S. Komar Kawatra

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Summary of Accomplishments:

- Primary area of research is chemical engineering, particularly instrumentation and on-line analysis for monitoring and control of chemical and particulate process plants, and treatment/ remediation of chemical and industrial wastes
- Served as Chair of the Mining & Materials Process Engineering Department from August, 2000. After becoming Chair, guided the Department in successfully attracting a total of 16 grants valued at $3,017,838 for the 2000-2001 fiscal year. This was 10% of the total University research budget of $30,624,267, even though the department only accounts for 2% of the total faculty at the University. The grant dollars awarded per faculty were higher than for any other department on campus.
- Have extensive administrative experience in contract management, Principal Investigator on over 22 funded research projects. These projects were funded by numerous federal agencies (Bureau of Mines, Department of Energy, National Science Foundation, NASA), state agencies (Ohio Coal Development Office, Illinois Clean Coal Institute, Minnesota Department of Natural Resources, Michigan Research Excellence Fund), and industries (Electric Power Research Institute, General Motors, Cleveland Cliffs Iron Co., Copper Range Co., Department of Education
- Served on Board of Directors of the Society for Mining, Metallurgy, and Exploration (SME) from 1997 to 2000, and was Chair of the Mineral Processing Division of SME for 1997-1998.
- Currently serving as Editor-in-Chief of the Minerals & Metallurgical Processing Journal, Published by the Society for Mining, Metallurgy, and Exploration (SME)
- Currently serving as Editor-in-Chief of the Mineral Processing & Extractive Metallurgical Review, Published by the Francis and Taylor
- Accomplished researcher, teacher, and lecturer in the fields of On-Line Sensors and Process Control, Particulate Processing, Plant Design, Industrial Waste Utilization, and Particulate Waste Management. Received eight prestigious awards for research activities.
- Author or editor of seven books, and author of over 110 technical publications.
- Extensive experience working with both government and industry to conduct research, and has heavily involved students in all aspects of research. Educational Qualifications:
- M. S. Physics, University of Poona, India, 1966
- Ph.D., Metallurgical Engineering, University of Queensland, Australia, 1975

Awards:

- Gaudin Award for Sustainable By-product Management Treatment and Utilization, Society for Mining, Metallurgy & Exploration, Inc., 2003
- Graduate Student Mentor Award, Michigan Technological University, First Recipient, 2002
- Frank F. Aplan Award, for Engineering or Scientific Contributions that Further the Understanding of the Technology of Coal and/or Mineral Processing, American Institute of Mining, Metallurgy and Petroleum Engineers, NY, 2002.
- Robert H. Richards Award, for Outstanding Contributions to the Mineral Industry through Prolific Innovative Research in Diverse Areas from Comminution, Concentration, and

Instrumentation to Waste Recovery, Treatment, and Utilization, American Institute of Mining, Metallurgy and Petroleum Engineers, NY, 2000.
- Taggart Award, for Advances in Coal Flotation Technology, Society for Mining, Metallurgy & Exploration, Inc., 1994
- Distinguished Member Award, Society for Mining, Metallurgy & Exploration, Inc., 1992
- Michigan Association of Governing Boards Distinguished Faculty Member Award for Extraordinary Contribution to Michigan Higher Education, 1988
- House of Representatives, State of Michigan, passed Resolution NO714 for Contributing to Higher Education in State of Michigan, 1988
- Michigan Technological University Research Award, 1987

Professional Work History:

