

PRELIMINARY PROGRAM

---Monday, October 4, 2010---

08:30

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: Rheology of Flotation Pulp & Rheological Characterization and Measurement I (MONAM1)

Paper Start Time: 08:30

Paper No.: 5643

Paper Title: **KEYNOTE: Rheology and the Resource Industries**

David Boger; University of Melbourne;

The world's resource industries, which include minerals, coal, and the sand mining of oil, are the world's largest producers of waste. Much of this waste is produced as a fine particle suspension which is pumped to a storage area generally at a low concentration where it behaves like a Newtonian fluid. Simply by removing water from the suspension and reusing and recycling water represents a step towards a more sustainable practice in this industry. As the concentration of such a suspension is increased as a result of dewatering, the materials exhibit non-Newtonian behaviour, characterized by shear thinning, a yield stress, and in some instances, by thixotropic behaviour. Such high concentration, non-ideal (dirty) suspensions in the resource industries has meant that new rheological methods and techniques were needed for both shear and compression rheology to measure and interpret the basic flow properties. Also, some older empirical techniques needed to be modified and interpreted in a more fundamental way so that the results could be used in design. The paper reviews these techniques and illustrates how the industry itself has motivated their development. Understanding and exploiting this rheology has resulted in dramatic improvement in the waste disposal strategy for some industries, but many have failed to embrace the available technology. Why? Is regulation the answer? Probably not. The paper concludes that a greater positive change in the waste management practice will occur in the future, motivated by a number of factors, including public perception and perhaps even by common sense accounting. The paper is an overview of thirty years of work with the resource industries on environmental waste minimisation. Aspects have been published in the Proceedings of Paste and Thickened Tailings Conferences held annually since 1999.

Paper Start Time: 09:20

Paper No.: 5429

Paper Title: **Pulp Rheology in the Flotation of Serpentinised Ultramafic Nickel Sulfide and its Effect on Flotation**

Janusz Laskowski; University of British Columbia; Isil Kilickaplan, University of British Columbia; Ayse Merve Genc, University of British Columbia;

In this paper, a correlation between the rheological properties of flotation pulp and the flotation response was investigated through a series of rheological and batch flotation tests. The flotation tests which have been carried out with very finely ground serpentinised ultramafic nickel sulfide ore confirmed that the flotation performance of this particular ore strongly depends on the pulp density. As rheological measurements revealed the viscosity/yield stress of the studied pulps, the system that contains needle-like particles, at solids contents of 15-20% is prohibitively high. This high solids content affects the flotation process: concentrate yield increases and concentrate grade dramatically declines with increasing pulp density. The observed boiling in the flotation tests at a high pulp density (15-20%) is likely the result of a high viscosity. The concentrate grades consistently decreases at the Casson yield stress higher than 2 Pa.

Paper Start Time: 09:45

Paper No.: 5528

Paper Title: **Effect of Altered Silicates on Metallurgical Performance - Part 1: Studies on the role of pulp rheology.**

Mukund Vasudevan; Cytec Industries Inc.; D.R. Nagaraj, Cytec Industries, Inc.; Partha Patra, Columbia University; Ponisseril Somasundaran, Columbia University;

In the processing of sulfide ores, the selective value mineral separation is significantly affected due to the presence of altered silicates, notably serpentines. These complex Mg silicates hinder the metallurgical performance through several pathways because they exhibit varied morphology and surface chemistry. One prominent pathway is mediated through rheological changes to the pulp and/or froth phase due to network formation, which, in the extreme case, can render the ore unprocessable. Currently, there is no robust method to quantify such changes to pulp/froth rheology since these mineral pulps are rapidly settling non-homogenous suspensions. In this paper, an attempt is made to address this challenge and to understand the physical and chemical contributions to pulp rheology and consequently metallurgical performance.

10:30

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: Rheology of Flotation Pulp & Rheological Characterization and Measurement I (MONAM2)

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Paper Start Time: 10:30

Paper No.: 5466

Paper Title: Effect of Altered Silicates on Metallurgical Performance: Part II - Development of Robust Solutions to Address Problems Attributed to Pulp Rheology

Tarun Bhambhani, Cytec Industries; D.R. Nagaraj, Cytec Industries; Puspendu Deo, Cytec Industries;

Analysis of existing literature on sulfide mineral flotation reveals excessive, unwarranted importance to value minerals and collector-value mineral interactions. The lack of focus on problematic gangue minerals and their effect on pulp chemistry and near disregard of the complex interactions between the various physical and chemical factors affecting flotation has culminated in a very rudimentary understanding of the problems manifested through slurry rheology. Very few solutions are available, most of which are either highly ore-specific or uneconomical. A critical analysis of the efficacy of available solutions to the problems associated with pulp rheology is presented. The benefits reaped from the use of potential (and existing) non-chemical (e.g. dilution) as well as chemical (modifiers) solutions are discussed, along with the associated technological challenges and economic constraints. A much-needed rational, scientific approach for the development of robust chemical solutions to address the problems manifested through slurry rheology is presented. This includes novel experiments that can a) determine the feasibility of physical or chemical solutions for a given ore system b) disambiguate the physical and chemical effects of a given solution. Finally, a discussion on the development of new synthetic polymeric modifiers that explicitly target problematic mineral species and mitigate their deleterious effects on slurry rheology is included.

