



Equipment Solutions for High-Purity Salt Production from the Li-Ion Battery Recycling Process

NAATBATT LITHIUM BATTERY RECYCLING WORKSHOP VII
July 23rd, 2024

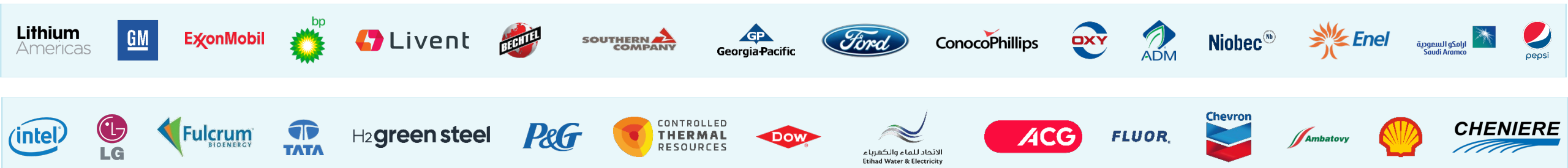


About Aquatech



Aquatech is a leading global **provider of process technology solutions** for **water** and **critical minerals**. With over 40 years of experience, Aquatech has developed the expertise and the experience of deploying **cutting-edge technology solutions and services** that significantly contribute to **Critical Minerals Security**.

<p>Valuable Outcomes for Our Clients:</p>	 <p>Refine & Purify Critical Minerals</p>	 <p>Recover Water Through Reuse & Desalination</p>	 <p>Reduce Costs of Disposal</p>	 <p>Improve Performance of Operating Plants</p>	 <p>Achieve & Sustain Environmental Compliance</p>
---	---	--	---	--	---



The Challenge for Battery Recyclers

Investors in the space require a **low technology risk approach** that delivers optimization and budget certainty.



Market Dynamics

Volatile EV Demand & Pricing

Demand & price fluctuation impacts offtake agreements and project financing dynamics.

Critical Minerals Security

Regionalization of supply chains as a result of concerns about supply chain security and ESG



Industry Challenges

Cost and Schedule Certainty

Unpredictable build costs and relative inexperience in project execution

Process Flowsheet Optimization

Definition of a reliable equipment solution from solvent extraction to intended purity



Risk Management

Equipment Technology Partner Selection

Selecting the right partner(s) will prevent the pitfalls of piecemeal equipment selection and unpredictable construction budget.

Effective Performance Guarantees

The importance of securing guarantees for the performance of overall project deliverables.

Aquatech Equipment Offerings for Li/Co/Ni Crystallization from Solvent Extract Stream



- Ion Exchange systems
- Ultrafiltration systems
- Phys/Chem Treatment Systems
- Spray Film Evaporators
- Vertical Tube Falling Film Evaporators



- Draft Tube Baffle Crystallizers
- Forced Circulation Crystallizers
- Reactive Crystallizers



- Re-Pulp
- Re-Crystallization



Recycling Process Raffinate

Raffinate from recycling process

Brine containing

- Ammonia
- Metals
- Sodium Sulfate
- Lithium
- High TDS –
20,000 – 70,000 mg/L

Treatment Technologies

Ammonia Stripping/Phys Chem Treatment

Bi-polar Electrodialysis for Sodium Sulfate to Caustic and Sulfuric Acid

Thermal Evaporation and Crystallization

Osmotically Assisted Reverse Osmosis

Fractional Electrodeionization

Aquatech has **in-house** technologies to meet the following raffinate handling goals:

- Salt & Lithium Recovery
- Compliance Discharge / Zero Liquid Discharge
- Water Recovery & Reuse



