***Qualifications:*** *BSc Metallurgical Engineering (1974); University of British Columbia*

 *SME Registered Member*

***Career Summary:***

*More than 45 years of varied process experience at all levels of project development from laboratory development through preliminary, and detailed engineering and continuing through commissioning, startup, and operations supervision. Skilled in process modelling with tools such as Metsim and HSC. My career has been broad based covering projects in the hydro and pyrometallurgical, industrial minerals, chemical, and environmental industries. Through much of my career I have worked as a lead process engineer responsible for preparation of PFD’s, mass balances, process design specification, equipment sizing and specification, utility, and operating cost evaluation, bid evaluation, commissioning, start-up and process optimization*. *In Jan 2016 I formed my own consulting company and have worked for a number of clients, both on the engineering and owner’s teams performing engineering studies, technical evaluations, and economic analysis.*

***Career History:***

January 1, 2016- Present

Mike Rockandel Consulting LLC

President

Technical specialist for Amman Industri 900 kt/a copper smelter in Indonesia. I have been responsible for the design of the electro-refinery, slag mill, precious metal refinery and the effluent treatment plant. My integrated mass and heat balance for the entire smelting complex has been used extensively to check/confirm and in many cases adjust the Outotec model. The project is in progress and I remain involved.

Assisting Lithium Nevada in the development of their clay-based lithium project. My duties have included flowsheet development, simulation, and optimization of the process, preparation of specifications and assistance with equipment selection.

Providing process support to Hanlon Engineering in the replacement of the pond based Freeport McMoran molybdenum leach decant system.

Supported Hanlon Engineering in a due diligence evaluation of Nevada Copper’s concentrator which is processing a small tonnage of underground ore.

Supported Agapito Associates Incorporated (AAI) to in the preparation of the 2020 SEC SK-1300 Resource/Reserves for Intrepid Potash New Mexico (IPNM). As a Qualified Person I was responsible for the evaluation of the plant technology and site operating costs. This included: solution mine (HB), West Plant, Langbeinite processing and product compaction and Glazing. Supporting Agapito in preparation of SK-1300 for Intrepid’s Wendover and Moab Solar projects.

Supported SRK in Due Diligences related to: Morton Salt, Mercedes Gold/Silver operation and Cozamin copper concentrator.

Evaluated the plant improvements necessary to re-start of the Intrepid Potash New Mexico (IPNM) West Plant following the plant shutdown in 2016. The study required the preparation of annual and life of mine mass balances, operating costs, and the re-start capital cost. The West Plant is low grade (13-16% K2O – sylvite + halite) and utilizes a combination of; two-stage crushing, grinding, attrition scrubbing, cyclones, screens, and flotation and centrifuges to produce a +60% K2O product.

Supported SRK in the preparation of a due diligence of the surface facilities for a planned capital investment into the Mercedes (Premier) Mine Sonora, Mexico.

Supported SRK in the preparation of a due diligence of the surface facilities for a planned capital investment into the Cozamin (Capstone) Mine in Zacatecas, Mexico.

Supported SRK in the preparation of a due diligence for the Sale by K&S or the Morton Salt assets. The Morton salt evaporative, solar, and processing plants were evaluated.

Supported Hanlon Engineering in the preparation of the Capstone Pinto Valley (PV3) expansion study. This work included evaluation of the existing asset, preparation of an integrated mass balance model, and updated operating for the facility from crushing through tailings.

Following completion of the hydromet test work, the Eurobattery study for production of high-grade nickel and cobalt sulfate and/or Mixed Hydroxy Precipitates was updated. Mass and energy balances along with updated operating costs were prepared.

Performing a preliminary process design and capital cost estimate for a copper smelter precious metals refinery for Masan Resources. The smelter feed posed numerous challenges such as, high bismuth and a lack of lead and arsenic.

Performing a technical and economic analysis for a potential investor in a clay-based lithium resource in Nevada, USA. The owner’s goal is through hydrometallurgical processing to make battery grade lithium carbonate and lithium hydroxide. The process is large and complex including beneficiation, leaching, solution purification, de-watering, several stages of crystallization. The project is in progress.

Performing a technical and economic analysis for a potential investor in a copper, nickel, and cobalt ore. The owner’s goal is to produce copper and nickel-cobalt concentrates. The study includes the evaluation of a hydrometallurgical upgrade of the nickel-cobalt concentrate to battery grade nickel sulfate. The project is in progress.

Prepared and delivered a process engineer tutorial for US Borax. This included the preparation of process models for the primary and boric acid processes, discussion on mass balance alternatives and the preparation of design documents from process engineer perspective.

Performed process evaluation in support of a potential purchase of the Tronox soda ash plant in Wyoming.

Lead process engineer for Tata chemicals Wyoming preliminary engineering study for a proposed 1.8 M t/y solution mine soda ash plant.

Lead process engineer for American Pacific Borate and Lithium pre-feasibility study (in-situ) colemanite leach process producing 90,000 t/y of boric acid. This project is now advancing to the FEED stage. This project includes a Mannheim potassium sulphate production facility. The project is in progress.