Paper Start Time: 10:55

Paper No.: 5118

Paper Title: The Use of Slurry Rheology Measurements in Mineral Processing

Caroline Boudrias-Chapleau, COREM; Denis Cotnoir, COREM; Claude Bazin, Laval University;

The rheological properties of mineral slurry have been recognised for several decades as having a significant influence on the operation of grinding mills. This paper describes an instrument used to measure and monitor the flow properties of mineral slurries in a laboratory or a plant. Laboratory results obtained using an iron oxide concentrate were consistent with results obtained during a full scale trial. The results provided a basis for analysing the effect of the solids concentration and particle size distribution on the operation of spiral concentrators through the slurry rheological properties.

Paper Start Time: 11:20

Paper No.: 5418

Paper Title: The Compressional Rheology of Flocculated Suspensions: Understanding and Optimizing Sedimentation, Thickening and Filtration

Peter Scales, School of Engineering; Shane Usher, University of Melbourne; Ross deKretser, University of Melbourne;

The optimization of solid-liquid separation processes is made difficult by the fact that whilst models using laboratory based parameter inputs are predictive of processes such as thickening for coarse particulates, this is usually not the case as the particles become finer. For fine particulates, it is common to add flocculants to create aggregates so as to produce faster settling suspensions. Measurement of the compressional rheology of these suspensions, along with robust phenomenological models, allows us to be quantitative in our understanding of the impediments to the prediction and optimization of full scale processes.

Paper Start Time: 11:45

Paper No.: 5719

Paper Title: Viscosity Effects on Bubble Shape and Terminal Velocity

Cesar O. Gomez, McGill University; Miguel Maldonado, McGill University; James A. Finch, McGill University; Rodrigo Araya, McGill University;

Three parameters are generally used to describe gas dispersion in a flotation machine: superficial gas (air) velocity, gas holdup and bubble size. Techniques and sensors to measure local values of these parameters in industrial flotation machines have been developed. Models proposed to predict one of these gas dispersion parameters from measured values of the other two have proven unreliable. Bubble terminal velocity is an important variable in these models its calculation being the initial step in the determination of the bubble swarm velocity. Numerous equations have been proposed to calculate bubble terminal velocity and their testing is the objective of this work. Measurements using a high speed camera have demonstrated that bubble shape and velocity are interrelated, and that bubble shape is affected by water viscosity and by the frother type and concentration in use. By adding a polymer to vary water viscosity, to produce changes in shape and velocity of single bubbles generated by controlled injection of air through a capillary, equations for bubble terminal velocity are being tested. The results demonstrated that only equations considering parameters describing bubble shape are able to predict terminal velocity with reasonable accuracy.

14:00

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

PRELIMINARY PROGRAM

Session: Rheology of Flotation Pulp & Rheological Characterization and Measurement II (MONPM1)

Paper Start Time: 14:00

Paper No.: 5427

Paper Title: **Power Draw Measurements as a Research Tool in Studying Flotation of the Nickel Sulfide Ore with Fibrous Gangue**

Janusz Laskowski; University of British Columbia; Ayse Merve Genc, University of British Columbia;

Power consumption of impeller is the amount of power required to rotate an impeller at a given speed in a tank having specific configurations and containing a fluid of certain physical properties. It is therefore obvious that power draw during conditioning stage must depend on pulp viscosity. Conventionally, pulp viscosity can be determined by rheological methods that are carried out on pulp samples which are withdrawn from the cell. The continuous sampling of the mineral slurry during experiments affects the hydrodynamic conditions in the conditioning tank whereas power draw measurements offer an on-line characterization of pulp viscosity without causing any disturbance to the system. The experiments described in this paper were carried out with a finely ground serpentinised ultramafic nickel sulfide ore from Australia. The power draw measurements confirmed a good correlation with the pulp rheology which had been studied using conventional techniques. The measurements which were designed to characterize particle agglomeration were not sensitive enough due to the dominating effect of the large amounts of fibrous gangue (chrysotile) minerals present in the ore. While this technique was not sufficiently sensitive to detect particle aggregation, it was found to be useful in optimizing the conditions of the agglomerate flotation of the studied nickel sulfide ore.

