# Lithium Mining Optimization and Sustainability

*Innovative measurement instruments are critical for improving the efficiency of lithium extraction and addressing sustainability challenges, while ensuring personnel safety.*

EMERSON™

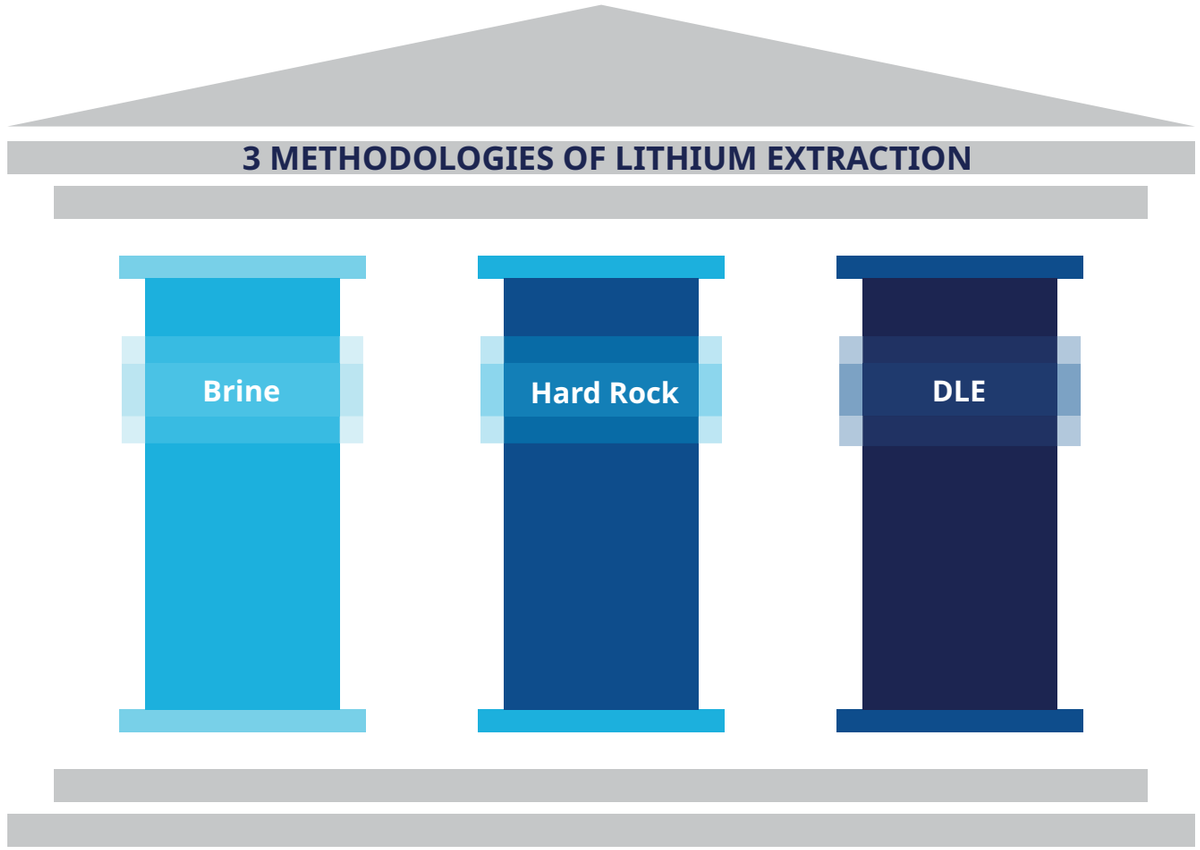
# OVERVIEW

As modern civilization works to move from fossil fuels to non-carbon based energy sources, the use of battery storage for countless applications is growing rapidly, particularly in electric vehicles (EVs) and its substantial kilowatt-hour intensity needs. The battery technology that leads all others today in terms of energy density is based on lithium, with commercialized versions of lithium ion (Li-ion) and lithium polymer (Li-po) assemblies powering everything from laptops and smartphones to EVs.

Global demand for EVs has been very strong in the last decade since 2016, keeping lithium and battery production at high-capacity levels. This creates an opportunity for all segments of the lithium industry to examine production processes at all levels, considering ways to improve efficiency, sustainability and safety.

In this eBook, we will focus on the upstream segment of lithium production, capturing it from two primary sources; solution brines and hard rock spodumene, up to lithium carbonate or lithium chloride compounds. Lithium is different from most metals because it is not refined to a pure metallic state, like copper or gold. Lithium must instead be refined from solutions or hard rock ore with very low concentration, and ultimately turned into high purity compounds, such as lithium carbonate and lithium hydroxide. The processes necessary to carry out this refinement are resource intense and costly. As such, production efficiency is highly dependent on effective measurement and control of operations.

We will discuss three methodologies of production: Brine Evaporation Ponds, Direct Lithium Extraction (DLE), and Hard Rock, explaining the many steps for each process, showing how effective instrumentation can be used to increase production efficiencies, sustainability and safety. Additionally, Emerson's offers industrial wireless technology with a wide variety of WirelessHART® devices that enable customers to operate remote locations easily and economically.