- Department of Chemical Engineering, Michigan Technological University, Houghton, MI, Professor, from August, 2002.
- Department of Mining and Material Process Engineering, Michigan Technological University, Houghton, MI, Professor and Chair, from August, 2000-2002.
- Department of Metallurgical and Materials Engineering, Michigan Technological University, Houghton, MI, Assistant Professor from September 1977, Associate Professor from September 1980, and Professor from September 1985 -2000
- Morgantown Energy Technology Center, Morgantown, Department of Energy, from May 1984 to August 1984
- Department of Mineral Engineering, University of Alberta, Edmonton, from April 15, 1977, to August 31, 1977
- Mineral Sciences Laboratories, Department of Energy, Mines and Resources, Ottawa, from January 1975 to April 1977
- Julius Kruttschnitt Mineral Research Center, University of Queensland, Australia, from January 1971 to December 1974
- Mount Isa Mines Ltd., Mount Isa, Australia, from January 1973 to July 1973
- Atomic Energy Commission, India, from March 1968 to January 1971

Membership in Professional Organizations:

- Distinguished Member, Society for Mining, Metallurgy and Exploration

Editorial Boards:

- Coal Preparation, Gordon & Breach Science Publishers, 1995-1998
- International Journal of Mineral Processing, Elsevier Scientific Publishing Company, Amsterdam 1991-1994
- Minerals & Metallurgical Processing, publ. by the Society for Mining, Metallurgy & Exploration, Inc., Editor-in-Chief
- Minerals Processing and Extractive Metallurgy Review, publ. by the Francis and Taylor Co., Editor-in-Chief
- International Journal of Environmental Issues in Minerals and Energy Industry, A. A. Balkema Publishing Co., Amsterdam

Advisory Panel:

- Indigenous Space Resource Utilization Advisory Panel, sponsored by Lunar and Planetary Institute, Houston

University Activities:

- Member of several committees of the Department, College of Engineering, and the University, including the University Best Researcher Award Committee, 1987-1990; Chairman, Promotion and Tenure Committee, College of Engineering, 1989; University Senator 1992-1995.
- Established and became the first chair of the Department of Mining and Materials Process Engineering, from 2000 to 2002, and worked closely with alumni to ensure the continued presence of mineral and particulate processing as an educational and research area at Michigan Tech.
- Established a Coal Research Laboratory in the Department of Metallurgical Engineering. The laboratory consists of several test rigs such as hydrocyclone, waste stream analyzer for ash and iron ore, and column flotation cells. These rigs are well instrumented. One article on this laboratory written by the editors of Coal Mining and Processing appeared in July 1982. Another article written by the editors of Design News appeared in the January 1984 issue.

Research Funding: (Single PI, except where listed)

Total Funding: $ 7,312,255 (funding for S. K. Kawatra only, not including the amount for multiple-PI grants)

- Development of Sensors for On-Line Analysis of Ash in Coal Slurries- funded by EPRI ; DOE
- Process Analysis of Comminution Circuits- Particle Size, Rheology, Temperature- funded by USBM
- Effect of Reagent Addition on the Response of a Fine Coal Flotation Circuit-funded by the U.S. DOE
- Column Flotation of Ohio Coals - funded by the State of Ohio
- Planetary Materials and Resource Utilization - funded by the NASA (Multiple Investigators)
- Bacterial Desulfurization of Coal - funded by the State of Michigan ; USDOE ; MERRA
- Coal Cleaning by Heavy Media Cyclones - funded by the USDOE/Process Tech
- On-Line Measurement of Viscosity and Rheology- funded by Dow Chemical Company
- Utilization of Gypsum - funded by State of Illinois , USDOE
- Analysis of Grinding and Flotation Circuit at Copper Range Company, White Pine, MI
- Production of Inorganic Pellet Binders from Fly Ash, Funded by the State of Illinois, Il Department of Natural Resources, State of Minnesota, USDOE
- Agglomeration of Granular and Fine Particulate Industrial Wastes, Funded by EPA,
- Froth Flotation of Coal, Funded by National Science Foundation,
- Physical Removal of Toxins from Contaminated Sediments, EPA,
- Separation of Flue Gas Scrubber Sludge in to Marketable Products, US DOE,
- Coal Grinding Model Development, Electrical Power Research Institute, Palo Alto, CA
- Investigation of Fly-Ash Based Foundry Molds, NSF
- Prevention of Self Heating of Swarf, General Motors
- Chemistry and Physics of Taconite Agglomeration, Minnesota DNR,
- Application of Chemistry and Physics of Taconite Agglomeration, Minnesota DNR,

