayantipuram mine of Andhra Pradesh/India has been investigated for amenability to beneficiation by flotation. The limestone sample was crystalline and consisted mainly of calcite and quartz. Direct flotation experiments were carried out using sodium silicate and sodium oleate as depressant and collector respectively. The reverse flotation process was used where in the gangue

minerals containing silica (quartz) are floated using a cationic collector SOMU Sokem 565C. The results are highly encouraging in enhancing the CaO and reducing the SiO2 content in the limestone and thus to make it suitable for cement manufacture.
http://eprints.nmlindia.org/4024/

Energetics of mechanical activation – Application to ilmenite.

Sasikumar, C and Mukhopadhyay, N K and Mehrotra, S P (2009)
Minerals Engineering, 22 (6). pp. 572-574.

An attempt is made to measure the energy stored in the material during mechanical activation and its manifestation in various forms (defects, new surfaces and interfaces, strain and structural disorder) through direct energy measurements, calorimetry, surface area and surface energy measurements. The elastic strain, grain size and extent of amorphisation is estimated from XRD analysis. The strain energy is calculated using the theory of elasticity and the amorphisation energy from thermodynamic calculations. For ilmenite, the energy transferred to the material is about 6% of the specific energy consumption in 4 h of planetary milling. A major part of the energy is stored as elastic strain energy, structural disorder and in point and line defects whereas the energy stored in additional surfaces and grain boundaries are comparatively much lower.
http://eprints.nmlindia.org/123/

Mineralogy and geochemistry of banded iron formation and iron ores from eastern India with implications on their genesis.

Roy, Subrata and Venkatesh, A S (2009)
Journal of Earth System Science, 118 (6). pp. 619-641.

The geological complexities of banded iron formation (BIF) and associated iron ores of Jilling-Langalata iron ore deposits, Singhbhum-North Orissa Craton, belonging to Iron Ore Group (IOG) eastern India have been studied in detail along with the geochemical evaluation of different iron ores. The geochemical and mineralogical characterization suggests that the massive, hard laminated, soft laminated ore and blue dust had a genetic lineage from BIFs aided with certain input from hydrothermal activity. The PAAS normalized REE pattern of Jilling BIF striking positive Eu anomaly, resembling those of modern hydrothermal solutions from mid-oceanic ridge (MOR). Major part of the iron could have been added to the bottom sea water by hydrothermal solutions derived from hydrothermally active anoxic marine environments. The ubiquitous presence of intercalated tuffaceous shales indicates the volcanic signature in BIF. Mineralogical studies reveal that magnetite was the principal iron oxide mineral, whose depositional history is preserved in BHJ, where it remains in the form of martite and the platy hematite is mainly the product of martite. The different types of iron ores are intricately related with the BHJ. Removal of silica from BIF and successive precipitation of iron by hydrothermal fluids of possible meteoric origin resulted in the formation of martite-goethite ore.

The hard laminated ore has been formed in the second phase of supergene processes, where the deep burial upgrades the hydrous iron oxides to hematite. The massive ore is syngenetic in origin with BHJ. Soft laminated ores and biscuity ores were formed where further precipitation of iron was partial or absent.
http://eprints.nmlindia.org/828/