# 1 Brine

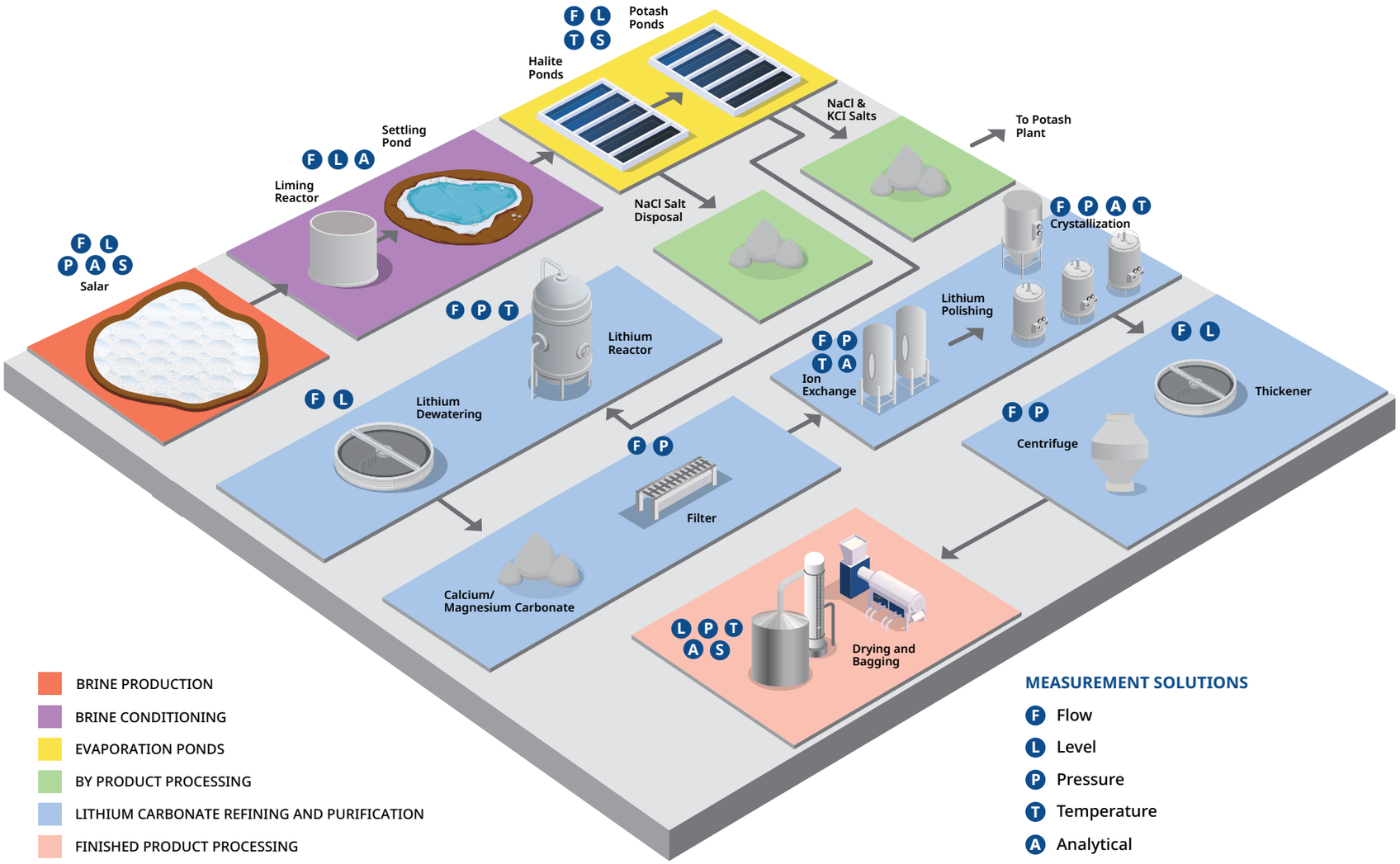



**FIGURE 1**

*Lithium extraction using evaporation ponds.*

# Plantweb Insight™ Applications Matrix: Brine

| | PUMP | WIRELESS PRESSURE GAUGE | NETWORK MANAGEMENT | NON-INTRUSIVE CORROSION | POWER MODULE | CONNECTED LIGHTING |
|---|---|---|---|---|---|---|
| Salar | ● | ● | ● | | ● | ● |
| Liming Reactor | ● | ● | ● | ● | ● | ● |
| Potash Ponds | ● | ● | ● | | ● | ● |
| Lithium Reactor | ● | ● | ● | ● | ● | ● |
| Lithium Dewatering | ● | ● | ● | | ● | ● |
| Crystallization | ● | ● | ● | ● | ● | ● |
| Lithium Polishing | ● | ● | ● | ● | ● | ● |
| Ion Exchange | ● | ● | ● | ● | ● | ● |
| Filter | ● | ● | ● | | ● | ● |
| Thickener | ● | ● | ● | ● | ● | ● |
| Centrifuge | ● | ● | ● | ● | ● | ● |
| Drying and Bagging | | | ● | | ● | ● |

# LITHIUM EXTRACTION VIA EVAPORATION PONDS

Lithium is highly reactive and therefore rarely exists in its elemental metallic form. Where lithium does exist, it is a relatively minor component of various natural minerals, with concentrations typically under 1% or 10,000 milligrams per liter. One of the two main commercialized extraction processes begins with underground brine solution deposits that carry lithium salts in concentrations ranging between 200 to 4,000 milligrams per liter.

As brine moves from the well field through a series of settling and evaporation ponds, and on to the chemical processing plant, operators must evaluate lithium compound solution concentration levels as water evaporates from the solution.

**Level measurement in ponds —** When a pond is in a static state with no new flow in or out, it is important to determine how much water has been lost due to evaporation, as the lithium compound solution gets concentrated. Emerson's **Rosemount™ 5408 Non-Contacting Radar Level Transmitter** can be mounted above the pond's surface to measure the level of the pond in real time. With accuracy of ±2 mm, it is possible to determine how quickly water is being lost from the evaporation pond. This instrument also provides the information for determining how much water is left to be evaporated, or if the solution is ready for the next step of processing. Monitoring water temperature in evaporation ponds is crucial, as it influences the evaporation rate, which is tracked and estimated based on the water level and temperature. The Emerson **Rosemount 648 Wireless Temperature Transmitter** is well suited for this application.

**FIGURE 1.1**

*Emerson's Rosemount 1208 Non-Contacting Level and Flow Transmitter can be paired with the Rosemount 3490 Controller to measure the pond level and determine the evaporation rate.*

**Level in brine wells and pipe leak detection —** Processing begins with extraction wells drilled into these deposits to pump brine to the surface, where it is stored in open evaporation ponds. This creates higher mineral concentrations in brine solutions, ideal for additional processing. These brine deposits must be managed, cycling production between multiple wells at different times, depending on brine solution levels, giving time to depleted wells to recharge.

Well management requires continuous level monitoring of the brine to optimize production and preserve local ground water sources. The Emerson **Rosemount 3051S Submersible Level Transmitters** work well in this application.