- Optimization of Comminution Circuit Throughput and Product Size Distribution by Simulation and Control., USDOE,
- Verification of Steel Making Slag Iron Content, USDOE, (PI Jim Hwang and Robert Greenlund),
- Chemical Engineering Doctoral Fellowship Program for Environmentally Benign Manufacturing in the Chemical Industry, Graduate Assistance in Areas of National Need (GAANN), U. S. Department of Education,
- Novel Binders and Methods for Agglomeration of Ore, U. S. Department of Energy,
- Dust Suppression in Iron Ore Processing Plants", Minnesota DNR Iron Ore Cooperative Research Program,
- Single-Step Ironmaking from Ore to Improve Energy Efficiency, U. S. Department of Energy,
- Direct Biohydrometallurgical Extraction of Iron from Ore", U. S. Department of Energy,

Administrative Experience and Philosophy:

- Initial administrative experience - service on the Board of Directors of the Society for Mining, Metallurgy, and Exploration (SME) from 1997 to 2000, and was Chair of the Mineral Processing Division of SME for 1997-1998.
- In 2000, established and became the first Chair of the Department of Mining and Materials Process Engineering at Michigan Technological University. Before establishing this Department, sought the written opinions of personnel working in a wide variety of industries that would be of direct interest to the new Department. Organized a meeting with them, presented plans, and used their input to plan a strong, practical set of goals for the Department. Also established a highly competent and motivated Industrial Advisory Board (IAB) to review the Department activities, to provide ongoing guidance as to the needs of industry that the Department needed to address, and to provide assistance in generating funds for the Department and in placing students in the best possible positions for beginning their careers.

Teaching Philosophy:

Teaching is the most important function of any university. In engineering education, it is very important that students learn the basic fundamentals of engineering thoroughly, and not simply memorize numerous facts that they could easily look up in any technical reference. This way, they will have the necessary background to adapt and learn on their own in their future careers.

I also feel that it is of great importance for students to be fully aware of how their engineering skills will be applied on an industrial scale. I therefore take my students on a large number of plant trips so that they can see how theory translates into practice, and what is involved in actually implementing a process after it has been developed in the lab. I also hire as many undergraduate students as possible to assist graduate students in their research, which gives the graduate students valuable management experience while also helping the undergraduates improve their knowledge and skills.

Perhaps most important, I make sure that all of my students acquire good communications skills, because even the most talented engineer is of little value to industry if he cannot communicate his knowledge to others. In undergraduate classes, particular emphasis is given to group projects and to both written and oral presentations of their project results. My graduate students give weekly presentations of their work in progress, present technical papers at national conferences, and publish in refereed technical journals.

Research Philosophy and Accomplishments:

My general research philosophy is to carry out research in close cooperation with industry, and to make sure that all of my students start with fundamental research, and carry it all the way to implementation in operating plants. I believe that this gives them the best possible preparation for their future careers. For example, our project with General Motors started with one of their plant engineers coming to us with the problem of spontaneous combustion of their machining wastes. They had been unable to solve this problem because they could not reproduce the effect in the laboratory, and so could not determine what approaches might be helpful. We first developed a sampling plan to ensure that our laboratory samples were in fact representative of the machining waste. Since there was no standard method available for measuring the rate and degree of spontaneous heating, we then devised a suitable test. Using this test, we determined which of several candidate treatments would actually reduce the degree of self-heating. As the final stage of the project, my student then travelled to the GM plant for full-scale tests of the anti-heating treatments. The most successful treatment was then adopted by GM and they used it to solve their problem. My student was intimately involved in all stages of this project, and gained invaluable experience in all stages of carrying out a solution to an engineering problem.

