APPENDIX D: PAUL B. QUENEAU – C.V.

Paul B. Queneau
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Areas of Expertise

Extractive metallurgy of nonferrous metals, recycling, and waste minimization

Experience Summary

Dr. Queneau's technical and project management responsibilities focus on extractive metallurgy of nonferrous metals, treatment of metal-containing wastes, recycling, and teaching. His 45 years of experience include the development of custom processes for primary and secondary feedstocks, plant startups and plant operation to increase output, yield, and product quality.

In-plant projects include recycling of tin solder and drosses, Ni-Co recovery from laterite ore (pressure acid leaching, Australia), processing spent copper etchants (Hong Kong), processing and utilization of nonferrous and waste-processing slags, production of ferro-niobium from enriched slag (Brazil), conversion of tungsten concentrates (U.S. and Russia), processing tantalum intermediates, production of molybdenum chemicals, Ni–Mo-W recovery from spent catalyst (Europe), recycling copper flue dust, production of secondary bronze ingot, recycling leady residues (seven plants in U.S., Canada, and Mexico), processing hazardous waste in rotary kilns (seven plants), production of antimony oxide (Bolivia), producing zinc and manganese micronutrient (five plants), recycling of secondary aluminum in short rotary furnaces (four plants), silver production (U.S. and Turkey), production of defluorinated phosphate, recycling calcium fluoride, processing ferromanganese furnace dust, and Ni-Cu-Co recovery from matte.

As an R&D supervisor for AMAX in Golden, CO, Paul Queneau led research on production of ammonium paratungstate (APT), leading to commercialization; he also led the team that innovated AMAX's acid pressure leach for treating nickeliferous laterite. Dr. Queneau was a member of the AMAX process engineering team that started up atmospheric and pressure leaching circuits, residue flotation and hydrogen reduction

plant at Port Nickel. As a research engineer at Kennecott, he developed the process, then supervised the startup of a five-ton-per-day plant to upgrade high-rhenium molybdenite inventory.

Credentials

Ph.D. Metallurgical Eng., U. of Minnesota, 1967.
B.S. Metallurgical Eng., Cornell University, 1964.

Member of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME), Mining and Metallurgical Society of America, and Canadian Institute of Mining and Metallurgy (CIM).

AIME-TMS 2001 Extraction & Processing Distinguished Lecturer Award. Past President of the Denver Section, AIME-ASM Chapter.

Elected to membership in Tau Beta Pi.
Adjunct Professor at the Colorado School of Mines (CSM).

Registered Professional Engineer, Colorado;
Authored 33 technical papers; holds 30 U.S. patents.

Employment History

1997 - Present	Consulting Metallurgical Engineer P.B. Queneau & Associates, Inc., The Bear Group
1990 - Present	Adjunct Professor Colorado School of Mines
1983 - 1997	Principal Metallurgical Engineer Hazen Research, Inc.
1982 - 1983	President/Owner P. B. Queneau Company, Inc.
1972 - 1982	R&D Supervisor AMAX, Inc.
1967 - 1972	Research Engineer Kennecott Copper Corporation

Key Projects

Developed and proved process to produce tungsten chemicals from scheelite and wolframite concentrates. A profitable commercial operation resulted.

Established operating criteria and started up plant to produce antimony oxide at a tin operation in Bolivia; a profitable operating facility resulted.

Worked with slagging kiln incineration operations to maximize throughput, and with ingot-plant and industrial waste furnaces to enhance slag quality and marketability.

Doubled the lead output from a Canadian secondary lead producer over a two-year period by implementing a computer model to optimize feedstock selection and blending, and coke-flux inputs.

Worked closely with waste management operation in Hong Kong to recover copper from spent etchants and to market byproduct salts produced.

Assisted lead-acid battery recycler with selection of blast furnace formulations to maximize slag environmental acceptability without significantly affecting production efficiency.

Detailed technologies for nickel and cobalt recovery from spent lithium ion, nickel metal hydride, and NiCd batteries. Worked out N. American sources of these spent batteries, as well as capabilities of the established recycling operations.

Provided in-plant technical support to produce bronze secondary ingot from red-metal scrap, increasing the quality and quantity of alloy output.

Upgraded operating practices of rotary furnaces converting complex tin drosses to solder, improving yield by over 20%.

Carried out an in-depth technical and marketing evaluation for producing byproduct $MnSO_4$ and MnO, resulting in a profitable production facility.

Provided onsite startup assistance (three months) for large silver production facility in Turkey.

Worked with an international oil firm to evaluate alternative outlets worldwide for recycling spent resid and HDS catalyst.

