MONDAY, AUGUST 23, 2004, P.M.

SESSION 10: FIFTH UBC-MCGILL INTERNATIONAL SYMPOSIUM ON PARTICLE SIZE ENLARGEMENT IN MINERAL PROCESSING

INTRODUCTORY LECTURES
Sponsor: Mineral Science and Engineering Section, The Metallurgical Society of CIM
Room: Chedoke C
Chairmen: D.W. FUERSTENAU, University of California, Berkeley, California, U.S.A., and J.S. LASKOWSKI, University of British Columbia, Vancouver, British Columbia, Canada

PAPER 10.1 — 14:00

SIZE ENLARGEMENT BY AGGLOMERATION IN MINERAL PROCESSING.

W. PIETSCH, Compactconsult Inc., Naples, Florida, U.S.A.

For a number of reasons, solids entering and leaving facilities for the treatment of minerals are becoming increasingly finer. Such materials pose problems throughout processing. Solids featuring small particle sizes tend to dusting, result in losses and segregation, exhibit various storage, transportation, and metering problems, and fine particulate effluents can not be easily captured, used and/or recycled.

Sustainable mineral processing must minimize the exploitation of natural resources and avoid the need for disposal of wastes. The first requires the use of lower quality raw materials and upgrading, which typically results in the production of fine grained concentrates, and the latter encourages the recycling of wastes and byproducts or efforts to investigate them as sources for secondary raw materials or other beneficial applications.

To overcome the difficulties associated with fine particulate solids, size enlargement by agglomeration is necessary. The resulting products have free flow characteristics, do no longer dust or segregate, and are sized and shaped as required for optimum processing. In addition, agglomerated materials may be engineered to feature desirable structure, composition, and a number of related, improved properties. Such engineering may be applied for the modification of fine run-of-mine and up-graded minerals as well as the production of secondary raw materials from by-products or wastes. By the interdisciplinary application of size enlargement by agglomeration waste-free processing of minerals becomes feasible.

PAPER 10.2 — 14:30

FINE PARTICLE AGGREGATION IN MINERAL PROCESSING CIRCUITS.

J.S. LASKOWSKI, University of British Columbia, Vancouver, British Columbia, Canada, and
A.L. VALDIVIESO, Universidad Autonoma de San Luis Potosi, San Luis Potosi, Mexico

Particle size enlargement processes play an important role in solid/liquid separation, and in beneficiation unit operations. In the latter, not only the size of the formed aggregates but also their surface properties are very important. Oil agglomeration has a special place among such processes: it is a selective process in which hydrophobic particles are agglomerated into hydrophobic agglomerates which can be recovered by flotation. This explains the broad applications of oil-assisted beneficiation processes not only in the beneficiation of fine coal, but also in agglomerate flotation of many different types of ores, and in coal/gold agglomeration

PAPER 10.3 — 15:00

AGGLOMERATION IN LEACHING: THE USE OF ELECTRICAL CONDUCTIVITY MEASUREMENTS FOR AGGLOMERATION CONTROL AND FINES/CLAYS MONITORING.

G. VELARDE, Sociedad Minera Cerro Verde S.A.A., Arequipa, Peru

Agglomeration has as main objective to form a uniform and highly permeable heap for leaching. An inaccurate dosage of moisture during agglomeration leads directly to poor agglomerate quality and segregation of particle sizes during stacking. This causes a heterogeneous distribution of the leach solution inside the heap which invisibly and practically permanently affects the recovery. Unfortunately, only when this becomes serious and the mineral contains an excess amount of fine particles and/or clays then the poor permeability of the pile becomes obvious. This paper is based on the experience of Minera Cerro Verde in the development and application of a quantitative method to control moisture during agglomeration. As the amount of fine particles/clays varies, the quantity of moisture has to be altered in real time. The measurement of agglomerate electrical conductivity is used for it. This concept is based on the sharp

change seen in conductivity when the mineral passes its absorption limit. A liquid conductive film then begins to form over the surface of the particles, which leads to the formation of agglomerates through liquid bridges, which are also electrical bridges. Moisture is adjusted to reproduce a value of conductivity established previously and is the guiding parameter. Moreover, moisture amount added to reach this conductivity parameter provides information about the fines/clays relative content for best leaching management.