**Brine conductivity —** Conductivity is a useful indicator of concentration, which is used in lithium brine production wells. It helps indicate the salinity of the brine, so that pumping can be halted when brine concentration gets too low. This helps prevent inadvertent pumping of fresh water, a potential environmental compliance issue. Additionally, if lithium concentration in some brines becomes too low, it will impact the recovery of the process thus increasing cost and water usage. Conductivity can be measured using Emerson's **Rosemount 228 Toroidal Conductivity Sensor** shown in Figure 1.2. It can handle the high conductivity of well production with a range of up to 2 S/cm (2,000,000 µS/cm). These conductivity sensors work well in the harsh and corrosive applications common to extraction sites, where metal electrode sensors have a short service life.

**FIGURE 1.2**

*Emerson's Rosemount 3051S Submersible Level Transmitters perform effectively in continuous well level monitoring of the brine, which is essential for optimizing production.*

**Pump condition monitoring —** Slurry pumps in lithium mining application can potentially have a short service life and cause unplanned outages, as is the case in most mining applications. Emerson offers a Pump Health Smart Wireless solution, designed to monitor the condition and performance of pump and motor installations. It uses a set of vibration and temperature sensors, such as the **AMS Wireless Vibration Monitor** (Figure 1.3), and WirelessHART pressure, temperature, and level sensors to monitor critical variables on rotating equipment. These sensors provide rich information about the motor and pump health by continuously monitoring overall vibration, PeakVue measurements, temperature readings, discharge pressure, and strainer differential pressure.

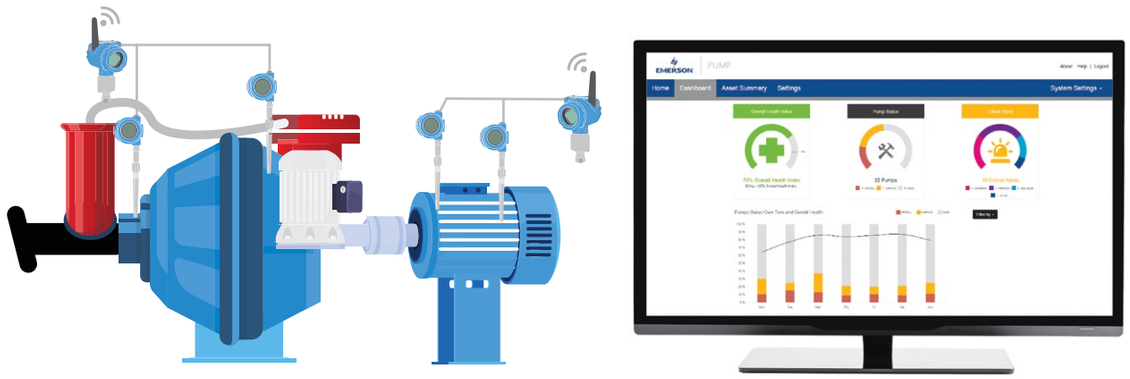



**FIGURE 1.3**

*Monitoring pump operations using WirelessHART sensors, including Emerson's AMS Wireless Vibration Monitor, can be combined with Plantweb Insight™ Applications for analysis and reporting.*

Data from the sensors can be displayed by **AMS Device Manager** or **Plantweb™ Insight Applications**, with alerts of developing problems sent to reliability, maintenance or operations teams. Additionally, if lithium concentration in some brines becomes too low, it will impact the recovery of the process thus increasing cost and water usage.

**Pipe integrity —** For the first steps of lithium extraction, it is necessary to pump brine from the wells through a series of ponds, as evaporation and concentration follows this processing sequence. This involves two critical mechanical maintenance areas: pipe leak detection and pipe constrictions caused by scale buildup.

Leaks can be detected and isolated by a combination of pressure and flow measurements. For example, if two flow meters are installed at opposite ends of a pipeline, any abrupt reduction in brine volume flow on the downstream flow meter compared to the upstream flow meter would indicate a leak somewhere in between them. Emerson's **Rosemount 8705 Magnetic Flow Meters** are excellent for this application.

Alternatively, Emerson's **Flexim™ FLUXUS® F731 Non-Intrusive Ultrasonic Liquid Flow Meter** (Figure 1.4) is a great fit for applications where downtime or pipe invasion is not required. It can be mounted on a pipeline without penetration through the pipe wall since the sensors use clamps to mount on the outside of the pipe. This makes it possible to change locations, facilitating troubleshooting without having to shut down flow or disassemble pipes.


**FIGURE 1.4**
*Emerson's Flexim FLUXUS F731 Non-Intrusive Ultrasonic Liquid Flow Meter can measure transfer flows without penetration through the pipe during installation. This non-intrusive instrument, makes it possible to take measurements at any location of piping, without shutting down the process.*

Loss of pressure can also indicate leaks as well as blockages. These are measurable using Emerson's **Rosemount 3051 Coplanar Pressure Transmitter** (Figure 1.5). It can be mounted in a variety of locations, with many connection options. Its 10-year stability and 150:1 range-down capability provides reliable measurements across a wide range of pressure applications. The **Rosemount 3051S Submersible Level Transmitters WirelessHART** version is especially useful in remote locations because it avoids the need for a wired connection.

**FIGURE 1.5**
*Emerson's Rosemount 3051 Coplanar Pressure Transmitter can be mounted using many connection options, and the WirelessHART version is well suited for remote locations.*

Taking both flow and pressure measurements makes it easier to determine if flow is being affected by leakage or blockage as these two conditions produce different pipe dynamic characteristics. With this information available, maintenance and operations teams can determine the issue and pinpoint the location where a leak is occurring. Leak detection is critical because leaks can lead to production losses, as well as environmental incidents. It is important to narrow down the location where a leak is detected because pipelines can be hundreds to thousands of meters long.

As brine flows through the pipes, minerals accumulate on the inner walls, which in turn may lead to reduced flow and potential blockages. Emerson offers smart solutions that can detect this build-up enabling customers to achieve optimal operational efficiency and maintain minimal disruption.

**Chemical processing of concentrated brine —**Once the brine solution has reached its highest practical concentration from evaporation, and some undesirable compounds have precipitated, solution begins its chemical treatment process to produce high-purity lithium carbonate.