I have worked on a wide variety of other research projects, with some of the most significant listed below:

1. Agglomeration

For the past decade, my research group has conducted extensive research in agglomeration of minerals, particularly iron ore pelletization. The particular thrust was development of methods for improving the effectiveness and reducing the costs of pelletization binders. A new, low-cost binder formulation was developed that uses fly-ash as the primary binder component, as a replacement for higher-cost bentonite. A novel method for mixing binders with mineral particles was also developed that could double the effectiveness of bentonite binders, which promises to greatly reduce binder costs in the industry. Studies of the effects of water chemistry on binder performance also lead to development of a new characterization procedure for bentonite, which for the first time makes it possible to evaluate the quality of bentonite as a binder before using it in an actual plant situation.

2. Ash Analyzer

I developed the first on-line slurry ash analyzer based on X-ray backscatter, which has been patented and licensed to Outokumpu Oy, Finland. The analyzer incorporates two sensors: a gamma-ray transmission unit to measure the percent solids of the slurry, and an X-ray backscatter/fluorescence unit to determine the ash content of the entire slurry. The combined signal from the two sensors provides a means for determining the ash content of the solids in the slurry.

3. On-Line Measurement of Rheology

My research group has developed a technique for rapid on-line measurement of the rheology of particulate processing streams. This method uses standard, off-the-shelf transducers, which are combined with computations using the gas law and the Hagen-Poiseuille equation to calculate the rheological behavior of the particulate suspension over a wide range of shear rates. Unlike existing vibrational and tube viscometers (which operate at fixed shear rates), the stress/strain data is calculated directly, which allows the viscosity to be determined at whatever shear rates are of most interest for the process.

4. Processing of Scrubber Sludge

We have developed a technique for purifying flue-gas scrubber sludge, to improve its marketability. A combination of water-only cycloning and column flotation is used to remove unreacted limestone from the sludge at a low cost, leaving material that can be used for manufacturing gypsum products. The water-only cyclone removes the coarse, higher-density particles (which are mainly limestone), and the flotation column then removes the remaining fine limestone. The horizontally-baffled flotation column used for this work was developed by my group to reduce the amount of axial mixing in column flotation, which results in a better separation efficiency than is achieved with unbaffled flotation columns.

Teaching Interests:

On-Line Sensors and Process Control, Particulate Processing, Plant Design

Consulting Activities:

- Arthur D. Little Company
- Norton, Hambleton, Inc.,
- Ontario Research Foundation
- Kobe Steel, Kobe, Japan
- United Nations

Professional Activities:

- Elected, Chair, Mineral and Metallurgical Processing Division, Society for Mining, Metallurgy and Exploration, 1997-1998.
- Elected, Vice Chairman, Mineral Processing Division, Society for Mining, Metallurgy and Exploration, 1996-1997.
- Elected, First Regional Vice Chairman, Mineral Processing Division, Society for Mining, Metallurgy and Exploration, 1995-1996.
- Elected, Second Regional Vice Chairman, Mineral Processing Division, Society for Mining, Metallurgy and Exploration, 1994-1995.
- Elected, Secretary-Treasurer, Mineral and Metallurgical Processing Division, Society for Mining, Metallurgy and Exploration, 1993-1994.
- Program Coordination Committee, Coal Division, Society for Mining, Metallurgy and Exploration, 1993-1995.
- Book Publishing Committee, Coal Division, Society for Mining, Metallurgy and Exploration, 1993-1996
- Book Publishing Committee, Vice Chairman, 1993-1994, Chairman, 1994-95, Society for Mining, Metallurgy and Exploration.
- Chairperson (1984-85) of the Mineral Processing Division of the Upper Peninsula American Institute of Mining and Metallurgy (U.P.-AIME); Vice-Chairperson (1985-86); Chairperson (1986-87); Board of Directors, 1986-90.
- Health and Safety Committee, Society for Mining, Metallurgy and Exploration: member, 1984-1986.
- Research and Development Committee, Coal Division, Society for Mining, Metallurgy and Exploration: member, 1990-1992; chairman-elect, 1990; chairman, 1991.