Paper Start Time: 14:25

Paper No.: 5438

Paper Title: **Rheology and Processing of Ni Based Nano-composite Pastes for Electronic Assembly**

Rajkumar Durairaj; Universiti Tunku Abdul Rahman; Mee Chu Wong, Universiti Tunku Abdul Rahman; Chee Leong Kau, Universiti Tunku Abdul Rahman; Chia Wea Lim, Universiti Tunku Abdul Rahman; Sabuj Mallik, University of Greenwich; N.N. Ekere, University of Greenwich;

The proper characterization of this time-dependent rheological behavior of solder pastes is crucial for establishing the relationships between the pastes structure and flow behavior. The study investigates the effect of nickel additional to the time-dependent rheological behaviour of lead-free Sn/Ag/Cu solder pastes using the structural kinetic model. A hysteresis loop test and constant shear test is utilized to investigate the thixotropic behaviour of the pastes using parallel plate rheometry. From this investigation, hysteresis loop test was shown to be an effective test method to differentiate the extent of structural recovery in the nano-composite solder pastes.

Paper Start Time: 14:50

Paper No.: 5454

Paper Title: **Yield Stress Determination From Slump Tests**

Donald Hallborn; Pipesys;

The slump test is a standard test for the flowability of concrete and other thick slurries, such as backfill paste. The only equipment required is a standard open ended container (e.g., a - 300 mm ASTM slump cone), a tamping rod, a ruler, and a floor. The test procedure is simple: the container is placed on the floor, filled with paste, tamped to remove any air bubbles, and then the container is removed. The distance that the top surface of the unsupported paste falls is measured and the resulting measurement is its slump. It is easy to understand why the slump test is by far the most widely used quantitative rheological test: it is quick, easy, and cheap. It is the presence of a yield stress that prevents the complete collapse of the paste in the slump test and it is clear that as the yield stress increases, the slump decreases. The yield stress is also the dominant rheological parameter when designing paste backfill systems (e.g., determining pressure loss in pipelines). Not surprisingly, the slump test has been adapted to the yield stress values found in pastes and the smaller sample quantities appropriate for laboratory work. Several correlations between slump test results and the yield stress determined using other more complicated methods have been proposed, but each has been found to have deficiencies when applied to a range of pastes. This paper presents a new slump-yield stress correlation for mineral pastes based on extrusion mechanics. The results are shown to be a significant improvement on existing correlations and the results are adequate for most engineering purposes.

15:35

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: Rheology of Flotation Pulp & Rheological Characterization and Measurement II (MONPM2)

Paper Start Time: 15:35

Paper No.: 5455

Paper Title: **Engineering Equations for the Pipe Flow of Casson Fluids**

Donald Hallborn; Pipesys;

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The shear thinning flow behaviour of many fine suspensions can be described using the Casson rheological model. The two-parameter Casson model is relatively simple and has parameters that can be related to reasonable physical properties: the yield stress and the limiting high shear rate viscosity. The model parameters are easily determined from rheometer data and have rational units (Pa and Pa·s). Despite these advantages, the Casson model is rarely used by hydraulics engineers designing slurry pipelines. Instead the Casson-like rheometer data is usually forced to fit either the Newtonian or Bingham models and the head loss gradient determined using that model is then corrected based on experience of what is observed in the field. The reason for this forcing and correcting is quite simple: straight forward engineering equations for pipeline hydraulics (i.e., ones for laminar and turbulent flow head losses and transition velocity) are available for Newtonian and Bingham fluids, but not for Casson fluids. This paper presents the pipeline engineering equations for Casson fluids.

Paper Start Time: 16:00

Paper No.: 5134

Paper Title: **A Study of the Production Conditions and the Fluidity of Milk of Lime (Calcium Hydroxide-water Slurry)**

Takashi Saeki; Yamaguchi University; Kenji Imai, Yamaguchi University; Masahiro Honda, Tokuyama Corporation; Yukihiro Miyamoto, Tokuyama Corporation; Shinpei Akiyama, Tokuyama Corporation;

Milk of lime samples, which are a mixture of water and slaked lime (Ca(OH)₂), made from Ohita limestone were produced under varying temperature and time conditions. Some of the chemical analyses and scanning electron microscope observations were also conducted in order to explain the differences in the rheological properties of the samples. It was found that the surface characteristics of the quick lime might have been related to the reactivity with water, and also related to the viscosity of the obtained milk of the lime.

Paper Start Time: 16:25

Paper No.: 5432

Paper Title: **Vane and Slump Tests as Tools for Characterizing the Rheology of Oil Sand Slurries**

Marek Pawlik; University of British Columbia; Leopoldo Gutierrez, ;

In an attempt to find correlations between the rheological properties of oil sand ores and the bulk properties of the ores (bitumen content, fines content, etc.), seven different ores were tested using the vane and slump techniques for yield stress measurements. Vane tests were conducted in a Haake Rotovisco VT550 rotational viscometer, connected to vanes of different lengths, and slump tests were performed by using a plastic cylinder of known dimensions. It was found that the vane yield stress increased as the amount of the < 3-micron size fraction increased in the tested ores. At the same time, the measured yield stresses decreased with the bitumen content in the same ores. A very good correlation was observed between the vane yield stress and the ratio of the ultra-fines content (< 3 µm) to the bitumen content. Experiments performed on slurries at 70 wt% solid content showed that the yield stress values obtained from the slump and vane techniques agreed very well.