**Mass balance and recovery control —** The chemical processing steps are designed to convert various other chemical compounds present in brine into forms that are more easily removable, while maintaining the highest levels of lithium compounds in the solution. For example, one chemical reaction with sodium hydroxide causes calcium carbonate and magnesium carbonate to precipitate, allowing them to be captured in a clarifier stage. The effectiveness of this reaction has a major impact on the ultimate lithium carbonate recovery. No chemical reaction is ever 100% effective, so controlling the conditions of this process is critical to maximizing lithium recovery.

To achieve the above, it requires controlling multiple physical and chemical variables, including fluid density, pH, ORP, and conductivity of all the process streams entering the reactors. Applying Emerson's **Micro Motion™ Coriolis Mass Flow Meters** on all the incoming streams, combined with measurements from strategically placed liquid chemistry sensors, provide an accurate picture of the reactants so they can be carefully balanced to ensure the highest possible reaction rate. This saves operating costs and improves product quality. For example, **Micro Motion Coriolis Flow Meters** can monitor chemical dosing and batching to a high precision, and Rosemount pH sensors can confirm the acidity and alkalinity of fluids.

Eventually, the final reaction in the series causes the lithium carbonate to crystallize so it can be removed via clarification. When mass balance of this reaction is carefully controlled, the highest quantity and quality of lithium carbonate is possible to be recovered from the brine. It is critical to minimize the amount of water used in the lithium recovery process to comply with environmental regulations and best practices. Liquid chemistry can be monitored using **Rosemount 396P pH/ORP sensors** with the **Rosemount 1058 Dual Channel Transmitter**. Also, the **Rosemount 3051S Submersible Level Transmitters** and **Rosemount 648 Temperature Transmitters** help to ensure optimized reactor performance.

**Filtration —** Solids from the thickener or clarifier still have excessive water content. Most of this water can be removed via filtration. Filtration requires optimal dense slurry flow and optimal pressure to maximize water removal. A **Rosemount 3051S Submersible Level Transmitters** can measure the differential pressure across the filter media to detect when to replace the media.

Optimizing flow of slurry is critical, and Emerson's **Rosemount MS Slurry meter** (Figure 1.6) is a robust solution for applications with a high percentage of solids in slurry because it provides accurate and reliable flow measurement in these types of applications.

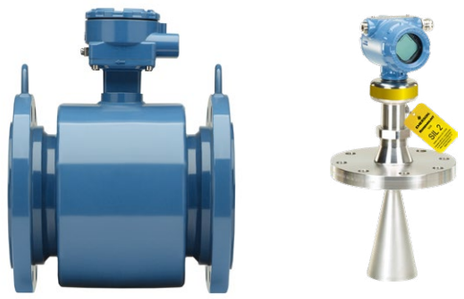


**FIGURE 1.6**

*Emerson's Rosemount MS Slurry meter (left) can measure high-solids slurry. Emerson's Rosemount 5408 Non-Contacting Radar Level Transmitter (right) can measure the thickness of product on the conveyance, downstream of the filtration.*

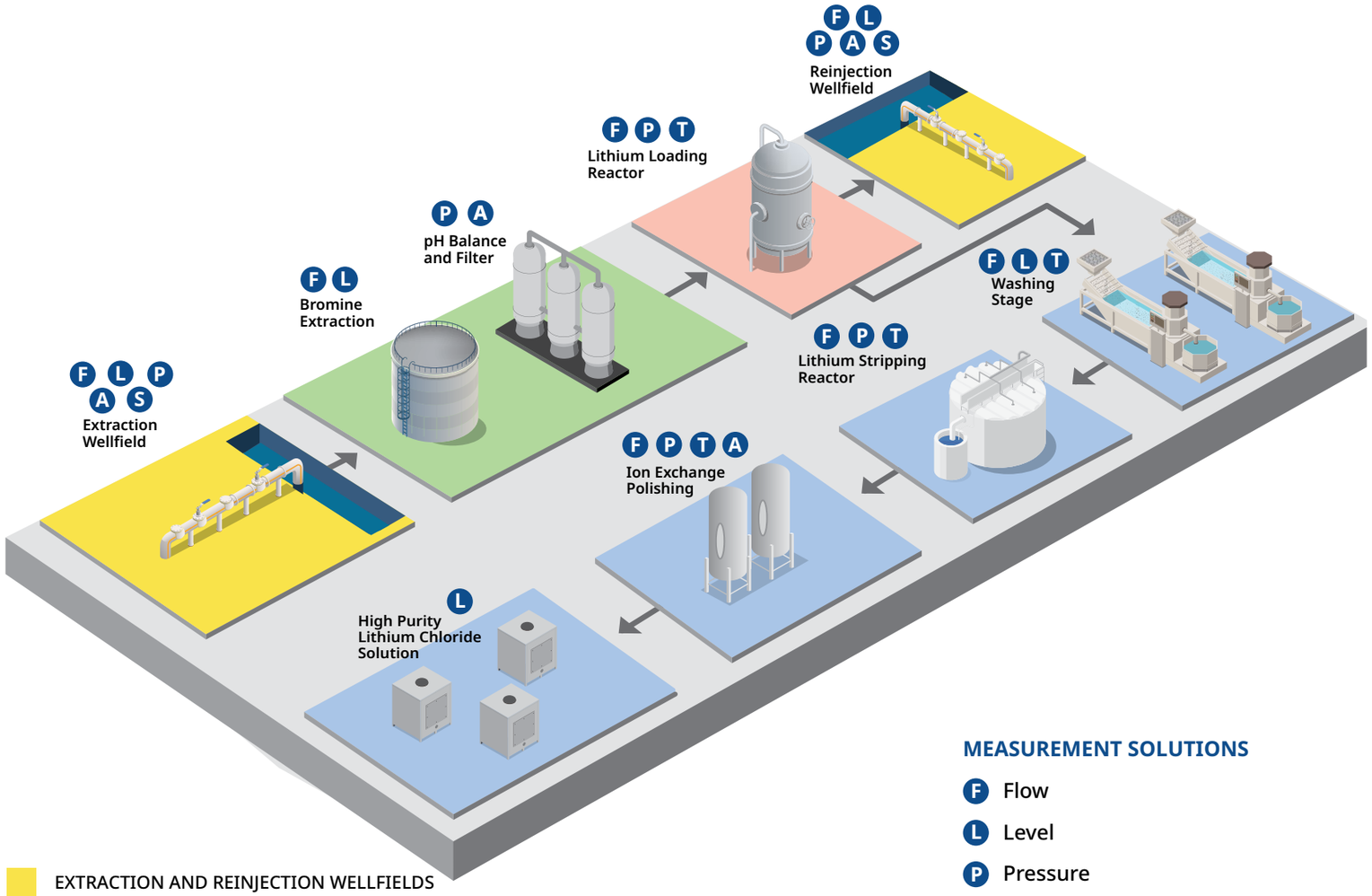
Emerson's **Rosemount 5408 Non-Contacting Radar Level Transmitter** can measure level in the slurry storage tanks that feed the filtration process.