Equipment Solution Ramp-Up with **Applied Development & Testing**

Process Development

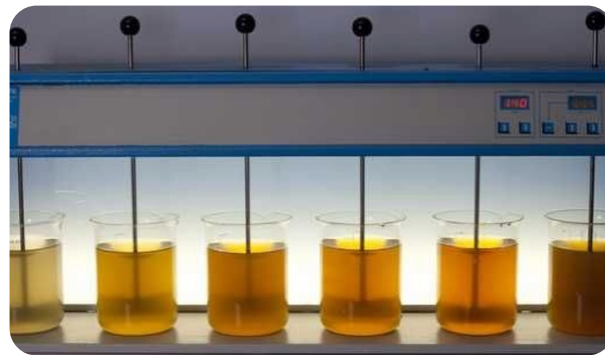
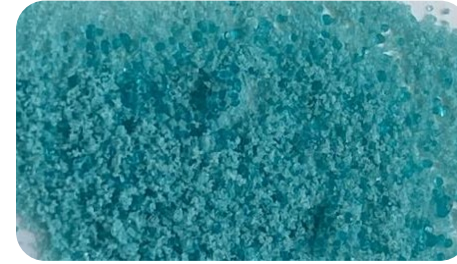
- Bench-Top Testing
- Process Simulation

Process Demonstration

- Pilot Testing
- Product Samples for Market

Product Characterization

- Elemental Analysis
- Microscopic Imaging
- Property Determination



**Aquatech's Applied Development & Testing Facility
Hartland, Wisconsin**

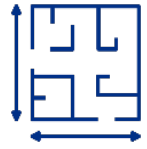
Process Train Methodology for High Purity Salt Production Optimization

Multiple Iterations

Extract/Raffinate Conditioning – Evaporation – Crystallization



Overall Recovery



Footprint



Water Balance &
Losses



Chemical Consumption



Capital Investment



Energy Balance

Modularization Cost & Schedule Certainty

Key Considerations

- Built in Aquatech's 100,000 ft² fabrication shop.
- Logistically compatible for transport in North & South America
- Plug-and-play design
- Designed to handle variable solvent extract/raffinate quality
- Reduce the site installation factor to around 2x from the typical 4x
- Delivery in 18-22 months

Modules for 3-5 KTPY Facility

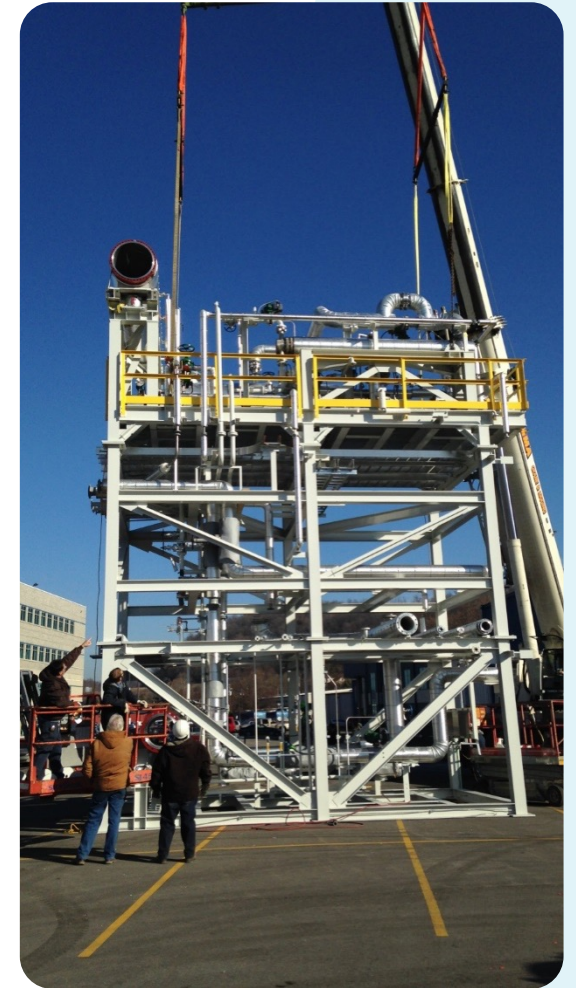
Concentration	Membrane Systems - Evaporator
Conversion	Crystallization & Bicarbonation
Refining	Ion Exchange & Crystallizer