---Tuesday October 5, 2010---

08:30

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: Rheology of Mineral Suspensions (TUESAM1)

Paper Start Time: 08:30

Paper No.: 5431

Paper Title: **KEYNOTE: Rheological Properties of Aqueous Suspensions of Anisotropic Minerals**

Janusz Laskowski; University of British Columbia;

Anisotropic minerals are important constituents of many ores. This group includes both valuable minerals (e.g. molybdenite in Cu-Mo ores) as well as gangue minerals (e.g. talc in platinum bearing sulfide ores in South Africa, graphite in Cu-Ni sulfide ores in Canada, chrysotile in Ni sulfide ores in Australia, clay minerals in all types of ores, etc.). While clays on one side, and molybdenite, graphite and talc on the other, are very different what they have in common is a sheet-structure (which is also referred to as laminar crystal structure). Because of this structure the topochemistry of the exposed planes (faces and edges) differ quite significantly. Clays are the best known examples of anisotropic minerals. Aqueous suspensions of anisotropic minerals exhibit quite different properties from the properties of the suspensions of isotropic minerals, and rheological measurements became a very important tool in studying properties of the anisotropic minerals. The examples explored in this paper will also include aqueous suspensions of talc and chrysotile.

Paper Start Time: 09:20

Paper No.: 5433

Paper Title: **Further Analysis of the Rheological Behavior of Kaolinite Suspensions**

Jan D. Miller; Dept of Metallurgical Engrg, University of Utah;

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The rheological properties of concentrated suspension of clay minerals such as kaolinite are very important in ceramics, in paper and pulp, in drilling mud, in filtration, in dewatering, and in many other new applications such clay-polymer nano composites etc. A few studies have shown that the rheological properties of kaolinite suspensions are characterized by a maximum shear-yield stress at pH of 5-5.5 (Street, 1956; Rand and Melton, 1976; Johnson et al., 1998, 2000). Such a maximum might be expected at its iso-electric point of pH < 3 (Sondi et al., 1997; Johnson et al., 1998, 2000; Chassagne et al., 2009; this study). This interesting behavior of anisotropic kaolinite particles is not yet completely understood. Several mechanisms on the state of aggregation of kaolinite particles have been proposed based on the commonly accepted notion that the basal planes of kaolinite carry a permanent negative charge due to isomorphous substitution of Al³⁺ for Si⁴⁺ in the silica tetrahedral, and Mg²⁺ for Al³⁺ in the alumina octahedral layer, whereas the edge surface carries a positive or negative charge depending on the pH of the system (Schofield and Samson, 1954; Street, 1956; Rand and Melton, 1976; Johnson et al., 1998, 2000). On this basis aggregation of kaolinite particles is explained by edge-face attractions, and some face-face attractions justifying the maximum shear-yield stress at pH 5.5. However, the assumption that both the basal planes carry a fixed negative charge has only recently been examined experimentally. Now, surface force measurements have been reported by Gupta and Miller (2010) using atomic force microscopy (AFM) to investigate the basal planes of kaolinite particles (silica tetrahedral face and alumina octahedral face). These colloidal force measurements reveal that the silica tetrahedral face of kaolinite is negatively charged at pH > 4, whereas the alumina octahedral face of kaolinite is positively charged at pH < 6, and negatively charged at pH > 8. Such measurements have not been reported previously and the results suggest that the iso-electric point of the silica tetrahedral face is at pH < 4, and that the iso-electric point of the alumina octahedral face lies between pH 6 and 8. These results contradict the generally accepted view that basal plane surfaces of kaolinite carry a permanent negative charge due to minor substitution suggesting some surface charge dependency of the two faces with respect to solution pH. With this new information the rheological properties of kaolinite suspensions are discussed and the maximum shear-yield stress pH is explained.

Paper Start Time: 09:45

Paper No.: 5456

Paper Title: **Testing Kaolinite-Bitumen Interactions Through Rheological Measurements**

Marek Pawlik; University of British Columbia;

The rheology of artificial mixtures of bitumen with fine kaolinite and alumina of varying bitumen content, was investigated under different physicochemical conditions (pH, temperature) in an attempt to the behavior of the silica-like faces and alumina-like edges of the kaolinite particles in the presence of bitumen. All rheological measurements were conducted using a Haake Rotovisco VT550 rotational viscometer, connected to a fixture specifically designed to measure properties of settling suspensions. The results obtained from rheological experiments performed on these slurries at pH values between 4 and 10 and temperatures of 25 and 50 °C showed that both types of slurries, kaolinite and alumina, qualitatively exhibited very similar behavior. On the other hand, the rheological results of our earlier studies on quartz-bitumen mixtures did not correlate so well with the kaolinite data. Overall, the data were discussed in terms of mineral-bitumen interactions and the resulting dispersion or aggregation phenomena.

