Nanostone CM-151 Ceramic Ultrafiltration Membrane Enhances Lithium Extraction in China's Salt Lakes

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Overview:

Membrane separation technology is one of the best ways to extract lithium from salt lakes in China. Although there are substantial lithium resources in the salt-lake brine, the high ratio of magnesium to lithium and significant levels of impurities have resulted in low lithium content grade and yields.

Membrane separation technology from Nanostone can address these challenges by providing a range of benefits including:

- Excellent magnesium-lithium separation
- High recovery rates
- A shorter production cycle
- Reduced environmental protection expenditures

Challenges:

Qinghai Salt Lake Lanke Lithium Industry Co., Ltd., located in the Qaidam Circular Economy Development Zone, Qinghai, China, was faced with a number of challenges:

- There were suspended solids in the intermediate liquid system (SS≤100ppm), which greatly affected the lithium extraction process.
- The amount of suspended solids fluctuated greatly, which made pretreatment of the nanofiltration system difficult.
- Due to the high salt content of the intermediate liquid and the location of the site in the alpine area of northwest China, the nanofiltration membrane pretreatment system sometimes had to operate in extremely cold conditions, creating more challenges for the operation.

Solution:

Using Nanostone CM-151 ceramic ultrafiltration membrane as a pretreatment method for the nanofiltration membrane led to the following benefits:

- The system was able to withstand severe water quality fluctuations and temperature changes. This allowed it to maintain stable processing capacity and output levels even when water inflows were close to zero degrees.
- Excellent filtration efficiency, which enabled the plant to capture and remove high concentrations of suspended solids, ensure water quality, and protect downstream nanofiltration membranes.
- A robust ceramic material that can withstand high Total Dissolved Solids (TDS) influent without fiber breakage.
- Excellent cleaning and recovery performance to ensure stable and continuous operation of the system and maintain production schedules.
- Easy operation and maintenance, which decreased the frequency of cleanings and reduced chemical and water usage.
- High operating flux and a large active membrane area resulted in highly integrated, compact equipment with a small footprint, making it possible to increase future production capacity, even with limited space.
- The quality guarantee and longer lifecycle provided an excellent return for the Build-Operate-Transfer (BOT) projects.

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About the End-user:

Qinghai Salt Lake Lanke Lithium Industry Co., Ltd., is located in the Qaidam Circular Economy Development Zone, Qinghai, China. It is a subsidiary of Qinghai Salt Lake Industry Co., Ltd., a company that is managed by the state-owned Assets Supervision and Administration Commission of Qinghai Province. Lanke Lithium develops and produces products such as lithium oxide, lithium metal and lithium magnesium alloys, using raw materials from the Chaerhan Salt Lake. Its brine resources have low lithium content and a high ratio of magnesium to lithium and include undesirable elements including boron, potassium, magnesium and sodium. A membrane process is generally used to extract lithium from this kind of brine. Lanke Lithium had been using a production process known as "super-high magnesium-lithium ratio salt-lake brine adsorption-membrane separation coupled lithium extraction."

Project Background:

The main consumable in membrane lithium extraction is nanofiltration membrane, which has a short service life and high maintenance cost. To maintain the nanofiltration system's long-term stability, pretreatment of the nanofiltration membrane is essential. The intermediate liquid treated through this process has a high content of suspended solids and a large concentration fluctuation. If traditional media filtration is used in pretreatment of the nanofiltration system, the suspended solids in the water cannot be effectively removed. In addition, the raw material liquid has high salinity and a low perennial temperature. It is also extremely challenging for the operation of organic ultrafiltration: it not only brings the problem of reduced flux, but crystal particles are easily precipitated in such an environment, with a fatal impact on the organic ultrafiltration membrane. The precipitation of crystals will scrape the membrane and harden membrane fibers until they break. This leads to a sharp deterioration of the nanofiltration, which greatly affects maintenance costs and the lifespan of the system. In severe cases, it can even lead to system downtime and a suspension of production.