- Mineral Processing Fundamentals Committee, Society for Mining, Metallurgy and Exploration: member 1983-1991; vice-chairman, 1990; chairman 1991.
- Educational Issues Committee, Society for Mining, Metallurgy & Exploration: member, 1991-1994.
- Program Committee, Coal Division, Society for Mining, Metallurgy & Exploration member, 1991, Chairman-Elect 1993, Chairman 1994.
- Stefanko Award Committee, Coal Division, Society for Mining, Metallurgy and Exploration, 1993-1994.
- Coal Preparation Unit Committee, Society for Mining, Metallurgy and Exploration, 1993-1994.
- Regional/Topical Meetings Committee, Program Chairman Elect, Society for Mining, Metallurgy and Exploration,1993.
- Outstanding Young Engineer Award Committee, Society for Mining, Metallurgy and Exploration, 1993-1999.
- General Committee, Mineral & Metallurgical Processing Division, member, 1991.
- Executive Committee, Coal Division, Society for Mining, Metallurgy & Exploration; member, 1992.
- Organized international symposium: "Comminution Practices," Society for Mining, Metallurgy and Exploration, Denver, 1997.
- Organized international symposium: "High Efficiency Coal Preparation," Society for Mining, Metallurgy and Exploration, Denver, 1995.
- Organized international symposium: "New Remediation Technology in the Environmental Arena", Society for Mining, Metallurgy and Exploration, Denver, 1995.
- Organized international symposium: "Comminution, Theory and Practice," Society for Mining, Metallurgy and Exploration, Phoenix, 1992.
- Organized and chaired several technical sessions for the Instrument Society of America, Canadian Institute of Mining and Metallurgy, American Institute of Mining and Metallurgy, and the International Mineral Processing Congress.
- Organized international symposium: "Biotechnology in Minerals and Metal Processing," Society of Mining Engineers, Los Vegas, 1989.
- Organizing and Advisory Committee for the Fourth International Conference on Processing and Utilization of High-Sulfur Coals and the International Symposium Control '90, sponsored by the Society for Mining, Metallurgy and Exploration.

Board of Directors:

- Process Technology, Inc., Calumet, MI, 1986-1989
- U.P. Section of the American Institute of Mining and Metallurgy, 1986-1990
- Society for Mining, Metallurgy and Exploration, 1997-2000.

Patents:

- On-Line Slurry Ash Analyzer - U.S. Patent No. 4916-719, 1990. Outokumpu Oy, Finland, has paid to license the technology, and is currently preparing to market the units worldwide. The instrument has been tested by Outokumpu on Russian, Chinese, and European coals with good results.
- Process for Extracting Oxygen and Iron from Iron-Oxide-Containing Ores - U.S. Patent No. 4,997,533 March 5, 1991.

- Flotation Column with Adjustable Supported Baffles - U. S. Patent No. 5,335,785, August 9,1994.
- Method for Producing Powder from Polycrystalline Inorganic Material, U. S. Patent No. 5,524,836, June 11, 1996

Books:

Scheiner, B. J., Doyle, F. M., and Kawatra, S. K. (editors), "*Biotechnology in Minerals and Metal Processing*", published by the Society of Mining Engineers, 1989, 209 pp.

Kawatra, S. K. (ed.), "*Comminution-Theory and Practice,*" published by the Society for Mining, Metallurgy & Exploration, Inc., 1992, 693 pp.

Scheiner, B. J., Chatwin, T. D., El Shall, H, Kawatra, S. K. and Torma, A. E. (editors), "*New Remediation Technology in the Environmental Arena*," published by the Society for Mining, Metallurgy and Exploration; 1995, 235pp.

Kawatra, S. K. (ed.), "*High Efficiency Coal Preparation*," published by the Society for Mining Metallurgy and Exploration, 1995, 449 pp.