COFFEE BREAK — 15:30 - 16:00

PAPER 10.4 — 16:00

FLOTATION AND AGGREGATION: TESTING A LINK.

D. LASCELLES, E. EL-AMMOURDI and J.A. FINCH, McGill University, Montréal, Québec, Canada

Flotation separation is expected to be related to the degree of dispersion of the pulp. For instance, highly aggregated systems may show reduced selectivity, reduced entrainment and increased flotation rate. In an attempt to test the impact of aggregation on flotation, we have taken advantage of the effect of Mg ions. Using combinations of Mg^{2+} and pH gave a wide variation in aggregation of several Cu-Zn ores (measured by settling rate) and corresponding flotation response was determined by batch tests. The trials were conducted on-site at Louvicourt and Agnico-Eagle. In a majority of cases a similar trend in aggregation and flotation selectivity (grade at given recovery) was observed. At Louvicourt, improved selectivity with increasing aggregation at pH 10.5 was found. At Agnico-Eagle, an analogous association between aggregation and selectivity was observed at pH 11.5. It is suggested that aggregation influences particle entrainment, the increased effective particle size reducing gangue recovery and hence improving selectivity.

PAPER 10.5 — 16:30

ROLE OF PARTICLE AGGREGATION IN FINE SPHALERITE FLOTATION STUDIED BY ON-LINE VISUALIZATION.

Z. XU, J.W. CHOUNG, X. YANG, T. FU, University of Alberta, Edmonton, Alberta, Canada, and
Z.A. ZHOU, Alberta Research Council, Edmonton, Alberta, Canada

An on-line visualization technique and methodology was developed to investigate the role of fine sphalerite (< 10 μm) aggregation in flotation. The images of particle aggregates under different operating conditions were recorded and analyzed. The effect of impeller design on particle aggregation was demonstrated. This difference was not mainly due to the energy input into the system, but due to the resultant hydrodynamic conditions created by the impeller and their effect on particle interactions. The recorded image showed that adding fine silica (- 5 μm) did not interfere with fine sphalerite aggregation, thereby showing no effect on the sphalerite recovery. Effect of the enlarged aggregate size on increasing flotation recovery was confirmed. Although Malvern Mastersizer produced consistently lower estimates of aggregate size than those by the image analysis, both methods responded to the changes in operating conditions in the similar trend. It was shown from this study that on-line visualization technique is a powerful tool for studying fine particle aggregation and morphology in the context of diagnosis for the flotation separation.

PAPER 10.6 — 17:00

PRINCIPAL COMPONENT ANALYSIS APPLIED TO SURFACE CHEMISTRY IN MINERALS FLOTATION.

M.C. BIESINGER, D.J. MILLER, J.T. FRANCIS, B. HART, University of Western Ontario, London, Ontario, Canada, and
R.S.C. SMART, Ian Wark Research Institute, University South Australia, Adelaide, Australia

Diagnosis of the surface chemical factors playing a part in flotation separation of a valuable sulfide phase requires measurement of the hydrophobic and hydrophilic species that are statistically different between the concentrate and tail streams. Time of flight secondary ion mass spectrometry (ToF-SIMS) can be used to identify sufficient particles of a specific mineral phase for reliable statistics determining a mean value for each species with 95% confidence intervals (1). Using the region of interest (ROI) facility in the Tof-SIMS software, a mass spectrum from each particle, at 1-2 monolayer sensitivity, is recorded and stored. This analysis is reported for a chalcopyrite / pyrite / sphalerite mineral mixture conditioned at pH 9 for 20 minutes in order to study transfer of copper from chalcopyrite via solution to the other two mineral surfaces since this mechanism can be responsible for their inadvertent flotation in copper recovery. Analysis from mineral selection based on specific ToF-SIMS signals (eg. Pb, Zn, Cu, Fe, Fe/Cu) indicated no statistical difference in the copper intensities on pyrite and sphalerite after this conditioning. Principal component analysis (PCA) of the ToF-SIMS imaging data identifies combinations of factors strongly correlated (positively or negatively) in

images or spectra from mass spectra recorded at each of 256x256 pixels in a selected area of particles. PCA is a better method of selecting minerals due to multi-variable recognition. It has clearly separated a statistical difference in copper intensities between the sphalerite and pyrite phases. The method has been extended to samples from an operating plant again with excellent phase recognition and diagnostic surface chemistry.