**Water management —** A major environmental challenge with brine extraction is the enormous amount of water it consumes. Specifically, producing one ton of lithium carbonate requires evaporation of two million liters of water from the ponds. This comes out of the local ground water and is not replenished, often creating higher salinity of local water supplies. Consequently, it is critical to monitor all water consumption and report to relevant stakeholders.

Emerson's **Flexim FLUXUS F731 Non-Intrusive Ultrasonic Liquid Flow Meter** (Figure 1.4) is perfectly suited for this application as it provides accurate and repeatable measurement readings, and it can also be installed as needed to monitor flow at different points along the piping. In addition, magnetic flow meters work very well when permanently installed at strategic points. With the wealth of data provided by these types of instruments, it is possible to look for areas where water use can be optimized.

# 2 | DLE

**FIGURE 2.1**
*General overview of DLE.*




**MEASUREMENT SOLUTIONS**

- **F** Flow
- **L** Level
- **P** Pressure
- **T** Temperature
- **A** Analytical
- **S** Pervasive Sensing

Reference Plantweb Insight Applications Matrix

# Plantweb Insight™ Applications Matrix: DLE

| | PUMP | WIRELESS PRESSURE GAUGE | NETWORK MANAGEMENT | NON-INTRUSIVE CORROSION | POWER MODULE | CONNECTED LIGHTING |
|---|---|---|---|---|---|---|
| Extraction Wellfield | ● | ● | ● | | ● | ● |
| Bromine Extraction | ● | ● | ● | | ● | ● |
| pH Balance and Filter | ● | ● | ● | | ● | ● |
| Lithium Loading Reactor | ● | ● | ● | ● | ● | ● |
| Reinjection Wellfield | ● | ● | ● | | ● | ● |
| Washing Stage | ● | ● | ● | ● | ● | ● |
| Lithium Stripping Reactor | ● | ● | ● | ● | ● | ● |
| Ion Exchange Polishing | ● | ● | ● | ● | ● | ● |
| High Purity Lithium Chloride Solution | ● | ● | ● | ● | ● | ● |

# DIRECT LITHIUM EXTRACTION

DLE, a new technology able to capture lithium from brine without the use of evaporation ponds, is emerging quickly and changing the market. DLE begins with pumping brine from the well fields. Lithium compound solutions are then extracted and concentrated, enabling the return of the brine to the ground, with as little lithium as possible. (Figure 2.1).

DLE provides substantial sustainability improvements since it significantly reduces the amount of water used during production. It also shortens the production cycle to mere hours, compared to the traditional evaporation cycle that can easily take a year or more. Additionally, DLE is less energy intense compared to hard rock lithium production, in that it does not have the hard rock mining processes, ie drilling, blasting, crushing, grinding and calcining.

Some aspects of DLE are the same as traditional lithium processing methods, such as the well field, pipelines, and equipment condition monitoring systems discussed in earlier sections. The main differences affect the method of lithium extraction and speed at which brine is processed chemically to remove contaminants.

Generally, after initial pre-treatment to remove unwanted solids, the brine undergoes a chemical process that causes just the lithium compounds to adhere to adsorbent material. The remaining brine can be reinjected back into the local aquifer. Once polished, the amount of lithium captured this way can be as high as 90% depending on the process. With this process, over 90% of the lithium free brine gets re-injected back to the aquifer.

Incorporating Emerson’s measurement instruments enables the production of sustainable battery-grade lithium, significantly optimizing the use of land, energy, water, and chemicals in a streamlined process.

**Lithium loading reaction —** This main reaction, often referred to as adsorption, makes a huge difference regarding the efficiency of the entire process. Downstream processes such as washing, stripping, and polishing stages are also critical, but if the adsorption reaction is not efficient, these subsequent steps will be suboptimal.

Monitoring a lithium adsorption process to ensure mass and energy balance requires a variety of instruments. The process is usually batched, so it must be monitored as there can be variability to any of the reaction conditions, such as pressure, temperature, and pH. Measurement of each of these conditions calls for specific instruments with suggested selections, many of which were discussed in previous sections:

- Brine pH must be adjusted to make sure adsorption is optimized — **Rosemount 3300HT High Performance pH/ORP Sensor**
- Lime slurry addition to change the pH should be monitored — **Micro Motion G-Series Coriolis Flow Meters**
- Brine flow must be measured to fill up the batch — **Rosemount 8705 Magnetic Flow Meter**
- Reactor pressure must be measured to maximize efficiency — **Rosemount 3051 Coplanar Pressure Transmitter**
- Reactor temperature must be measured to optimize recovery — **Rosemount 644 Temperature Transmitter**
- Reactor level should be measured to maintain safety and quality of the batch — **Rosemount 3408 Non-Contacting Radar Level Transmitter**

**Polishing and recrystallization —** After the adsorption reaction, there are additional steps to purify and polish the product until it is battery-grade lithium chloride is obtained. Thickener stages help remove undesirable calcium and magnesium compounds, leaving just lithium carbonate solution. Thickener underflow density can be measured with Emerson's **Rosemount MS Slurry meter** and Emerson's **Micro Motion FDM Fork Density meter**, delivering real-time density measurements. Requirements for other instruments vary according to the process design, but most require the same types of instrumentation mentioned above, particularly **Micro Motion G-Series Coriolis Flow Meters** to optimize flow precision and density. Ultimately the finished lithium chloride must be dewatered, which may also use filtration technology.