10:30

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: Rheology of Mineral Suspensions (TUESAM2)

Paper Start Time: 10:30

Paper No.: 4954

Paper Title: **Effect of Electrolytes and Montmorillonite Addition on the Viscosity of Kaolinite and Illite Clay Suspensions**

Joe Zhou; Alberta Research Council; Jacob Masliyah, University of Alberta; Luoxiang Wang, University of Alberta; Luoxiang Wang, University of Alberta; Oly Worku, Syncrude Canada Ltd; Zhenghe Xu, University of Alberta;

Viscosity of concentrated kaolinite or illite clay aqueous suspensions in the absence and presence of a small amount of montmorillonite (<1%) was measured. Solids concentrations higher than 38 wt% were used to avoid the solids settling and to increase the sensitivity of suspension viscosity measurements. The results showed a significant increase in viscosity with the addition of as low as 0.25 wt% of montmorillonite. The pH of the suspensions and the concentration of calcium and bicarbonate ions were found to significantly impact the viscosity of the clay suspensions. In addition to illustrating the role of water chemistry in clay gelation, our study demonstrated that viscosity measurement could be a simple, yet sensitive technique for determining the content of smectite clay, such as montmorillonite in a complex mix of various types of clays.

Paper Start Time: 10:55

Paper No.: 5430

Paper Title: **Rheology of the Aqueous Suspensions of Needle-like Mineral Particles**

Janusz Laskowski; University of British Columbia; Isil Kilickaplan, University of British Columbia; Bulelwa Ndlowu, University of British Columbia;

The results of model tests available in literature all indicate that the shape of particles affects very strongly rheology of mineral

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suspensions. In this project, a fibrous mineral, chrysotile, was used to verify such conclusions. The tests were also carried out with the use of serpentinised ultramafic nickel sulfide ore that contains chrysotile. The tests confirmed that the particle shape indeed plays a dominant role and is responsible for a high viscosity of such pulps. The tests also revealed that such aqueous suspensions exhibit tixotropic properties.

Paper Start Time: 11:20

Paper No.: 5646

Paper Title: Rheological Properties of Copper Flotation Tailings in the Presence of a Binding Agent

Maria Holuszko, University of British Columbia; Malgorzata Jaron-Kocot, University of British Columbia; Krystian Kadlewicz, University of British Columbia;

Utilization of flotation tailings as a backfill material for underground mines requires a pipeline system to transport these slurries to the underground mine workings. The rheology of flotation tailing slurries with the addition of various binding agents under different transport conditions becomes an important process variable. The rheology of copper flotation tailings in the presence and absence of cement-based binding agents was studied using two instruments: a rotational rheometer - Rheotest 2, and a capillary viscometer RK 2. The flow curves obtained from these experiments were described using the Oswald de Waele model. An increase in the apparent viscosity of the slurry was directly related to the solids content in the slurry and to the shear history of the slurry, especially under static/rest conditions.

Paper Start Time: 11:45

Paper No.: 5133

Paper Title: Rheology and Gelation Structure of Silica Sol in Sol-gel Transition

Saori Kikuchi, Yamaguchi University; Takashi Saeki, Yamaguchi University; Masahiro Ishida, Yamaguchi University; Kazuaki Tabata, Tokuyama Corporation; Kohzo Ohta, Tokuyama Corporation;

Silica sols were produced continuously by using a newly developed Y-shaped reactor. Diluted sodium silicate and sulfuric acid were forced to collide against each other at the intersection of the reactor. The produced silica sols gradually increase in the viscosity and finally form silica gels, however; the aging characteristics of silica sols have not been well known. In this study, the gelation process of silica sols was considered by dynamic viscoelastic measurements. The onset time of gelling was strongly affected by both the concentration of SiO₂ and the excessive rate of sulfuric acid. Furthermore, we observed directly the gel surface using a scanning probe microscope (SPM). It was found that a larger coalescence of silica particles presented in gels. A simple calculation which simulated the aging characteristic was also conducted.

