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Lithium Extraction from Carbonate-type Saline Lake by Utilizing of Geothermal Solar Pond in Tibet

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1 Introduction

The geothermal solar pond is a kind of special solar pond. It is different from traditional solar pond, which high temperature geothermal water can be used to heat brine. When the salt in the brine reaches saturation temperature, it precipitate out and is separated from the brine. Compared with solar pond, the geothermal solar pond does not rely entirely on solar radiation as a heat source, but on the high temperature geothermal water. So it does not be affected by temperature and season changing. The geothermal solar pond can be used in the Qinghai-Tibet Plateau. The annual average temperature in this place is less than 0℃; the temperature difference between day and night is large; the rainy season concentrates on the high temperature month from June to September. Therefore the geothermal solar pond may shorten the time of natural brine evaporation.

The Damxung Co salt lake is located at southwest of the Qinghai-Tibet Plateau, nearby the north area of narrow intermountain basin formed by Xuru Co-Tangra Yumco-Damxung Co trending NS direction. This region is in the Indian-Eurasian plate collision belt, which has intense tectonic activity and complex geological structure. The unique crustal structure of continent-continent collision zone make this area store enough thermal resources. The geothermal belt in south of Bangong-Nujiang suture zone is rich in high temperature geothermal resource according with the 1:14000000 Chinese underground hot water distribution map published by the Institute of Hydrogeology and Environment Geology of CAGS, Geothermal distribution and heat releasing take up more than 2/3 of Tibet.

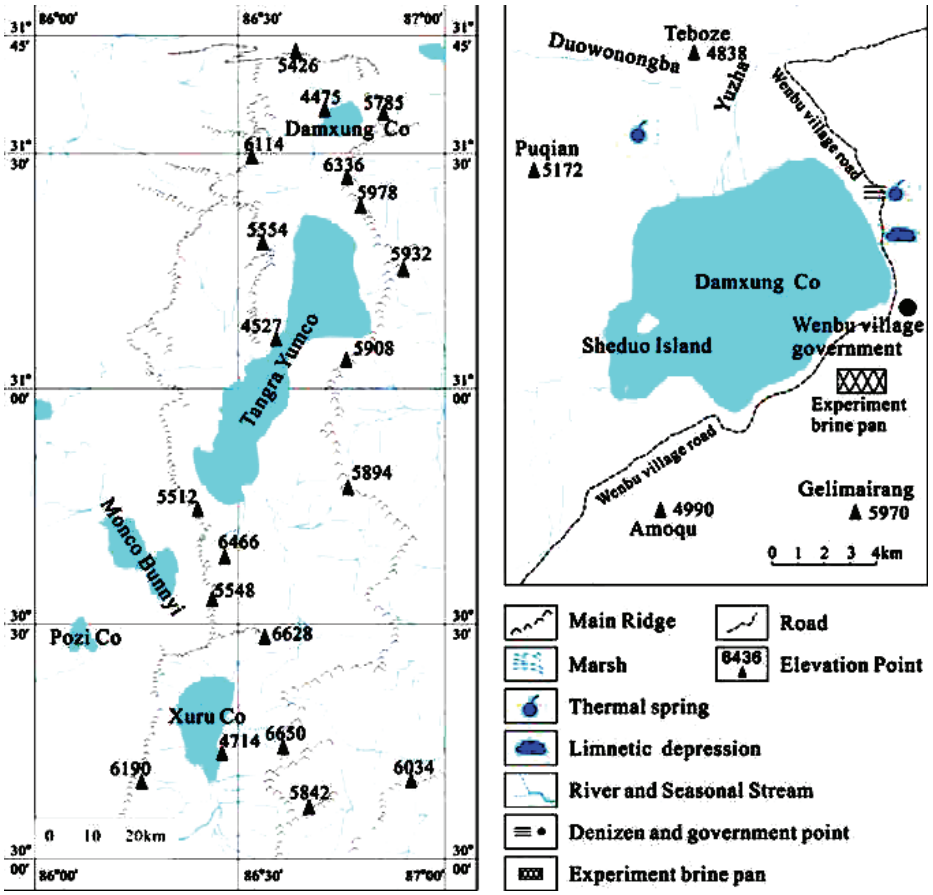

Fig. 1. Geographical position of Damxung Co salt lake.

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It can be seen from this figure that the Damxung Co salt lake is located at south high-temperature geothermal water-steam belt of Bangong-Nujiang suture zone. In 2005, we made geophysical IP sounding experiment around this area. By measuring electrical parameters of geological bodies, we found that only hot spring water have low apparent resistivity characteristics compared with other types of geological bodies on survey area. The result of geothermal exploration shows the close relationship between low-resistivity anomalies reflected in the survey area and hot water, and also shows that a plenty of geothermal water is conserved in this region.