**DLE water management —** DLE returns most of the brine back to the aquifer after lithium has been extracted. Reinjection wells, located some distance from extraction wells, are typically used to pump the lithium free brine back into the aquifer. Installing flow meters on both the extraction and reinjection pipes allows the DLE operator to account for water usage and report to regulators.

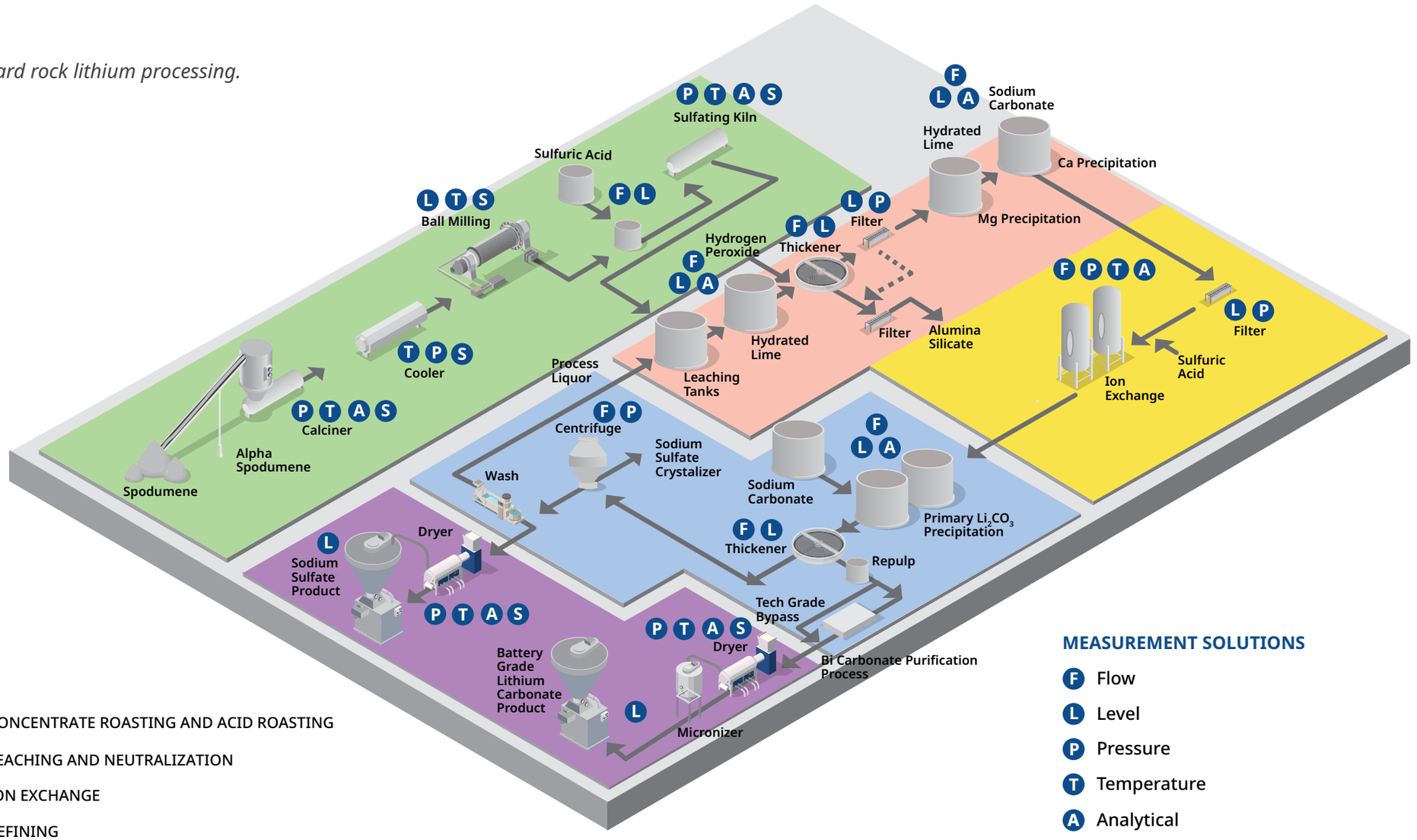
Emerson's Rosemount 8705 Magnetic Flow Meters (Figure 2.2) are ideal for permanently mounted well monitoring, both in extraction and reinjection. Emerson's **Flexim FLUXUS F731 Non-Intrusive Ultrasonic Liquid Flow Meter** (Figure 1.4) provides high-accuracy readings, acting as an alternative to magnetic flow meters. A FLUXUS F731 can be installed as a permanent flow meter. The FLUXUS 7 series includes stationary devices. If a temporary measurement is needed, the portable FLUXUS F601 (Figure 2.3) can be used as a convenient and reliable solution.

**FIGURE 2.2**
*Emerson's Rosemount 8705 Magnetic Flow Meters.*

**FIGURE 2.3**
*Flexim FLUXUS F601 offers a portable, non-intrusive solution for liquid flow measurement, delivering highly accurate readings across various applications.*

# 3 Hard Rock

**FIGURE 3.1**
*General overview of hard rock lithium processing.*




CONCENTRATE ROASTING AND ACID ROASTING
LEACHING AND NEUTRALIZATION
ION EXCHANGE
REFINING
PURIFICATION

## MEASUREMENT SOLUTIONS

- F Flow
- L Level
- P Pressure
- T Temperature
- A Analytical
- S Pervasive Sensing