14:00

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: General I (TUESPM1)

Paper Start Time: 14:00

Paper No.: 5058

Paper Title: Fibrous Minerals in Ultramafic Nickel Sulphide Ores

Manqiu Xu, Vale Inco; Zongfu Dai, Vale Inco; Jie Dong, Vale Inco; Fred Ford, Vale Inco; Andrew Lee, Vale Inco;

As high grade nickel sulphide ores are being depleted and the continuing challenges in economically processing nickel laterite ores, it appears that the future of nickel extraction lies with the low grade ultramafic ores. Low grade ultramafic nickel sulphide ores are widely available in Canada, particularly in the Thompson nickel belt. Most of the deposits are large tonnage and open pitable but with low Ni grade and high MgO contents. The common MgO containing minerals are amphibole, olivine, chlorite, talc and serpentine. While chlorite and talc are naturally floatable, they can be effectively depressed with CMC. The main challenge in processing the low grade ultramafic ores is serpentine which has three polymorphs: chrysotile, lizardite and antigorite. Chrysotile is the most common form of asbestos and this poses a serious health challenge in processing this type of ores due to the hazardous nature of the fibrous minerals. In addition, low grade ultramafic nickel ore may also contain brucite or hydrotalcite which cause slurry viscosity to increase substantially and make grinding and flotation only possible at a very low solids percentage. This paper is to study the nature of these fibrous minerals in the context of flowsheet development to recover nickel sulphide minerals from the low grade ultramafic ores. In particular, the processes of wet desliming by hydrocyclone and dry defibering by air lift are discussed.

Paper Start Time: 14:25

Paper No.: 5645

Paper Title: Effect of Flotation Reagents on Hetero-aggregation of Pentlandite and Serpentine

James A. Finch, McGill University; Mitra Mirnezami, McGill University; Mayeli Alvarez Silve, McGill University;

Particles suspended in solution will tend to coagulate or remain dispersed depending on the particle-particle interaction forces.

Generally well-dispersed slurries have lower viscosities and settle slower than aggregated ones. This paper investigated the effects of

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CMC, pH and xanthate on the aggregation of pentlandite and serpentine. The state of aggregation was examined using light absorption technique. A factorial experimental design 2³ with two central-point repeats was used to determine the most important factors and their interactions. The levels of the variables were CMC, 0 and 50 mg/L; pH, 6 and 10; and xanthate, 0 and 5 mg/L. CMC and the interaction between CMC and pH were the most important factors determining aggregation. Optical microscopy validated the findings.

Paper Start Time: 14:50

Paper No.: 5737

Paper Title: Comparative Study of the Use of HPGR and Conventional Wet and Dry Grinding Methods on the Flotation of Base Metal Sulfides and PGMs

Cyril O'Connor; University of Cape Town; Nicky A. Palm, Anglo Research; Natalie Jean Shackleton, Anglo Research; Vratislav Malysiak, Anglo Research;

High Pressure Grinding Rollers (HPGR) are known to reduce energy consumption and wear costs and improve the throughput in the circuit. It has been suggested that they can also modify the liberation characteristics of the ore. In the present study the effect of using conventional crushing as opposed to HPGR in combination with either dry or wet milling was investigated using, respectively, a base metal sulphide, viz. sphalerite, and platinum group minerals (PGMs), in order to determine whether any of these processes may improve the flotation performance. In the case of sphalerite, irrespective of the crushing procedure (HPGR or conventional), dry milling resulted in the highest grades and recoveries of zinc. On the contrary, in the case of PGMs, a similar treatment produced the worst results and the highest grades and recoveries were obtained for the case of conventional crushing in combination with wet milling. The HPGR showed no advantages in terms of flotation performance and dry milling produced particularly poor flotation results. The results were investigated further by characterizing the surfaces of the feed and product ore particles using techniques such as ToF-SIMS, XPS and MLA. The paper will propose reasons to explain the different flotation behaviour of the two ore types following the various comminution processes.

15:35

Room: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: General I (TUESPM2)

Paper Start Time: 15:35

Paper No.: 5805

Paper Title: Rheological Characterization and Measurement (Title to be confirmed)

Bern Klein; University of British Columbia;

Abstract not available.

Paper Start Time: 16:00

Paper No.: 5507

Paper Title: Impact of Oxidation and Stockpiling Conditions on Flotation Behaviour of Chalcopyrite

Sadan Kelebek; Queen's University;

In general, the oxidation of sulphide minerals is known to have a negative impact on the performance of flotation plants. As part of a larger research program directed to stockpile oxidation of massive sulphides of the Sudbury district, behavior of pentlandite and pyrrhotite have been previously reported. The current paper presents results on behavior of chalcopyrite that co-exists in these ores at roughly the same amount as pentlandite. Effects of slurry characteristics on chalcopyrite flotation in terms of variations in pH, conductivity, flotation rate constants and surface chemical analysis by XPS will be discussed in relation to oxidation.