Kawatra, S. K. (ed), "*Comminution Practices*", Published by the Society for Mining, Metallurgy and Exploration, Littleton, CO, 1997, 352 pp.

Kawatra, S. K. and Eisele, T. C. , "*Coal Desulfurization*", Taylor and Francis, 2001, 360pp.

Kawatra, S. K. and Natarajan, K. A. (editors), "*Mineral Biotechnology*", Society for Mining, Metallurgy and Exploration, 2001, 263pp.

Publications:

Pelletization

Eisele, T.C., and Kawatra, S.K., "A review of binders in iron ore pelletization," Mineral Processing and Extractive Metallurgy Review, Vol.24, No. 1, 2003, pp.1-90

Kawatra, S. K., and Ripke, S. J. "Laboratory studies for improving green ball strength in bentonite-bonded magnetite concentrate pellets," International Journal of Mineral Processing, Vol.72 No.1-4, 2003. pp. 429-441

Ripke, S.J., and Kawatra, S.K., "Effect of cations on unfired magnetite pellet strength," Minerals and Metallurgical Processing Journal, Vol.20, No.3, 2003, pp.153-159

Kawatra, S.K. and S.J. Ripke , "Effects of Bentonite Fiber Formation in Iron Ore Pelletization" International Journal of Mineral Processing, Elsevier Press, Amsterdam, Vol. 65, No. 3-4, 2002,

Kawatra, S.K. and S.J. Ripke, "Pelletizing Steel Mill Desulfurization Slag", International Journal of Mineral Processing, Elsevier Press, Amsterdam, Vol.65, No. 3-4, 2002

Kawatra, S.K. and Ripke S.J., "Developing and Understanding the Bentonite Fiber Bonding Mechanism," Minerals Engineering, Elsevier Science Ltd., Vol.14, No.6, , 2001, pp. 647-659

Ripke, S. J. and Kawatra, S. K, "Fibrous Binding Mechanisms for Reducing Bentonite Dosage", AFS Transactions, 2000, Vol. 108, pp. 101-104

Ripke, S. J. and Kawatra, S. K., "Iron Ore Pellet Binding Mechanism, Pozzolanic VS. Physical Binders", Proceedings of the XX1 International Mineral Processing Congress, Massaci ed., Elsevier, Vol.A, 2000, pp. A4 120-127

Pollution Prevention and Remediation

Kawatra, S. K. and Eisele, T. C., Mineral Processing Techniques for Coal Combustion Byproducts", Proceedings of the XX1 International Mineral Processing Congress, Capetown, South Africa, 2003, pp. 584-593.

Kawatra, S. K. Review of the book "Waste Characterization and Treatment ", by W. Petruk, Minerals and Metallurgical Processing Journal, Vol. 15, No.4, 1998, pp. 65

Hess, M. J. and Kawatra, S. K, "Environmental Beneficiation of Machining Wastes-Part I: Material Characterization of Machining Swarf ", Journal of the Air and Waste Management Association, 1999, Vol. 49, No.2, pp. 207-212

Hess, M. J. and Kawatra S. K, "Environmental Beneficiation of Machining Wastes-Part II: Measurement of the Effects of Moisture on the spontaneous Heating of Machining Swarf", Journal of the Air and Waste Management Association, 1999, Vol. 49, No.3

Kawatra, S. K., Eisele, T. C and Banerjee, D.D., "Use of Fluidized-Bed Combustor Fly-Ash as an Iron Ore Pellet Binder, Proceedings of the 71st Annual Meeting, Minnesota Section Society for Mining, Metallurgy and Exploration, 1998, pp. 127-134

Kawatra, S. K., Eisele, T. C and Banerjee,D.D., "Binding Iron Ore Pellets with Fluidized Bed Combustor Fly-Ash", Minerals and Metallurgical Processing, 1998, Vol. 15, No.2, pp. 20-23

Eisele, T. C., Kawatra, S. K and Banerjee, D.D, "High-Carbon Fly-Ash Binders for Iron Ore Pellets", ICSTI/IRONMAKING Conference Proceedings, 1998, pp.1175-1181

Eisele, T. C., Kawatra, S. K and Banerjee, D.D,"Binding Iron Ore Pellets with Fluidized-Bed Combustor Fly Ash", Minerals and Metallurgical Processing, Vol. 15, No.2,1998, pp. 20-23.