Module Assembly

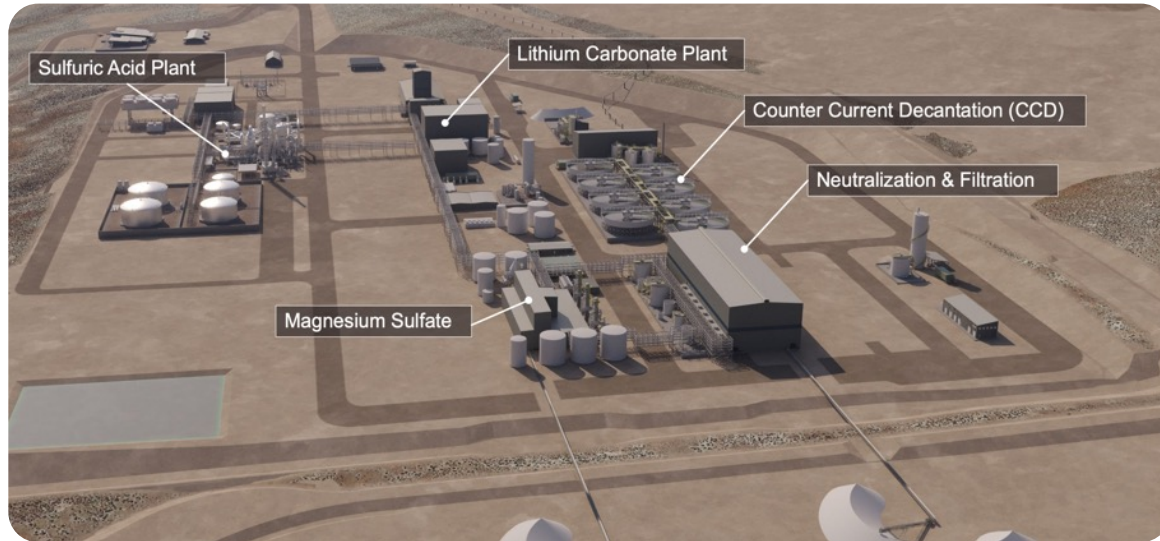


Module Fit-Up



Final Assembly

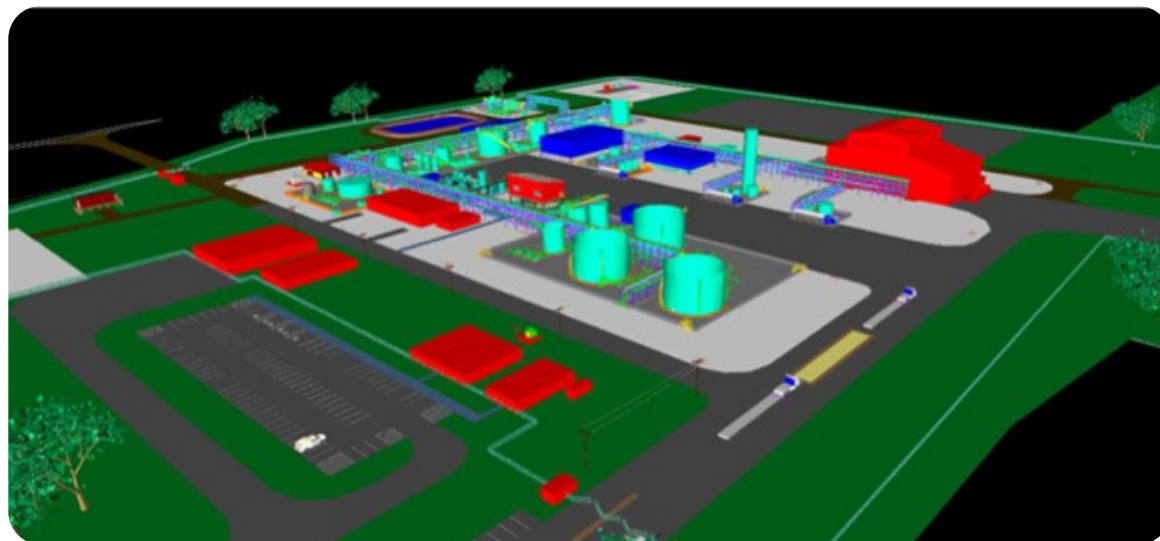
Reference Projects in Upstream Lithium Supply Chain