Paper Start Time: 16:25

Paper No.: 5598

Paper Title: Understanding the Roles of Polyethylene Oxide and Xanthate in Reducing Quartz Gangue Entrainment in Sulfide Ore Flotation

Mohamed Ourriban, COREM; Weikang Liu, University of Alberta; Qi Liu, University of Alberta; Jihua Gong, University of Alberta; Yongjun Peng, University of Queensland; Ahmed Bouajila, COREM;

Photometric dispersion analysis (PDA), scanning electron microscope (SEM) and zeta potential measurements were used to study the roles of polyethylene oxide (PEO) and xanthate in sulfide flotation. When a high molecular weight PEO was added to a sulfide flotation pulp, it flocculated both sulfide and non-sulfide minerals to form large hetero-aggregates. However, with subsequent addition of xanthate, the sulfide mineral particles broke away from the aggregates. This led to the disintegration of the large hetero-aggregates and the formation of smaller and separate homo-aggregates of sulfide and non-sulfide minerals. This process can be utilized to lower the hydraulic entrainment of ultrafine gangue minerals in sulfide ore flotation.

---Wednesday October 6, 2010---

PRELIMINARY PROGRAM

08:30

Room number: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: General II (WEDAM1)

Paper Start Time: 08:30

Paper No.: 5447

Paper Title: Microstructure Analysis of Several Kinds of Common Magnesite

Chunyan Wang, Refractory Institute of Qing Hua Co. Ltd. ; Jian Luan, University of Science and Technology Liaoning; Wang Jiandong, Refractory Institute of Qing Hua Co. Ltd. ; Yang Xiaofeng, Refractory Institute of Qing Hua Co. Ltd. ;

The microstructure of some common magnesite raw material in production was analysed systematically using Quanta Inspect scanning electronic microscope of FEI company. Microstructure characteristics of different kinds of magnesite were summarized from size and distribution of pore, grain size dimension of periclase, distribution of silicate phase and binding state between periclase and periclase. The results show that the macroscopic performance of magnesite depends on its microstructure characteristics.

Paper Start Time: 08:55

Paper No.: 5465

Paper Title: A Geometallurgical Model of the Flotation Rate Constant

Willy Kracht; Universidad de Chile; Constantino J. Suazo, Compañía Minera Doña Inés de Collahuasi SCM; Oscar M. Alruiz, Compañía Minera Doña Inés de Collahuasi SCM;

A geometallurgical model of the flotation rate constant is presented. It is based on the collision-attachment-detachment approach, includes air dispersion properties, and also the complete feed particle size distribution. The model introduces a parameter (?) that represents the inherent floatability of the ore. This parameter is characteristic of the geometallurgical unit, independent of the main operating conditions, and can be estimated either from laboratory testwork or directly from an industrial kinetics survey. The model shows good correlation at both laboratory and industrial scale. This communication includes a simulation at industrial scale using values of ? determined in the laboratory where the model was able to predict metallurgical results in a time frame of several weeks at Compañía Minera Doña Inés de Collahuasi SCM, with an average relative error below 2%.

Paper Start Time: 09:20

Paper No.: 5218

Paper Title: Comparison of Gold Department Study Using QEMSCAN and Tradition Optical Microscopy

Zhijing Wang; SGS Lakefield Research Ltd.;

The main purposes of gold department study are to determine the gold minerals size, species, liberation and association, and the gold bearing minerals liberation and association. QEMScan analysis and tradition optical microscopy method can meet the need. In this paper, The comparison of gold department study results by QEMScan and by tradition optical mineralogy are made and discussed in data collection, data processing, data properties and visualization, and detecting limitation in the investigation of gold minerals and gold bearing minerals. These two methods have their own advantages and can be complementary with each other in gold department study.

Paper Start Time: 09:45

Paper No.: 5474

Paper Title: Feasibility Studies Truths and Half Truths

Damian Connelly; Mineral Engineering Technical Services Pty. Ltd.;

Feasibility Studies are a vital part from resource discovery to a technically viable and profitable operation. The study levels and use on a stage gate process approach are typically Concept, Pre Feasibility, Feasibility and Definitive Studies. Each level must assess all aspects including a Risk Analysis. The Study developed as a result describes a business opportunity and becomes the basis for investment decisions. This paper looks at the history of Feasibility Studies and demonstrates Uses and Abuses of Feasibility Studies. A number of Case histories are discussed and common mistakes as well as lessons learned over the last twenty years are presented. The paper outlines a framework for the conduct of Feasibility Studies and provides guidance to Minimum Standards and best practice.

