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Solubility and Supersaturation of Lithium Carbonate in Zabuye Salt Lake Brine, Tibet

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The highest abundance of lithium has been found in brine of salt lakes in China, such as Zabuye Salt Lake in Tibet and Dongtaijinaier and Xitaijinaier salt lake in Qinghai. Lithium has been produced from such brines since 1959. The alkaline Zabuye Salt Lake is hydrochemically unique, containing a comparatively complex and special mineral assemblage rich in Li, B, K, and sodium carbonate. The amount of the mineral zabuyelite (Li_2CO_3) is particularly large. The solar pond technology was developed based on the evidence that the solubility of Li_2CO_3 decreased with increasing temperature, as documented by Zheng Mian-ping between 1995 and 2002. The first industrial scale production line for Li_2CO_3 was founded in Zabuye Salt Lake in 2004. However, detailed solubility data for Li_2CO_3 in the presence of other salts in Zabuye Salt Lake brine have not been reported. Solubility data for pure Li_2CO_3 in fresh water cannot be used for the accurate prediction of zabuyelite production. Therefore, the solubility of Li_2CO_3 in Zabuye brine has to be determined. Because lithium production in solar ponds was not in chemical equilibrium because of the increasing temperature of the solar pond, the degree of supersaturation of Li_2CO_3 in the brine is very important in estimating the production rate and quality of the product. We have investigated the solubility of Li_2CO_3 and its degree of supersaturation in Zabuye brine. Solubility was studied using the isothermal method. The effect of sodium carbonate on Li_2CO_3 solubility was also studied. Based on the crystallization theory, salt supersaturation in solution depends on many factors such as the mixing intensity, cooling (or heating) rate, and the presence of solid surfaces. We studied lithium carbonate supersaturation at different heating rates because the solubility of lithium carbonate is decreased with increasing temperature. Lithium carbonate has limited solubility and its concentration change in solution is difficult to measure in supersaturation experiments. Therefore, supersaturation of lithium carbonate was expressed by a temperature difference calculated from (a) the directly measured temperature of the solution in the experiments. The lithium concentration is considered to be saturated at this temperature. (b), the temperature calculated based on the measured concentration of lithium carbonate in the solution. There is a saturation temperature which corresponds to the measured concentration of lithium carbonate, and this temperature is used to express the degree of supersaturation of the solution. The difference between these two temperatures can then be used to express the level of solution supersaturation. The solubility of Li_2CO_3 in Zabuye brine was found to be quite different from that in fresh water, and to be strongly affected by the Na_2CO_3 concentration as shown in Figure 1. The solubility of the salt was expressed by weight percent, defined as the amount of salt in the solution divided by the total weight of the solution. At low temperature, Na_2CO_3 has a complex effect on the solubility of Li_2CO_3. At low Na_2CO_3 concentration the solubility of Li_2CO_3 decreases with increasing Na_2CO_3. However, when the Na_2CO_3 concentration is high, the solubility of Li_2CO_3 is increased with increasing Na_2CO_3. At high temperature, the solubility of Li_2CO_3 decreased with increasing Na_2CO_3 concentration. With increasing heating rate, the supersaturation level was increased (Figure 1).

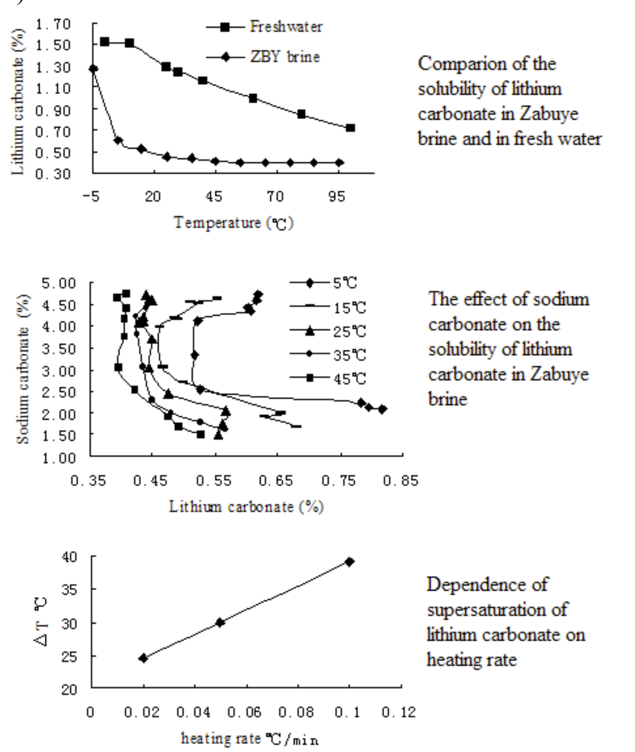

Figure 1–Solubility of Li_2CO_3 in Zabuye brine and the dependence of Li_2CO_3 supersaturation on heating rates.

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