Improved Al° furnace yield while recovering NaCl-KCl-NaF and Al° fines from salt cake at U.S. secondary aluminum smelters. Worked out alternative markets for the metallic aluminum fines.

Provided technical support for facility manufacturing molybdenum chemicals: troubleshooting, unit operation startups and new product development.

Selected and evaluated three routes to recover Mo/Co/Ni chemicals and aluminum-rich byproducts from spent catalyst; detailed market outlets.

Developed wet oxidation - solvent extraction process to recover vanadium and nickel from Venezuelan petroleum coke

Identified volumes and producers of etchant, alternatives for processing the outputs, and market outlets for products therefrom.

Provided startup expertise to a refinery producing nickel, cobalt, and copper from matte; work included startup of the leaching and reduction operations.

Worked out handling of phosphorus electric furnace slags. Developed byproduct alternatives for the furnace flue dust.

Developed a process for beryllium hydroxide recovery from phenacite concentrate by leaching, solution purification, and precipitation.

Evaluated alternative technologies to recover gallium and germanium from carboniferous shale. Later examined likely areas worldwide for increased Ge output in response to escalating Ge price.

Worked with aircraft manufacturer to evaluate VC_4 production in U.S., Europe and Japan.

Worked with EPA contractor to assemble "a guide on recycling low-metal-content wastes for use by decision makers at superfund, RCRA, and other waste sites."

Presented on-site short courses on recycling metals from industrial waste. Locations include CSM, a DOE facility, EPA’s Office of Solid Waste in Washington, AIME and CIM annual meetings, and at a waste processing facility.

Assisted in the startup of a rhenium-chemical production facility from roaster flue gas.

Helped chemical producer to identify opportunities for production of nickel and cobalt chemicals, as well as secondary sources for feedstocks.

Worked with team evaluating hydromet process for Ni, Cu, Au, and pgms, recovery from flotation concentrates.

Worked with firm producing chromated copper arsenate to establish secondary sources for its copper, chromium, and arsenic raw materials.

As Technical Assessor reporting to the Tribunal for an international arbitration related to nickel production, was responsible for documenting agreements between 28 expert witnesses and providing technical assistance to the Tribunal during the trial.

Books

Meeting Chairman and Editor, Third Int. Symposium on Recycling Metals and Engineered Materials, TMS/AIME, Point Clear, AL (November, 1995).

Editor, International Symposium on Residues and Effluents Processing, The Metallurgical Society of AIME, Warrendale, PA (1991).

Editor, Symposium on Arsenic Metallurgy: Fundamentals and Applications, The Metallurgical Society of AIME, Warrendale, PA (1987).

Technical Publications and Presentations

Understanding Slag: A Metallurgist's View of Rotary Kiln Incineration, Coalition for Responsible Waste Incineration, Technical Meeting, Arvada, CO (2013).

Recycling Metal-Rich Industrial Products, Nickelhütte Aue's 375th Anniversary, Nickelhütte Aue, Aue, Germany (2010); Graduate Seminar Lecture Series, Colorado School of Mines, Golden, CO (2010).

Roasting Molybdenite – Today and in the Future, Materials Research Seminar, Colorado School of Mines, Golden, CO (2009).

Rich Country – Rich Wastes: Meeting Needs and Grasping Opportunities, MiMeR/Boliden Foresight Seminar, Lulea, Sweden (2008).

Recent Developments: Specialty U.S. Metals Recycling Plants, Recycling Metals from Industrial Waste Short Course, Colorado School of Mines, Golden, CO (2008).

Recycling Zinc in the United States, The EI Digest Gathering, San Diego, CA (September 2005).

Hazardous Waste to Valued Byproducts, The EI Digest Gathering, San Diego, CA (September 2004).

Recycling Non-Ferrous Metals from Industrial Waste, Hydrometallurgy 2003, AIME/TMS, 1543 – 1553.

U.S. Plants Operated Solely to Recycle Metal-Rich Secondaries, Extraction and Processing Distinguished Lecturer, AIME/TMS Annual Meeting (2001).

Recycling Lead and Zinc in the United States, Zinc and Lead Processing, The Metallurgical Society of CIM, 127 – 153 (1998).

Production of Copper Chemicals from Secondary and Byproduct Sources in the United States, Journal of Metals, 34-37, 49 (October, 1997).

Production of Byproduct Mercury, Journal of Metals, 24-28 (October, 1995).

State of the Art in Mercury Recycling, Intl. Symp. on Treatment and Minimization of Heavy-Metal Waste, AIME/TMS Annual Meeting, Las Vegas (Feb. 1995).