Reference Plantweb Insight Applications Matrix

# Plantweb Insight™ Applications Matrix: Hard Rock

| | PUMP | WIRELESS PRESSURE GAUGE | NETWORK MANAGEMENT | NON-INTRUSIVE CORROSION | POWER MODULE | CONNECTED LIGHTING |
|---|---|---|---|---|---|---|
| Spodumene | | | ● | | ● | ● |
| Alpha Spodumene | | | ● | | ● | ● |
| Calciner | | | ● | | ● | ● |
| Cooler | | | ● | | ● | ● |
| Ball Milling | ● | ● | ● | | ● | ● |
| Sulfuric Acid | ● | ● | ● | ● | ● | ● |
| Sulfating Kiln | ● | ● | ● | | ● | ● |
| Leaching Tanks | ● | ● | ● | | ● | ● |
| Hydrated Lime | ● | ● | ● | | ● | ● |
| Thickener | ● | ● | ● | | ● | ● |
| Filter | ● | ● | ● | ● | ● | ● |
| Hydrated Lime | ● | ● | ● | ● | ● | ● |
| Mg Precipitation | ● | ● | ● | ● | ● | ● |
| Ca Precipitation | ● | ● | ● | ● | ● | ● |
| Ion Exchange | ● | ● | ● | ● | ● | ● |
| Primary Li2CO3 Precipitation | ● | ● | ● | ● | ● | ● |
| Repulp | ● | ● | ● | ● | ● | ● |
| Tech Grade Bypass | ● | ● | ● | ● | ● | ● |
| Bi Carbonate Purification Process | ● | ● | ● | ● | ● | ● |
| Centrifuge | ● | ● | ● | ● | ● | ● |
| Sodium Sulfate Crystallizer | ● | ● | ● | ● | ● | ● |
| Wash | ● | ● | ● | ● | ● | ● |
| Process Liquor | ● | ● | ● | ● | ● | ● |
| Dryer | | | ● | | ● | ● |
| Micronizer | | | ● | | ● | ● |
| Battery Grade Lithium Carbonate Product | | | ● | | ● | ● |
| Sodium Sulfate Product | | | ● | | ● | ● |

# LITHIUM HARD ROCK MINING

Lithium can be extracted from a handful of granitic pegmatite mineral ores, primarily spodumene and petalite (Figure 3.1). Spodumene tends to have higher concentrations of lithium, so most commercialized mining operations use this ore. Still, the lithium content of spodumene is in the form of lithium oxide with a concentration typically 3% or less for the best recoverable deposits. Consequently, large quantities of spodumene ore must be processed to deliver useful quantities of lithium carbonate concentrate suitable for battery manufacturing.

**Spodumene conversion —** The first processing step is crushing the raw run-of-mine material, which is alpha-spodumene. This crushed ore must be heated to 1,000 to 1,100 C to change the structure to beta-spodumene. This happens in a rotary kiln fired with natural gas. Since this is an energy-intensive process, continuous monitoring is necessary for efficient and sustainable operation:

- Raw product flow must be maintained continuously as rotary kilns are not easy to start and stop. Emerson's **Rosemount 3408 Non-Contacting Radar Level Transmitter** can monitor storage areas to help ensure the spodumene supply is not interrupted.
- The kiln itself must be monitored, not only inside for the process, but also the outer shell to verify that no internal refractory lining has broken away. Emerson's **Rosemount 248 Wireless Temperature Transmitter** can be mounted on the kiln since there is no cabling necessary. Where multiple sensors are required, the **Rosemount 848 Wireless Temperature Transmitter** can support up to four sensors.
- The kiln's mechanical drive elements, especially the large support bearings and gear drive, must be monitored to prevent breakdowns. Emerson's **AMS Wireless Vibration Monitor** can indicate if bearings are wearing out, providing the data required for proactive maintenance to mitigate possible unplanned failure.
- Gas flow to the kiln burners can be monitored using Emerson's **Micro Motion Elite Coriolis Mass Flow Meters**.
- The **Rosemount 6888A In Situ Oxygen Analyzer** is essential for optimizing kiln combustion in lithium hard rock mining by accurately measuring combustion flue gas oxygen levels. This not only boosts combustion efficiency and reduces energy costs but also ensures durability and reliability in harsh mining conditions.
- The **Rosemount 3051SFA Annubar Flow Meter** is ideal for measuring air flow from the kiln to the bag house and onward to the atmosphere, ensuring efficient dust removal. To safeguard filter media longevity, a **Rosemount 214C RTD Temperature Sensor** accurately monitors the temperature of exhaust air to the bag house.

**Chemical processing —** Chemical processing of converted spodumene concentrate includes the use of sulfuric acid, hydrated lime, hydrogen peroxide, and sodium carbonate to leach out and separate various components. Generally, various chemical streams are utilized, mixed and separated, requiring effective management and control to sustain operational efficiency.

These processes require a range of instruments installed at strategic locations, such as chemical dosing and hand-off points between different stages:

- Numerous tanks require level monitoring, using Emerson's **Rosemount 3408 Non-Contacting Radar Level Transmitter**, while Emerson's **Rosemount 8705 Magnetic Flow Meters** or Emerson's **Flexim FLUXUS F731 Non-Intrusive Ultrasonic Liquid Flow Meter** can both measure the flow of chemicals and process water, and Emerson's **Rosemount MS Slurry Sensor** for slurries.
- Since many of process conditions require specific acidity, pH monitoring at such stages can use Emerson's **Rosemount 3300HT High Performance pH/ORP Sensor**.
- Preventive detection of gradual filter media plugging and potential process shut down can be measured by using Emerson's **Rosemount 3051 Coplanar Pressure Transmitter**. The vacuum pulled by press filters can be measured using Emerson's **Rosemount 3051 Pressure Transmitter**.
- Hydrated lime and sodium carbonate volume and concentration can be measured using Emerson's **Micro Motion Elite Coriolis Mass Flow Meters**.
- Many points within the ion exchange process require measurement of pressure and temperature using **Rosemount 3051S Submersible Level Transmitters** and **Rosemount 648 Temperature Transmitters**.
- The polishing filtration stage for lithium chloride, if using a filter press, calls for careful control of flow and solids content. Emerson's **Rosemount 5408 Non-Contacting Radar Level Transmitter** can measure level in the storage tank feeding the filter press, and the thickness of product depositing on the conveyor belt downstream of the press.
- A belt filter press requires a differential pressure measurement to determine when filter media needs to be replaced. This measurement can be accurately provided by using Emerson's **Rosemount 3051S Submersible Level Transmitters**.
- Thickener under flow volume can be accurately measured using **Rosemount MS Slurry Meter**. For real-time density and concentration measurements, the Emerson's Micro Motion FDM Fork Density Meter is the recommended instrument (Figure 3.2).

**FIGURE 3.2**

*Emerson's Micro Motion FDM Fork Density Meter (left) can determine the density of slurry stream. The Rosemount 3408 Non-Contacting Radar Level Transmitter (right) is crucial for monitoring the tank level to ensure safety and batch quality.*

**Polishing lithium carbonate —** Creating pure lithium carbonate suitable for battery manufacturing requires a final stage able to separate it from any remaining contaminants.