10:30

Room number: Plaza A (Plaza-2nd Floor)

Stream: MINERAL PROCESSING: RHEOLOGY AND PROCESSING OF FINE PARTICLE SYSTEMS

Session: General II (WEDAM2)

Paper Start Time: 10:30

Paper No.: 5473

Paper Title: The Challenges Ahead For Mineral Processing & Resource Projects

PRELIMINARY PROGRAM

Damian Connelly; Mineral Engineering Technical Services Pty. Ltd.;

Metal prices have declined in real terms and this makes it more difficult over time to bring new projects into production. The Global Financial Crisis (GFC) has had a major impact on the mineral industry with a sharp decline in commodity prices and profitability. Banks are more cautious lending to new resource projects. They also require better researched and optimised projects with more robust economics. There is little doubt some form of carbon tax will be increased and our energy sources will have to change. Carbon Trading will add another \$A0.50 to the cost of processing every tonne of ore. Innovation and the introduction of new technology will be a major challenge required to succeed and overcome some of these issues. Australia's record of technology innovation in the gold industry for example has been brilliant by any standards. Energy is a major cost for processing minerals and the comminution processes we use are inefficient and large consumers of energy. The development of new grinding technologies is long overdue. There will be an increasing trend to hydrometallurgical processing and a decline in pyrometallurgical processes. The tougher environmental constraints being placed on new projects will mean that some projects will not be allowed on environmental grounds. Exploration activities will be curtailed in sensitive areas and even excluded altogether. Water is going to become a scarce resource and access is going to be difficult with an emphasis on conservation and re use. Social and Political issues are impact on new projects like never before. The common cry not in my back yard makes it more difficult to win hearts and minds and gain acceptance for new projects. Mining companies will be called on more and more to provide schools, hospitals and services where governments fail to do so particularly in impoverished areas. Mining projects are only now starting to implement sustainability policies and understand the full impact of such policies. The mining industry could become a global leader in sustainable development. The industry has in the past demonstrated a willingness to better understand and resolve difficult issues at the local level.

Paper Start Time: 10:55

Paper No.: 5289

Paper Title: **Effect of EDTA and Hydrochloric Acid on the Structural Properties and Flotation Behaviour of a Serpentine Rich Ni Ore**

Salah Uddin; McGill University; James Finch, McGill University; Mitra Mirnezami, McGill University;

The Flotation behaviour of a serpentine rich lateritic Ni ore was studied. Conventional flotation techniques give poor separation between sulphides and Mg bearing silicates. One possibility of silicate activation is by metal ions. Chelating agent, EDTA was used to capture the metal ions and flotation response of Ni and Mg was tested. Fibrous serpentine can, also, physically entangle the sulphide particles and thereby entrain to the froth zone. Hydrochloric acid, by dissolving Mg from serpentine, can weaken and disintegrate the fibres. A flotation methodology and different hydrochloric acid concentrations were tested. A significant increase in Ni and decrease in Mg grade/recovery relationship was achieved when 10 wt% and 15 wt% hydrochloric acid concentration was used.

Paper Start Time: 11:20

Paper No.: 5292

Paper Title: **The Effect of Leaching Parameters on Vanadium Recovery from Oil Residue**

Mohammadreza Tavakoli Khaledi; Sharif University of Technology; Hossein Yoozbashizadeh, Sharif University of Technology; Mohammad Halali, Sharif University of Technology;

Fuel oil residues may contain 2.5 - 20 weight percent vanadium as oxides. In the present work, boiler ash from Besat power station, Tehran, Iran, was initially roasted with sodium carbonate and sodium chloride and the resulting material was leached in H₂SO₄ and NaOH. Effect of process parameters such as salt concentration, temperature, time, pH and weight ratio on the recovery of vanadium was studied with the view to optimizing the process. It was found that the optimum roasting efficiency for vanadium recovery occurred with 40%wt Na₂CO₃ additive at 800°C and 1 hour. It was also observed that at temperatures higher than 70°C both acidic leaching and basic leaching resulted in vanadium recoveries in excess of 80%.

Paper Start Time: 11:45

Paper No.: 5343

Paper Title: **Cold Briquetting of Sponge Iron (CBSI)**

Mohammadreza Tavakoli Khaledi; Sharif University of Technology; Masoud Askari, Sharif University of Technology; Mehdy Farahni, Mipecc Company; Ali Shahahmadi, Tadbir Sanat Asia Company;

Due to the different production cycles of ironmaking and steelmaking plants, sponge iron composition can be changed because of re-oxidation and corrosion while it has been waited to be charged in steelmaking furnace. Therefore, the process efficiency decreases and energy consumption increases. There is no suitable technique available in existing plants to prevent reoxidation of the pellets, so it was tried to develop a new method in order to protect sponge iron. In this study, the possibility of cold briquetting of the pellets as a new method was investigated at two levels, laboratory as well as pilot tests. In the laboratory experiments (in Iran), some important factors such as pressing pressure, the presence of sponge iron fines and percentage of the binder were examined. At the second step (in France), based upon the optimum results obtained in laboratory tests, the feasibility of cold briquetting of sponge iron in the pilot plant level has been tested. Satisfactory results revealed that the presented method was a good solution to overcome DRI reoxidation problem in the existing plants.