Eisele, T. C., Kawatra, S. K and Banerjee, D.D, "Utilization of Fly- Ash as Inorganic Pellet Binder", Proceedings of the XX th Int. Min. Processing Congress, Aachen, Germany, Vol.V, pp. 121-134,1997.

Kawatra, S. K., Eisele, T. C., and Banerjee, D.D, "Recovery of Gypsum and Limestone from Scrubber sludge by Water-Only Cyclone and Conventional Froth Flotation", Chapter 13 in New Remediation Technology in the Changing Environmental Arena (ed. Scheiner et. al), Society for Mining, Metallurgy, and Exploration, Inc., Littleton, CO, 1995, pp. 99-104.

Kawatra, S.K., Eisele, T. C. and DeLa'O, K. A., "Dewatering of Fine Particulates from Dilute Silicone Waste Dispersions", Proc. of the Second International Symposium on Metallurgical Processes for the year 2000 and Beyond, Minerals, Metals and Materials Society, 1995, pp. 497-504

Ripke, S. J. and Kawatra, S. K. "Can Fly-Ash Extend Bentonite Binder for Iron Ore Agglomeration?", International Journal of Mineral Processing, 2000, Vol. 60, pp. 181-198

Comminution

Shoop, K. J. and Kawatra, S. K," Effect of Rock Breakage Characteristics and fines/clay content on the Autogenous Grinding of Iron Ore" Minerals and Metallurgical Processing, Vol. 13, No.1,1997, pp. 14-21.

Kawatra, S. K., Bakshi, A. K., Shoop, K.J. and Eisele, T.C. "Slurry Rheology in Autogenous Grinding and Classification, Chapter 21, Comminution Practices (ed Kawatra), Published by

the Society for Mining, Metallurgy and Exploration, Littleton, CO,1997 pp. 155-154.

Bakshi, A. K., Rusesky, M. T.and Kawatra, S. K., "Effect of Viscosity on the Cut Size of Hydrocyclone Classifiers, Minerals Engineering, Vol. 9, No.8, 1996, pp. 881-891.

Bakshi, A. K. and Rusesky, M. T.and Kawatra, S. K., "The Effect of Slurry Viscosity on Hydrocyclone Classification", International Journal of Mineral Processing, Vol. 48, 1996, pp. 39-50.

Bakshi, A. K., Shoop, K. J. and Kawatra, S. K., "Changes in Autogenous Grinding Performance due to variation in Slurry Rheology", Proc. of Autogenous and Semiautogenous Grinding Technology, University of British Columbia, Vancouver. Vol.1, 1996, pp. 361-372.

Shoop K. J. and Kawatra, S. K., "Effect of Rock Breakage Characteristics and Fines/Clay Content on the Autogenous Grinding of Iron Ore", accepted for publication, 1995.

Kawatra, S. K., Moffatt, S. A., Eisele, T. C. and DeLa'O, K. A., "The Effect of Freezing Conditions on Rock Breakage", Minerals and Metallurgical Processing, Vol. 11, No.,3, 1994, pp. 178-184.

Kawatra, S. K., Moffatt, S. C. and Eisele, T. C., "Chemical Comminution by Alkali Metal Vapors," Chapter 46, Comminution-Theory and Practice, Society of Mining Engineering, Littleton, CO, 1992, pp. 627-643.

Kawatra, S. K., and Eisele, T. C., "Influence of Temperature on the Energy Efficiency of an Industrial Circuit Processing Iron Ore," Mineral and Metallurgical Processing, Vol. 8, No. 1, 1991, pp. 32-37.