Polishing requires level measurement in the reaction tank, with Emerson's **Rosemount 2120 Level Switches** (Figure 3.3) used to provide high- and low-level alarms. Once the final product is precipitated, the final drying stage is usually performed with a small-scale rotary kiln fired with natural gas. The kiln mechanical drive system should be monitored using vibration and heat sensors such as Emerson's **AMS Wireless Vibration Monitor** for critical indicators on rotating equipment potential unplanned failure.

**FIGURE 3.3**
*Emerson's Rosemount 2120 Level Switches can monitor a reactor or storage tank, acting as high- and low-level indicators.*

**Hard rock lithium water management —** While this process does not involve brine, there is still significant water consumption to facilitate some of the process steps, and any water that starts out fresh will leave the process brackish due to all the mineral content. This diminishes local water supplies, while also producing effluent that has potential to contaminate the local water sources and farmland. Consequently, facilities must recycle water internally as much as possible to minimize drawing from outside sources. This process involves the use of both large and small water lines, incorporating Emerson's flow measurement solutions. For smaller line sizes, Emerson's **Rosemount 8705 Magnetic Flow Meters** are suitable, while larger line sizes can benefit from Emerson's **Flexim FLUXUS F731 Non-Intrusive Ultrasonic Liquid Flow Meter**.

# LOOKING AHEAD

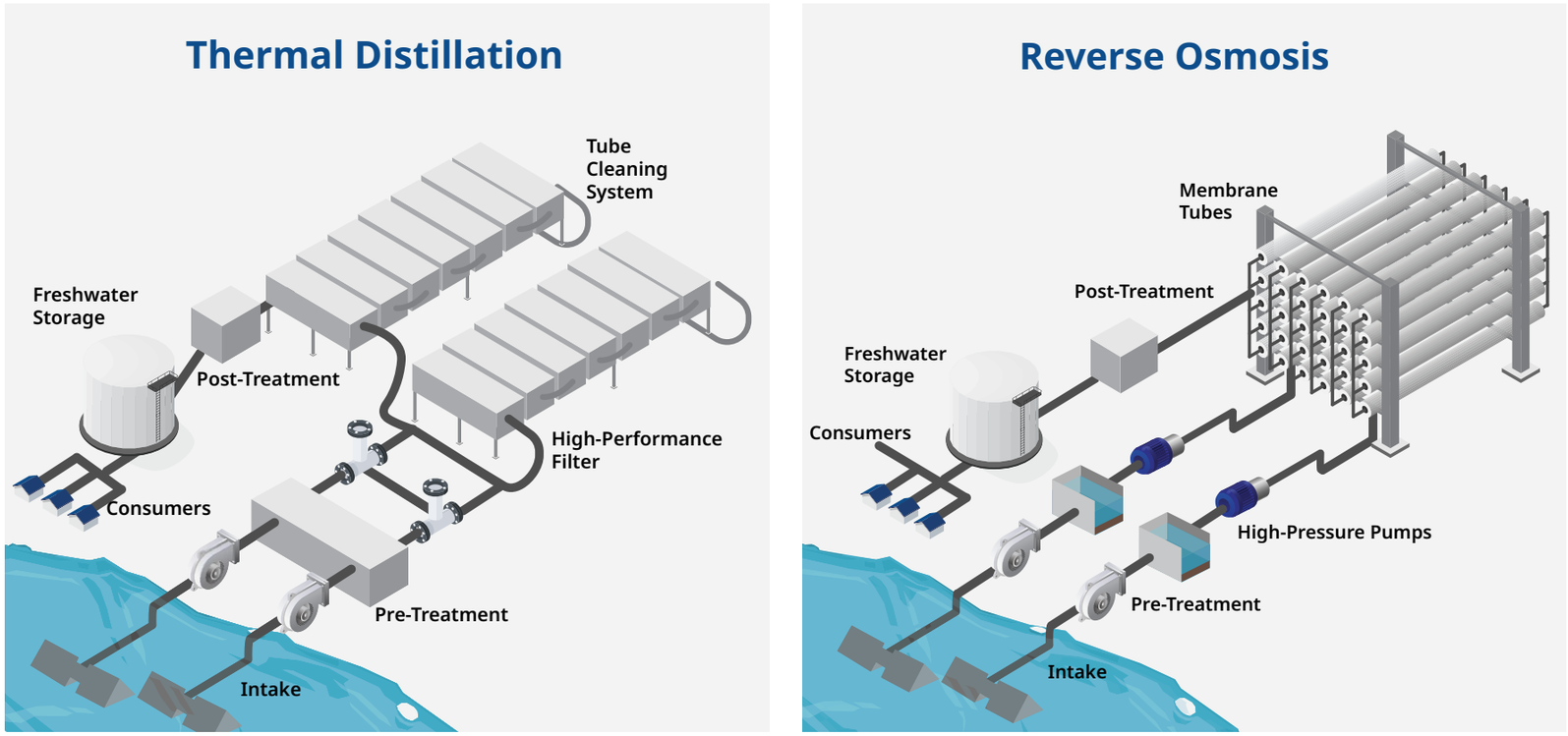
Monitoring the water being supplied to the processing plant as well as the water being consumed at all stages of lithium production is critical to minimize environmental impact. Flow measurement of water intake and discharge back into the environment can use the technologies discussed in earlier sections. In some locations, environmental regulators require a mining operation to use seawater for production, requiring the facility to have its own desalination capability (Figure 4.1).

Changing environmental demands are driving conversions to electric vehicles because they have the potential to reduce transportation's enormous carbon footprint. This increases demand for lithium, along with other battery metals. However, the environmental and social challenges of producing these minerals must be addressed using the solutions outlined in this eBook.

Every portion of this value chain has its own challenges, but the common solution for all is achieving efficient and sustainable mining practices. That's where Emerson comes in. We're helping at all phases, from the mine, to a new EV rolling out of the plant, and all stages in between. We have innovative solutions to work with the whole lithium production value chain, along with the experience and know-how to put it all together in a working system.

**FIGURE 4.1**

*Desalination units can be used to convert salt water to fresh water, which may be required for lithium mining in regions where ground and surface freshwater is scarce.*



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