Secondary Zinc Production and Waste Minimization, Pollution Engineering, 42-44 (November, 1994).

U.S. Mercury Recyclers Expand Process Capabilities, Hazmat World, 31-34 (February, 1994).

Recycling Lead and Zinc in the United States, 4th Intl. Symp. on Hydrometallurgy, Salt Lake City (1993).

Waste Minimization: Recycling of Spent Lead-acid Batteries, Hazmat World, 34-37 (August, 1993).

Slag Control in Rotary-kiln Incinerators, Pollution Engineering, 26-32 (January 15, 1992).

Producing Zn/Fe-Based Micronutrient from Copper Flue Dust, Intl. Sym. on Processing Residues and Effluents, San Diego, TMS/AIME, 239-254 (1992).

Application of Slag Technology to Recycling of Solid Wastes, Intl. Incineration Conf., Knoxville (1991).

Optimizing Matte and Slag Composition in Rotary- Furnace Lead Smelting, Intl. Symp. on Primary and Secondary Lead Processing, 145-178, Halifax (1989).

Processing Petroleum Coke to Recover Vanadium and Nickel, Hydrometallurgy, vol. 22, 3-24 (1989).

Germanium Recovery at Lang Bay, CIM Bulletin, 79(886), 92-97 (February, 1986).

Iron Control during Hydrometallurgical Processing of Nickel Laterite Ores, Iron Control in Hydrometallurgy, The Metallurgical Society of CIM, 76-105 (1986).

Silica in Hydrometallurgy: An Overview, Canadian Metallurgical Quarterly, 25(3), 201-209 (1986).

Control of Autoclave Scaling during Acid Pressure Leaching of Nickeliferous Laterite, Metallurgical Transactions B of AIME, 433-440 (1984).

Control of Silica Deposition during Pressure Letdown of Acidic Leach Slurries, Third International Symposium on Hydrometallurgy, 121-137 (1983).

Soda Ash Digestion of Scheelite, Extr. Metallurgy of Refractory Metals, AIME/TMS, 237-267 (1981).

Ion Exchange Purification of Ammonium Molybdate Solutions, Hydrometallurgy, vol. 6, 63-73 (1980).

Fluid-bed Electrolysis of Nickel, Metallurgical Transactions B, 659-666 (December, 1979).

Leaching of Cu/Ni/Fe Matte, Canadian Metallurgical Quarterly, Met. Soc. of CIM, 18, 145-153 (1979).

Nickel/Cobalt Separation by Ozonation, CIM Bulletin, 74-81 (October, 1978).

Leaching of Nickeliferous Limonites, Metallurgical Transactions B of AIME, 547-554 (December, 1977).

Processing WO_3/SnO_2 Concentrate for Brannerite Removal, AIME/SME Met. Trans., 218-221 (1975).

Turbine Mixer Fundamentals and Scaleup at Port Nickel, Met. Trans. B of AIME, 149-157 (1975).

Atmospheric Leaching of Nickel-Copper Matte at Port Nickel, CIM Bulletin, 74-81 (February, 1974).

Nitric Acid Processing of Copper Concentrates, AIME-SME Met. Transactions, 117-123 (June, 1973).

Acid Bake / Leach / Flotation of Molybdenite, Met. Transactions of AIME, 23-27 (November, 1971).

Sulfation of Copper/Iron Sulfides with Concentrated Sulfuric Acid, Journal of Metals, (December, 1970).

Kinetics of Scheelite Dissolution in Alkaline Solutions, Met. Trans. AIME, 2451-59 (Nov, 1969).

U.S. Patents

Autoclave Control during Pressure Oxidation of Molybdenite: U.S. Patent 6,818,191 (2004).

Producing Pure MoO_3 from Low-grade Molybdenite Concentrates: U.S. Patent 6,730,279 (2004).

Pickling of Refractory Metals: U.S. Statutory Invention Registration H2087H (2003).

Inhibiting Lead Leaching in Water: U.S. Patents 5,544,859, 5,632,285 & 6,013,382 (1996, 1997, 2000).

Electrolytic Dissolution and Control of NiS Scale, U.S. Patent 4,627,900 (1986).

Recovery of Alumina Values from Alunite Ore, U.S. Patent 4,618,480 (1986).

Stripping of Tungsten from Organic Solvents, U.S. Patent 4,450,144 (1984).

Recovery of Vanadium and Nickel from Petroleum Coke, U.S. Patent 4,443,415 (1984).

Silica Control during Acid Pressure Leaching of Nickel Laterite Ore, U.S. Patent 4,399,109 (1983).