Kawatra, S. K. and Eisele, T. C., "Effect of Temperature on the Performance of an Autogenous Grinding Circuit," Proceedings of Semi-Autogenous Grinding Conference (A. L. Mular, ed.), University of British Columbia, 1989, pp. 485- 502.

Kawatra, S. K., Eisele, T. C., Zhang, D., and Rusesky, M., "Effect of Temperature on Hydrocyclone Efficiency," International Journal of Mineral Processing, Vol. 23, 1988, pp. 205-211.

Kawatra, S. K., Eisele, T. C., Zhang, D., and Rusesky, M., "Temperature Effect on Grinding Circuit Performance," Minerals and Metallurgical Processing, Vol. 6, No. 2, 1989, pp. 85-87.

Kawatra, S. K. and Eisele, T. C., "Rheological Effects in Grinding Circuits," International Journal of Mineral Processing, Vol. 22, 1988, pp. 251-259.

Kawatra, S. K. and Eisele, T. C., "Rheological Effects in Wet Grinding Circuits," Proceedings of the XVI International Mineral Processing Congress (K.S.E. Forssburg, ed.), Elsevier, NY, 1988, pp. 195-207.

Kawatra, S. K., review of the book, Process Engineering of Size Reduction: Ball Milling, A Modern Approach, by L. G. Austin, R. R. Klimpel and P. T. Luckie, Mining Engineering, Vol. 36, No. 10, 1984, 1465.

Instrumentation and Control

Kawatra, S. K., "Estrategia de Control Computarizado para el Control de Espesadores", Infomina 2000 Symposium, Instituto de Ingenieros de Minas del Peru, September, 2000, Lima, Peru.

Kawatra, S. K. Bakshi, A. K. and Eisele, T. C. "An On-Line Pressure Vessel Rheometer for Slurries", Proceedings of the 9th European Symposium on Comminution, Albi, France, pp.

725-734, also in Powder Technology, 1999, Vol. 105, PP. 418-423

Bakshi, A. K. and Kawatra, S. K., "On-Line Measurement of Slurry Rheology in a Thickener at a Copper Concentrator", Minerals and Metallurgical Processing Journal, 1998, Vol. 15, No. 4, pp. 37-40

Bakshi, A. K. and Kawatra, S. K., "Plant Trials of a Pressure Vessel On-Line Rheometer to Monitor the Performance of a Thickener at a Copper Concentrator", Proceedings of the XX th Int. Min. Processing Congress, Aachen, Germany, Vol.I, pp. 183-192,1997.

Bakshi, A. K. and Kawatra, S. K., "Plant Trials of a New On-Line Pressure Vessel Rheometer for Slurries", Chapter 10, Comminution Practices (ed Kawatra), Published by the Society for Mining, Metallurgy and Exploration, 1997, pp. 70-76.

Bakshi, A. K.and Kawatra, S. K. "On-Line Measurement of Viscosity and Determination of Flow types for Mineral Suspension" International Journal of Mineral Processing, Vol. 47, 1996, pp. 275-283.

Kawatra, S.K, Bakshi, A. K. and Miller(Jr.)T. E. "Rheological Characterization of Mineral Suspensions Using a Vibrating Sphere and a Rotational Viscometer" International Journal of Mineral Processing, Vol. 44-45, 1996, pp. 155-165.

Bakshi, A. K and Kawatra, S. K."Rapid Determination of Non-Newtonian Flow Behavior Changes in Mineral Suspensions" Minerals and Metallurgical Processing, Vol. 13, No.4,1996, pp. 165-169.

Bakshi, A. K.and Kawatra, S. K, "Measurement of Rheological Properties of Coal and Mineral Suspensions", Proc. of Mineral Processing - Recent Advances and Future Trendiest (Mehrotra and Shekhar eds), Allied Publishers Ltd., 1995, pp. 341-348.

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