Lithium Americas – Thacker Pass Project



Salar Brine – Confidential Project



Smackover Brine – Confidential Project



Controlled Thermal Resources – Hell's Kitchen Project

Reference Projects Globally



United States & Canada

- Deer Park Energy* (54MLD)
- Orascom Iowa* I & II (24MLD)
- Sabine Pass* I, II, III, IV (30MLD)
- Salt River Project (83MLD)
- Puerto Rico Electric* (8MLD)
- Brazos Electric* Multiple Projects (45MLD)
- MEG Energy* (17MLD)
- Tenaska* (34MLD)
- Pastoria (28 MLD)
- Calpine Corp.* Multiple Projects (274 MLD)
- Kemper (5 MLD)
- Chevron REG (0.4 MLD)
- Fulcrum Sierra Biofuels (1 MLD)
- Oxy 1PointFive Stratos (6 MLD)
- Lithium Americas
- Controlled Thermal Resources

South America

- Bechtel Chile LTDA (142 MLD)
- Petroleum Co. of Trinidad & Tobago (24 MLD)
- Compania Mega SA (2 MLD)
- Continental Gold Buritica (14 MLD)
- Water-en Energiebedrijf (36 MLD)
- Lithium Client - Argentina

Europe

- ENEL (Italy)* (11 MLD)
- Ras Laffan Petro* (23 MLD)
- Spalding Energy (19 MLD)
- Winnington (13 MLD)
- Italsider (11 MLD)
- H2Green Steel (56 MLD)

Middle East & Africa

- Oman Oil* (20 MLD)
- Aramco* (195 MLD)
- KOC Kuwait (32 MLD)
- Mukhaizna Oman (141 MLD)
- Shell (Qatar) (26 MLD)
- FEWA (UAE) (68 MLD)
- Egyptian Ethylene & Derivatives Co.* (26MLD)

- Sete Energy Saudia (4 MLD)
- SCECO (46 MLD)
- Jeddah Airport (KSA) (45 MLD)
- DMSA Madagascar (85 MLD)
- Aegean Refinery* (12 MLD)
- Petro Development Oman* (11 MLD)