To ensure large-scale, sustainable and stable operation of its process, in 2021 Qinghai Salt Lake Lanke Lithium Industry Co., Ltd. adopted Nanostone CM-151 ceramic ultrafiltration membrane as a nanofiltration pretreatment. The process flow chart is as follows(on the next page).

To meet environmental requirements for lithium recovery, before the CEB process, the lithium-containing water in the membrane is replaced with an external clean water source (RO product water or tap water). The backwash water of the self-cleaning filter, the ceramic membrane device and replacement water of the No. 1 ceramic membrane system (50 pcs X 6 sets) are collected. They then pass through the No. 2 ceramic membrane system (38 pcs X 1 set) for filtration. At the same time, the backwash water and replacement water of the No. 2 ceramic membrane system are collected and returned to the system after precipitation. The entire process is conducted without wasting any lithium-containing water.

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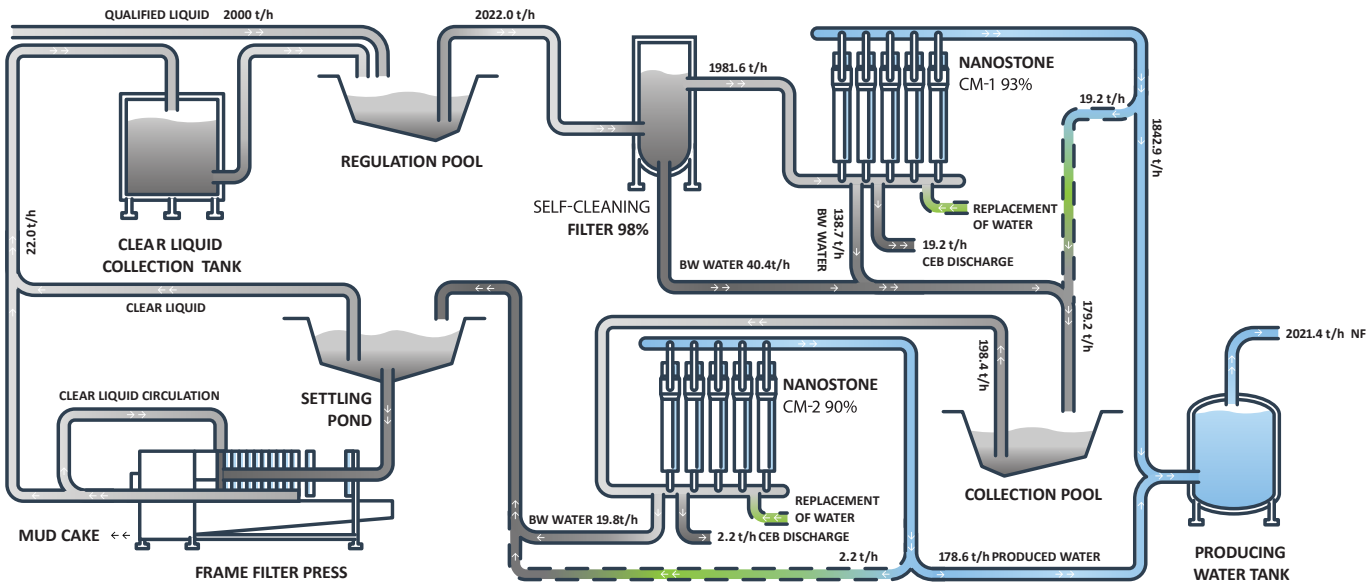
Nanostone Ceramic Membrane as the Pretreatment for Nanofiltration



Intermediate liquid water quality analysis:

The influent of the No. 1 ceramic membrane system is an intermediate liquid with a high ratio of magnesium to lithium, and its SS content fluctuates frequently within 100 mg/L. The particle size distribution and chemical water quality analysis of the intermediate liquid are as follows:

Table 1. Intermediate liquid particle size distribution

Particle size distribution range	Proportion
Dc < 3.701μm	Ω=10%
Dc < 9.514μm	Ω=25%
Dc < 26.49μm	Ω=50%
Dc < 71.46μm	Ω=75%
Dc < 196.9μm	Ω=90%

