News and Highlights

Great Breakthrough Achieved in Extraction of Lithium from Brine with High Magnesium to Lithium Ratios

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With the worldwide rise in electric vehicles, the demand for lithium batteries is increasing day by day. In 2015, China's new energy vehicles developed rapidly, and the price of lithium carbonate rose from fifty or sixty thousand yuan per ton to 150 thousand yuan. In the past, lithium was often extracted from spodumene ($LiAlSi_2O_6$), which is time consuming, laborious and expensive. Over the past decade, abundant lithium has been discovered in brackish and salt water lakes, which is an important way to obtain lithium resources.

There are abundant salt lake resources on the Tibetan Plateau, where more than 350 brackish and salt water lakes have been discovered with potassium, sodium, lithium, magnesium and boron resources. One third of the world's lithium reserves are there. However, China's salt lakes often have high magnesium to lithium ratios of 40:1−1200:1, which has limited the development and utilization of lithium resources for the difficult extraction.

In recent years, a large number of work units in China have conducted development and production to extract lithium from brine with high magnesium to lithium ratios (>10:1). These operation bases are mainly built in the Taijinaier saline lake and its northwestern Yiliping saline lake in the Qaidam Basin, Qinghai Province.

The Taijinaier Lake contains rich potassium, boron and lithium resources. The eastern and western parts of the Taijinaier Lake have 3.23 million tons of available lithium reserves and 26.35 million tons of available potassium reserves. Particularly, we now know from detailed geological exploration that the lithium deposits in the eastern Taijinaier Lake have 2.85 million tons of LiCl porosity reserves (1.59 million tons of specific yield reserves), 1.64 million tons of B_2O_3 porosity reserves (0.92 million tons of specific yield reserves) and 18.29 million tons of KCl porosity reserves (10.39 million tons of specific yield reserves). These deposits have been considered to represent a super-large scale of lithium and boron reserves and a medium-sized scale of potassium reserves.

The Yiliping lake contains 360 km^2 of salina area, at a lake elevation of 2683 m, and is a dry saline lake. Salt deposition is dominated by halite, and is rich in intercrystalline brine that belongs to a magnesium sulfate subtype of the sulfate type, with total dissolved solids of 327.243 g/L. The upper intercrystalline brine occurs in Holocene halite layers, and the lower underground brine occurs in Upper Pleistocene halite-bearing fine sandstones. This saline lake contains typical brine with high magnesium to lithium ratios, as high as 100:1, and is rich in lithium, associated with boron, potassium, magnesium, bromine and iodine.

As early as in 1999, the CITIC Guoan Lithium Industry Company conducted comprehensive development and utilization of the Taijinaier saline lake. However, because of the difficulty of magnesium and lithium extraction, the lithium chemical production process has been at a low level, and China has needed to import large quantities of lithium carbonate and potassium sulfate from Chile, Australia and other countries. Later, this company carried out critical studies on the comprehensive utilization of lithium, potassium and boron resources in the Taijinaier Lake, and successfully conducted industrial experiments to output 3000 tons of potassium sulfate and 250 tons of lithium carbonate annually.

In 2010, the Saline Lake Company of China Minmetals Corporation introduced the multi-stage lithium ion concentration patent from the Technische Universität Bergakademie Freiberg in Germany. Later, this company, together with the Qinghai Institute of Salt Lakes, Chinese Academy of Sciences, conducted experiments on the comprehensive utilization of lithium, boron and magnesium from the Yiliping salt lake. In 2014, they finally addressed the technical problems of magnesium and lithium extraction from brines with high magnesium and lithium ratios. Subsequently, they can produce high-

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quality lithium carbonate, boric acid and magnesium series products from the Yiliping brine, which has provided technical support and an important reference for the large-scale and continuous production of lithium carbonate.

In 2016, the Qinghai Lithium Industry Company announced that they had developed the technology of selected ion migration to synthesize lithium carbonate and successfully solved the world-class problem of lithium extraction from brine with high magnesium to lithium ratios. This company has produced high-quality lithium carbonate from the eastern Taijinaier salt resources, and has reorganized and expanded the 3000-ton lithium carbonate equipment to 10000-ton equipment. This technology is easy to operate, consumes low energy, and has low noise, low cost and good product quality. In addition, there is no waste gas, no waste residue, no waste liquid, no discharge and no pollution, with a high-resource comprehensive utilization rate. The relevant three techniques have been patented (Fig. 1). According to the lithium, potassium and boron reserve status of the eastern Taijinaier Lake and the unique technology, this company has production scales of the three primary products as 20000 tons of lithium carbonate per year, 150000 tons of potassium sulfate per year and 15000 tons of boric acid per year. That is, the three products need to expand production of 17000 tons per year, 125000 tons per year and 125000 tons per year, respectively. It will provide more high-quality and low-price lithium products for the world's lithium resource market.

Acknowledgement

Thanks are given to Susan TURNER for her improvement of the English.

Fig. 1. Production workshop and mechanical hands-on worker in the deployment of lithium carbonate in the Qinghai Lithium Industry Company.