China

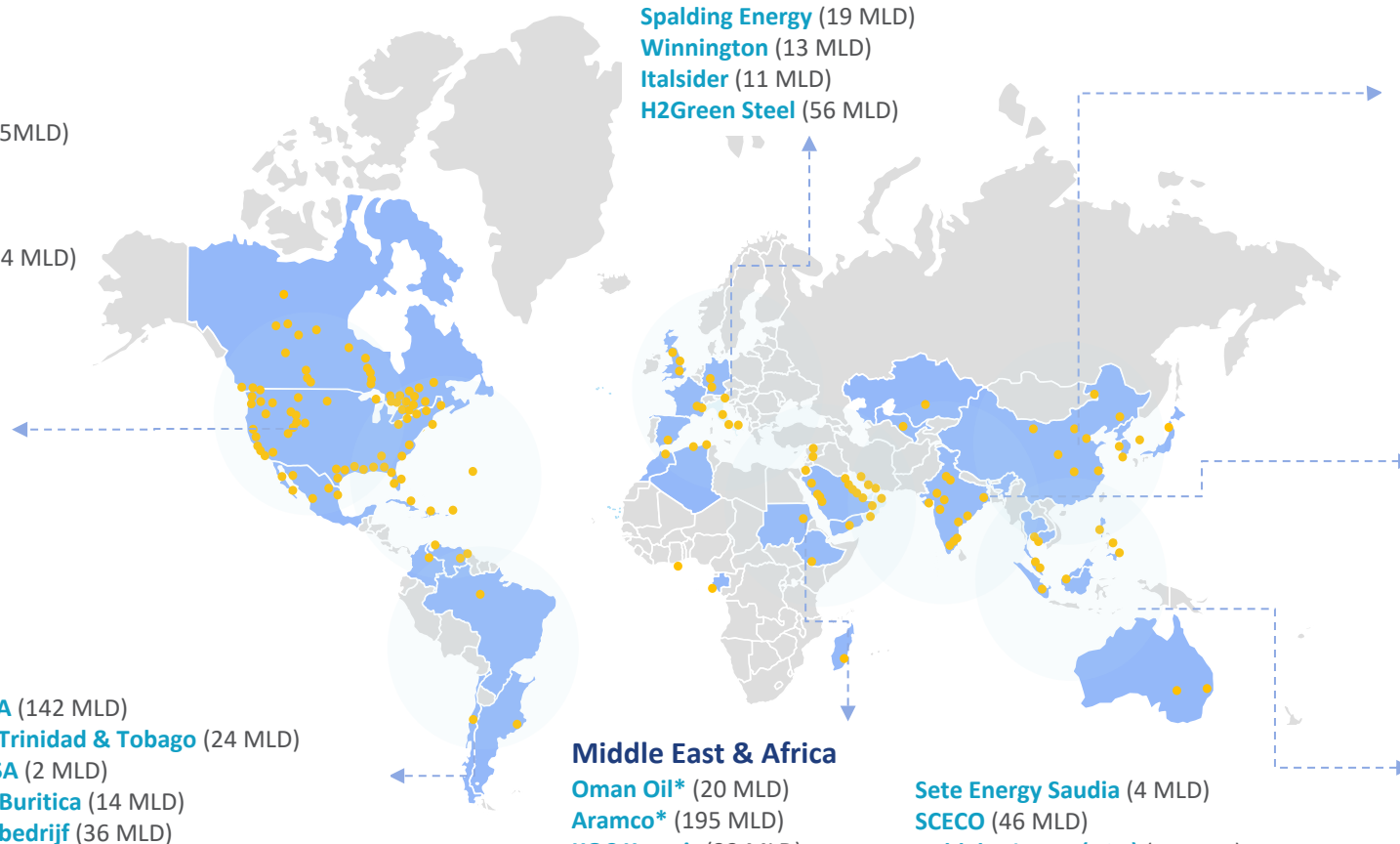
- Shenhua Ningxia Coal* (66 MLD)
- CNOOC & Shell Petro. (29 MLD)
- China Huadian (29 MLD)
- ChinaCoal Xian* (19 MLD)
- Inner Mongolia Huineng Coal (6 MLD)

India

- GWIL (270 MLD)
- CGPL* (25 MLD)
- Nirma-I* (15 MLD)
- Nirma-II* (16 MLD)
- CEPL* (38 MLD)
- HMDA* (55 MLD)
- RIL* (186 MLD)
- MIAL* (10 MLD)
- Tata Steel (25 MLD)
- HPCL Mittal (64 MLD)
- Serum Institute of India* (5 MLD)

Southeast Asia

- Pertamina (99 MLD)
- JEWEL Singapore (30 MLD)
- Shell Thailand (10 MLD)
- LG Electronics Korea (25 MLD)



Aquatech's Value Proposition for Battery Recycling Projects

Overcoming Equipment Flowsheet Development Risk

- Several Projects with uncertain budgets
- Technology Risks
 - Achievement of consistent product quality
 - Risks associated with piecemeal procurement of equipment

Overcoming Project Execution Risks

- Delivery of the project on time
- Technical expertise for operation

Value Aquatech Adds

- Providing performance guarantee for process downstream of solvent extraction
- 40+ years of relevant technology development experience
- Evaluate multiple flowsheets for high purity EV metal production and byproduct management

Value Aquatech Adds

- Experience with delivering complex, integrated equipment systems
- Modular Systems to give more certainty
- Can take over the Operation and train the site



Ashu Sharma
Project Development Manager

✉ ansharma@aquatech.com

☎ +1 (412) 916 8888



www.aquatech.com