Precipitation of Low-sulfur Calcium Tungstate, U.S. Patent 4,397,821 (1983).

Digestion of Scheelite Concentrates, U.S. Patent 4,351,808 (1982).

WO_3 Feedback Control When Producing Ammonium Paratungstate, U.S. Patent 4,325,919 (1982).

Combined Treatment of Wolframite and Scheelite, U.S. Patent 4,320,096 (1982).

Processing of Refractory Tungsten Concentrates, U.S. Patent 4,320,095 (1982).

Upgrading of Scheelite Concentrates, U.S. Patent 4,313,914 (1982).

Separation of SiO_2, P_2O_5 and F from Tungsten Liquors, U.S. Patent 4,311,679 (1982).

Separation of Molybdenum from Tungsten, U.S. Patent 4,303,623 (1981).

Processing Concentrates Having a High MoO_3/WO_3 Ratio, U.S. Patent 4,303,622 (1981).

Electrolytic Cell for Oxidation of $Ni(OH)_2$, U.S. Patent 4,183,792 (1980).

Ion-exchange Process for Recovery of Copper and Nickel, U.S. Patent 4,100,043 (1978).

Selective Leaching of Ni/Cu/Fe/S Matte, U.S. Patent 4,094,754 (1978).

Sulfuric Acid Leaching of Nickeliferous Laterite, U.S. Patent 4,044,096 (1977).

Separation of Cobalt from Nickel by Ozonation, U.S. Patent 4,034,059 (1977).

High-temperature Neutralization of Nickel Laterite Ores, U.S. Patent 3,991,159 (1976).

Atmospheric Leaching of Nickel-Copper-Cobalt Matte Containing Iron, U.S. Patent 3,962,051 (1976).

Selenium Rejection during Acid Leaching of Nickel-Copper Matte, U.S. Patent 3,959,097 (1976).

Separating Copper, Lead, and Insol from Molybdenite Concentrates, U.S. Patent 3,834,893 (1974).

Nitric Acid Process Chalcopyrite Concentrates, U.S. Patent 3,793,429 (1972).

Projects That Involved Zinc and Lead Extractive Metallurgy

Worked with venture capital firms to evaluate the current capabilities and future potential of U.S. zinc smelters.

At a zinc monohydrate plant, improved leach circuit operation, and the quality of copper and cadmium cementation byproducts, then converted the leady leach residue to a commercial product.

Prepared a summary of U.S., Canadian and Mexican steel-mill outputs of electric arc furnace (EAF) dust; detailed alternative methods in use for recovering zinc therefrom; and worked with client to implement dust processing improvements.

Evaluated alternative methods for zinc recovery from a manganese-rich silver ore, including assessing production of electrowon metal vs micronutrient.

Physical and thermal processing of spent alkaline batteries to recover zinc oxide fume and a iron-manganese calcine.

Evaluated primary zinc plant (roast/leach/electrowin) as an acquisition candidate for processing sphalerite concentrate output from a proposed mine/concentrator.

Worked with operating management to improve yield at a plant recovering zinc slab, zinc granules, and micronutrient fines from skimmings.

Developed technical and marketing criteria to profitably recover zinc-iron sulfate micronutrient from secondary copper smelter dust.

Studied alternative raw materials and technologies for preparing zinc oxide and hydroxide secondaries to be processed by leaching and purification, followed by electrowinning.

Provided technical support and economic evaluation for a power plant preparing to produce ZnO byproduct recovered from combustion of tires. Worked with a second power plant to improve zinc recovery.

Worked with EPA contractor to assemble “a guide on recycling low-metal-content wastes for use by decision makers at superfund, RCRA, and other waste sites.”

Prepared secondary-lead-plant operating criteria for the International Lead Management Center for a third-world plant, including a leach circuit for desulfurizing the reverberatory furnace feed.

Worked with a major U.S. chemical manufacturer and North American secondary lead smelters to process sludge and soil contaminated with tetraethyl lead.

Assisted a lead-acid battery recycler with blast furnace formulations to maximize slag environmental acceptability without significantly affecting production efficiency.

Assisted in developing a method to minimize lead transfer into tap water. Our modified procedure for manufacturing bronze valves was then implemented by a major water-valve producer.

Established means to predictably integrate diverse waste byproducts from lead chemical production into a spent lead-acid-battery rotary-furnace operation.

Developed a slag solidification procedure to minimize concentration of cadmium and lead reporting to the leachate in the EPA’s TCLP procedure.

Upgraded operating practices of furnaces converting drosses to Sn-Pb solder, resulting in the doubling of furnace output while improving yield by over 20%.