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DISSERTATIONS

Triboelectric Charge Characteristics and Electrical Separation of Industrial Minerals, Hamid-Reza Manouchehri, Luleå University of Technology, Luleå, Sweden, Doctoral Thesis (February 2000), 271 pp. Supervisors: Professors K.H. Rao and K.S.E. Forssberg.

In order to investigate the possibilities for applying triboelectrostatic separation method for separating complex mineral systems, this thesis deals with the studies into identification of triboelectric charge on minerals particles and the factors affecting this charge. Charges imparted on different particle size fractions of various industrial minerals were monitored by utilising different tribocharging systems and tribocharging materials under different conditions. Electrical properties, e.g., dielectric constant and electrical conductivity were measured for all particle size fractions before and after chemical treatment. Trajectories of mineral particles through the electric field of the free-fall electrostatic separator before treating were determined. The role of different organic and inorganic chemical species on charge acquisition and separation behaviour of minerals was investigated.

The results show that, in spite of the simplicity in theory, the contact/triboelectrification and consequently the triboelectric separation are complex processes and special care must be taken into account to apply this technique for beneficiation of minerals. It can be concluded from the findings that a relation exists between the triboelectric charges accumulated on mineral grains and the work function of both the minerals and tribocharger medium. The electrokinetic results indicate that the minerals can be arranged in triboelectric series since their donicity and point of zero charge were found to be in good agreement with triboelectric charges acquired by them.

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The study reveals that, notwithstanding the truth that triboelectric charge is not being completely understood even at the beginning of the third millennium, triboelectric separation deserves to be considered in more detail and must be examined for different mineral systems, especially when the technology offers possibilities to use new separation machines that are able to separate fine particles. More research and development is recommended to develop the triboelectric separation process for beneficiation of complex raw materials.

Dephosphorization of Magnetite Fines, Fenwei Su, Luleå University of Technology, Luleå, Sweden, Doctoral Thesis (1998), Supervisors: K.S.E. Forssberg and K.H. Rao.

The dephosphorization of magnetite fines by flotation and simultaneously reducing fatty acid coating on magnetite surface are currently important challenges facing the mineral industry in Sweden. These problems can be resolved to a greater extent by optimising apatite flotation process, which depends largely on the proper control of chemical variables. The primary objective of the research work presented in this thesis is to investigate the influence of chemical and operational variables on the apatite flotation kinetics and to establish a suitable model using traditional method and fuzzy logic.

Rotating Magnetic Field Separation of Minerals, N.R. Allen, University of Tasmania, Hobart Tasmania, Australia, Ph.D. Thesis (March 1999), 284 pp. Supervisors: J.C. van Moort and D. Clark.

The behaviour of particles in a rotating magnetic filed can be used as a basis for a new mineral separation method, where particles are separated on the basis of their relative ability to rotate in a rotating magnetic field. Both particle attraction and particle rotation separations may be combined in a single separation process, to offer previously impossible magnetic mineral separations, such as the separation of high-Mg ilmenites (picro-ilmenites) from other ilmenites of the same magnetic susceptibility, or to produce separations which are more precise than those currently available, such as the low-entrapment separation of magnetite or monoclinic pyrrhotite.

Whereas mineral separation by particle attraction involves the use of material properties such as the number of unpaired electron spins and their relative orientations, separation by particle rotation adds the properties of magnetic anisotropy and such dynamic magnetisation processes as domain wall velocity in ordered magnetic compounds. The use of a continuously rotating magnetic field also generates eddy currents in particles, in proportion to particle electrical conductivity, which allow conductive particles to be rotated by eddy current effects, and extends the same separation process into the practical separation of small particles of non-magnetic metallic compounds.

Particle rotation characteristics may be estimated using similar equipment to that used for practical rotating field mineral separations, so that these characteristics may be readily applied to practical separations. These estimations are presented in the form of a "rotation index", which relates the actual particle rotation strength to the maximum possible rotation strength indicated by particle magnetisation. Although the measurement of particle rotational characteristics by these methods is only approximate, it is accurate enough to demonstrate the presence of, and estimate the magnitude of, such dynamic magnetisation processes as domain wall velocities in small particles of natural ordered magnetic compounds.

Particle rotation by magnetisation is also shown as being able to cause particle rotations for which the particle rotation axis is at right angles to the field rotation axis, and which are of sufficient strength to play a part in a rotating magnetic field mineral separation process.

Some Aspects of Ferrohydrostatic Separation of Minerals and the Recycling of Ferrofluid, Stanford Dumbu, De Beers Diamond Research Laboratory, Johannesburg, South Africa, M.Sc. Thesis, submitted to the University of Stellenbosch (November 2000), 120 pp. Supervisor: Jan Svoboda.

The efficiency of ferrohydrostatic separation depends on numerous variables. The most important variables, which were investigated individually, are the effects of moisture content, ferrofluid level in the separation chamber, federate, particle size and material density distribution. The recovery and recycling of ferrofluid are affected by particle size, moisture content and material porosity. It was found that the amount of ferrofluid absorbed into and absorbed by particles decreased with an increase in the material content. The increase in porosity increases the amount of ferrofluid lost due to the difficulties in recovering ferrofluid embedded in the pores of the particles. Adding water to coarse matieral lowers the amount of ferrofluid lost. The quality of ferrofluid recovered was found to be the same as the initially used for material separation.

It was also found that the effect of ferrofluid level on separation efficiency is a function both the density difference of the particles to be separated and the particle size. Separation efficiency as a function of ferrofluid level is poor for particles larger than 2 mm, and is good when the density difference of the material to be separated is high; for instance 0.8 g/cm^3.

Experimental Investigation into the Application of a Magnetic Dense Medium Cyclone in a Production Environment, Ilana K. Brits, De Beers Namaqualand Mines, South Africa, M.Sc. Thesis submitted to the University of Potchefstroom (November 2000), 110 pp., Supervisors: J. Svoboda and Q.P. Campbell.

The magnetic dense medium cyclone project was undertaken on a 250 mm and 510 mm diameter cyclones. The aim of the project was to evaluate the performance of a magnetic DM cyclone in a production environment. Previous testwork on magnet DM cyclones were conducted earlier on small 100 mm cyclones in a laboratory environment. Solenoid position, magnetic field strength and medium inlet density were varied, while the operational parameters such as medium grade, cyclone configuration and inlet pressure were kept constant.

The performance of the magnetic DM cyclone in the production environment was found to be similar to that of laboratory-scale magnetic DM cyclones. The magnetic field stabilised the medium for all tests conducted reducing the extent to which medium segregation inside the cyclone occurred. This was observed by a reduction in the underflow medium density. Since the underflow density primarily determines the cut point, the application of the magnetic field allows direct control over the cut point of the DM cyclone as well as improved separation efficiency due to increased medium stability. It was shown that the direct stabilisation of the medium and manipulation of the underflow density by the magnetic field brings metallurgists one step closer to on-line control of all relevant DM cyclone parameters.