The altitude of Damxung Co Salt Lake is 4475m, and the lake area is about 55.53km^2. The terrain around the lake has the characteristic of high southeast and low northwest (Figure 1). The geothermal solar pond is built on this lakeside trending southeast direction. The Damxung Co salt lake belongs to carbonate-type, and is rich in Li, B, K and other useful trace elements with high economic value. The ratio of Mg/Li in the lake is very low, so heating method is suitable to extract the lithium carbonate from the brine. Zhabuye salt lake is the carbonate-type lake at Tibet of China and is the only one under exploration at present. The annual output of lithium carbonate is about 8,000 tons. With the completion of the phase II project, the lithium carbonate output is expected to reach 16,000 tons. But under the background of increasing demand, only expanding the production scale is not an effective solution to the supply and demand balance, and the extensive mode of production would cause more damage to the fragile ecological environment in Tibet. The geothermal solar pond made full use of the resources with local conditions. It shortens the production cycle of lithium carbonate and makes a higher pureness of lithium carbonate.

2 Description of geothermal solar pond

The geothermal solar pond (Figure 2) is an inverted quadrangular frustum pyramid which the ratio of length to width at bottom is 2:1, and the angle between inner wall of pond and the bottom is about 120°. The entire pond body is fixed with concrete and bricks after excavation. The inner wall is covered by 10cm diatomaceous earth, as thermal insulating layer, and EPDM is paved above the thermal insulating layer, as impermeable layer.

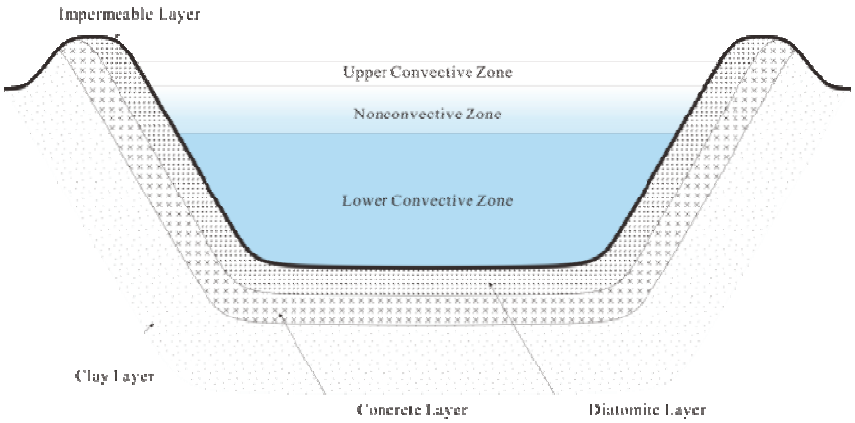

Fig. 2. Structure of geothermal solar pond.

The geothermal solar pond has three regions. The lower region is called lower convective zone (LCZ), and also called the energy storage zone, which is consist of concentrated brine. Each component of salt in the brine is almost saturated. The heat from heat exchanger can be absorbed and accumulated by the high density and high salinity brine of this region, and then the temperature of brine increase quickly. The middle region is non-convective zone (NCZ), also called the salinity gradient layer. In the NCZ, salinity is increasing exponentially from top to bottom. Heat is not transferred by convection in this region, so the NCZ separate the LCZ from the external environment and make LCZ form a closed system. The top region is called the upper convective zone (UCZ), which is consist of freshwater. It has the function of providing fresh water to compensate evaporation and protecting non-convective zone from damage caused by external force.

3 Conclusions

The Damxung Co salt lake is rich in geothermal resource. By utilizing the geothermal energy, the geothermal solar pond is designed to extract lithium from the salt lake. The experiments show that the heat exchanger is the primary factor in extracting lithium carbonate from the brine. The ideal crystallization temperature of lithium carbonate is above 45℃ in the LCZ. The formation of temperature curves zone and salinity gradient greatly reflect the state of brine. By quantitative analysis, the content of Li^+ in the lithium mineral extracted by the geothermal solar pond reaches up to 16.57%, and the content of lithium carbonate reaches up to 87.3%. The results of experiment indicate that the geothermal solar pond is high efficiency for extracting lithium carbonate from brine. But at present, it lacks data to support application on large area. Further research will be made in view of material balance and heat transfer by enlarging the heating pond.

Key words: geothermal, geothermal solar pond, lithium carbonate, solar pond