Performed a production evaluation and energy intensity reduction study for Tata’s Magadi Soda Ash Plant (Kenya). The project is in progress.

Providing process design and order of magnitude economics to Ciner, Wyoming (formerly OCI) for several potential expansion projects. Assisted with optimization of the Decahydrate recovery options plant troubleshooting and dust mitigation. Designed a chemical caustic plant. Simulated and developed a strategy to reduce water input to the evaporative ponds. Design a causticizing system that is now progressing. Oversaw various laboratory test programs. Lead engineer for a Class 3 engineering study evaluating a 1.1 Mt/a conventional expansion.

Technical advisor to FMI for their Grasberg Indonesian Smelter and electro-refinery. Lead process engineer for design of their proposed hydrometallurgical precious metals refinery. Duties included preparation of the electro-refinery and precious metal refinery process design criteria and mass/energy balances, review of PFDs, PIDs, test design and evaluation.

Providing process design to Rio Tinto Copper and Coal for their proposed primary copper sulphide heap leach demonstration project.

Prepared a smelter complex mass balance simulation (smelting, refining, anode casting, acid plant and precious metals recovery) for Rio Tinto Indonesia to assist with project evaluation.

Providing technical support to Rio Tinto Iron and Titanium for their developmental Ion Exchange recovery project. The project is currently dormant but remains in progress.

Helped Barr Engineering develop an unsuccessful bid to perform preliminary engineering for the Sevier Lake (Crystal Peak) potassium sulphate project. This included extensive review of the evaporative test work, numerous conversations with Swenson and the development of a mass balance to put forward an option for pond management.

November 2008 – December 2015

Rio Tinto, Technical and Innovation Group

Chief Advisor Process

Supervised and mentored two junior engineers and managed two senior engineers.

Participating in project planning and engineering reviews for copper smelter studies for Oyu Tolgoi and the Freeport (JV)

External Reviewer La Granja primary copper sulphide heap leach project.

Oyu Tolgoi integrated value chain evaluation member responsible for the flotation circuit.

Project lead on Kennecott Utah Copper (KUC) copper recovery from acid mine drainage. Various options were examined before settling on cementation using vibrating ball mills with consumable steel media.

Engineering manager for Phase 2 – Oyu Tolgoi (65,000 t/d) copper/gold concentrator in Mongolia. Duties included project engineering, document review, development of; annual water balance, mass balance, design criteria, operating cost LOM development and final report write-up.

T&I representative for the detailed design of KUC Molybdenum Autoclave Project. Lead the development of modification of: Rhenium Continuous IX design, Molybdenum Oxide two-stage calcination, selenium removal and various other optimization studies. Coordinating the transition of the molybdenum flotation plant (52% Mo) to producing MAP grade concentrate (24% Mo). Numerous economic and trade-off studies. Developed and maintained the process mass and energy balance.

Project Lead for KUC smelter Continuous Ion Exchange (CIX) Rhenium recovery project. This culminated in a commercial installation.

Lead the study for KUC slag concentrate leaching.

Participated in several projects in the KUC precious metal and hydromet plants, including the cessation of dust leaching, tellurium recovery, Au SX, etc,

T&I representative on KUC refinery cathode quality study.

T&I representative on the elevated temperature bio-heap leach SX/EW project (chalcopyrite/pyrite). Duties included technical reviews and consultation to the plant personnel.

Lead the development of an integrated mass/energy balance (Metsim) for KUC smelter, refinery, PMR, slag mill and Hydromet plant. This model has become the RTKUC tool to determine suitability of custom concentrates and to determine impurity fate. The model is being modified to simulate Oyu Tolgoi and Freeport (Indonesia) smelter studies.

Lead Iron Ore of Canada tailings flume modifications and re-optimization of the AG mill and spiral circuits. Supervised the development of an integrated concentrator/pellet plant mass balance.

Supported the US Borax design efforts to reduce sulfate in Owens Lake trona.

Evaluated the US Borax 5-Mole sodium borate production capacity. This included process modelling and evaluation of equipment capability and operating practices.

T&I representative to the Rio Tinto Minerals Jadar project – Lithium and Boron recovery in Serbia.

January 2008 – November 2008

Baja Mining

Manager of Process Engineer

Owner’s Representative for process engineering related to the development of Baja Mining’s proposed polymetallic plant that is being designed to produce 60,000 mtpa Cu, along with cobalt, zinc sulfate and manganese carbonate by processing 10,000 tpd of clay-based oxide ore. Duties included; over-seeing AMEC’s design effort, updating the mass/energy balance and design criteria, flow sheet optimization, testwork development and supervision. The project which proceeded and is in start-up, is complex including; copper SX/EW, zinc SX and zinc sulfate crystallization, cobalt SX/IX/EW, double contact acid plant, thermal de-salination, oxidative and SO2 reductive leaching and a 6-stage CCD.

2005 – December 2007

Aker Kvaerner

Senior Principal Process Engineer

Lead Process Engineer on Kennecott MAP molybdenum autoclave leach project

Assistant Process Engineer on Freeport McMoran Morenci copper pressure leach project.