Table 2. Intermediate liquid ion content

Name	Content	Unit
Li^+	440.96	mg/l
Mg^{2+}	2480	mg/l
Ca^{2+}	28.14	mg/l
Na^+	160	mg/l
SO_4^{2-}	2.29	mg/l
HCO_3^-	43.57	mg/l
Cl^-	7210	mg/l
B	49.03	mg/l
PH	7.54	

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Data from Qinghai Salt Lake Lanke Lithium Industry Co. demonstrates that Nanostone's CM-151 ceramic ultrafiltration membrane system ensures the long-term stability and success of the treatment process. Even if the content of suspended solids of the influent fluctuates and the peak value reaches 100 ppm, the large flow channel design of Nanostone's ceramic membrane will provide sufficient space for high concentrations of suspended solids. Moreover, the high porosity and concentrated pore size distribution can effectively filter the intermediate liquid by nano-coating it with high filtration accuracy of 30 nm membrane diameter. When the influent turbidity is 96 NTU, the turbidity of the permeate is only 0.054 NTU, which provides a strong guarantee for the downstream nanofiltration membrane.

Even during the coldest times of the year, the ceramic membrane system has remained stable, and the flux can be maintained above the design value. This not only ensures water quality, but also provides a guaranteed yield.

Since it was put into production, the ceramic membrane system has operated smoothly. The chemical cleaning cycle lasts up to one month, and the permeability restore after cleaning is excellent. After long-term operation of the system, the actual production capacity of the company's high-purity and high-quality lithium carbonate device will exceed the designed output value of 30,000 tons, achieving considerable economic benefits.

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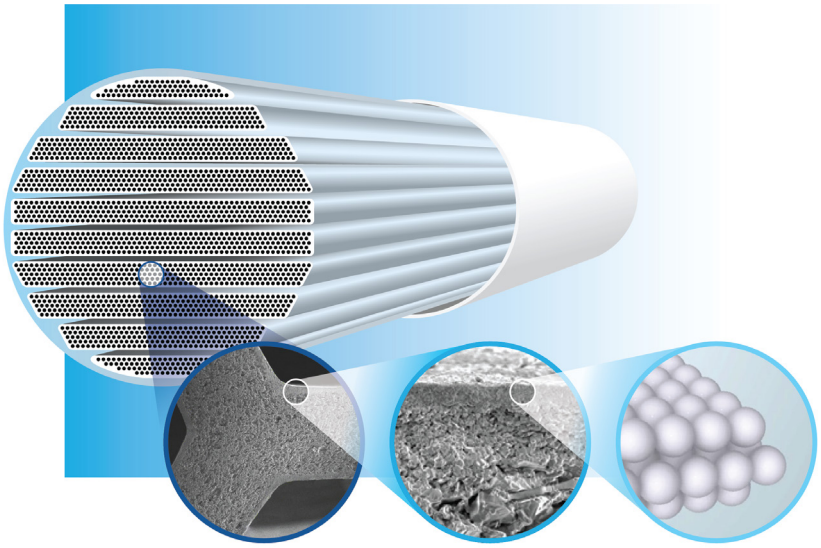

- *The rock solid, hydrophilic, and oxidant stable ceramic provides long life and resistance to fouling*
- *True ultrafiltration membrane with tightly designed 30 nm pore size for reliable removal of suspended solids and pathogens*
- *Inherent high permeability, high flux structure and pore channels*
- *The ceramic structure is fabricated using Nanostone's proprietary nanomaterials*
- *Ceramic sheets are configured into a patented segmented monolith design*
- *The design allows unrestricted permeate flow out of the ceramic material along the entire length of the module, eliminating flow restrictions and unnecessary pressure drop*
- *The patented design maximizes surface area per module*
- *The segmented module format, along with proprietary materials and production processes, facilitate high throughput, low-cost manufacture*

FOR MORE INFORMATION
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