Duties included preparation of specifications, vendor bid analysis, process simulation and equipment design

For Lihir, Papua New Guinea gold plant expansion feasibility study, included SAG mill and modifications to PAL and gold circuit

Developed material and energy balances for the Phelps Dodge high and medium temperature pressure leach processes.

Lead process engineer for the Gencor South Africa zinc pressure leach study.

Performed process simulation and debottlenecking calculations for the Lihir gold pressure oxidation plant.

2004– 2005

Rio Tinto Diavik Diamond Mine

Process Manager of Expansion Project

Coordinated data collection to identify process bottlenecks, managed the construction of a slewing conveyor as part of the process optimization and participated in several studies in the wash plant.

1996– 2004

Aker Kvaerner

Principal Process Engineer

Lead process engineer on numerous soda ash projects. My responsibilities included; management of the process team, design and test supervision, development of the Metsim based material and energy balances, PFD’s, PID’s, design criteria, specifications, bid analysis, start-up planning and commissioning/start-up supervision, etc. The soda ash projects that I lead included;

Rio Tinto – Kazan study

Park / ETI Bank - Beypazari study (1 mtpa). Worked with and educated the China engineering consortium that won the commercial contract for the solution mine.

Lake Magadi Pure Soda Ash study (350 ktpa). A novel flash calcination process and non-evaporative crystallization were developed and implemented commercially. Tata took this project through commercialization.

American Soda Ash (1 mtpa) – Nahcolite project (included start up supervision).

OCI Unit 6 expansion (1 mtpa) (included start up supervision)

IMC two-stage crystallizer expansion study at the Trona facility in which Burkeite and Borate would be recovered.

General Chemicals calcination optimization study.

Owens Lake study (1 mtpa) (this work continues to-date through US Borax but is now related to reduction of sulfate in the trona)

Texasgulf Solution mine study (1 mtpa)

Wold solution mine study

Botash – Botswana optimization study (focus was bicarbonate filters, calciners and plant ventilation)

Other projects;

Lead process engineer for Las Brisas, Venezuela, Copper/Gold definitive estimate.

Developed the mass and energy balances for the gas handling system upgrade at Inco’s nickel smelter in Sudbury, Ontario.

Updated mass and energy balances for the Thai Copper Smelter.

1991– 1996

Universal Dynamics

Process Manager

Supervised Alcan Aluminum, Kitimat BC, Two Dry Scrubber replacement and upgrade projects for potlines 1-3 and then 7 and 8. This included the installation of alumina injection, reaction ducting, dust recovery and pneumatic conveying systems for product alumina

Developed and co-invented a hydrometallurgical process for the removal and recovery of mercury from chlor-alkali plant water treatment residues. Three commercial plants were constructed in the USA.

Supervised and provided process design for a fluid bed sodium chlorate drying, pneumatic conveying and truck/rail bulk load-out system at BC Chemical, Prince George, BC.

**1988-90**

**Graeton Technology Ltd., Hong Kong**

**Plant Manger**

Supervised a plant with 60 employees. The PVC additive plant produced tri-basic lead sulphate by an autoclave leach and stearate based one-pack additives by batch fusion and continuous flaking

1978-1987

Cominco / Teck

Metallurgist/Research/Development Engineer

Process engineer and start-up coordinator for Cominco’s fume leach plant. This plant de-halogenated Lead slag fuming dust using a sodium carbonate leach allowing the residues to be leached in the roaster circuit.

For Cominco’s zinc pressure leach plant (first commercial medium pressure sulphide concentrate leach project), I was the plant and start-up superintendent, coordinated the start-up plan, was involved in operating manual preparation, operator training and late stage project design. Modelling and process design for a large 3-stage crossflow scrubber absorber smelter sinter plant off gas in an ammoniacal scrubber.

The lead process engineer for the PFS of Cominco’s proposed residue leaching plant based upon Akita Hematite technology.

Responsible for troubleshooting operating plants including bi-polar lead refining and lead refinery arsenic fluoride scrubbing.

Helped develop the Modbal program which was used to simulate Cominco’s modernization plan. Responsible for the simulation of several plant areas including; the acid plants, fertilizer operations and Kivcet smelter.

Developed a dynamic simulation of an ammonium sulfate scrubber for the zinc plant. The system was installed and performed as predicted. Ammonium sulfate scrubbing in complicated because of the need to avoid smoke and fog formation.

Lead process engineer on the de-bottlenecking and modification of the former Cominco Con Gold Mine arsenic trioxide plant. Sale of the property which occurred was contingent on successful demonstration of the plant capacity.

Worked for several weeks at the Cominco Vanscoy potash mine near Saskatoon, Canada. The work included several small projects around flotation, granulation and water level control in the mine.

1974-1978

Texasgulf

Research Metallurgist and Maintenance Engineer

Troubleshooting acid plant corrosion problems and leach plant pumping problems.

As a development engineer performed various assignments, tests and optimization studies in the Texasgulf copper/lead/zinc concentrator and gravity recovery tin circuit.

Was a team member on the unsuccessful development of a low temperature pressure leach process designed to treat low grade lead concentrate with substantial quantities of copper