HE Jing, YANG Lixin, WANG Yi and FU Mi, 2014. New Extraction System for Lithium from Brine with High Magnesium Content. *Acta Geologica Sinica* (English Edition), 88(supp. 1): 333-334.

New Extraction System for Lithium from Brine with High Magnesium Content

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Lithium is an important element with a wide variety of applications, especially in lithium ion batteries and in the exploration of nuclear energy. Salt lake brine is the most abundant lithium source available in world, comp- rising 70%~80% of all known lithium deposits. Lithium can be abstracted from brines with low magnesium content and processed into kinds of lithium compound in Atacama and Hombre Muerto of South America (Nie et al., 2013).

In this work, tri-n-amyl phosphate(TAP), an self-made extractant was utilized for lithium extraction from brine solution with high ratio of magnesium to lithium (C_{Mg}=80.59 g/L, C_{Li}=1.35 g/L), and $NaClO_4$ was chosen as a co-extracting agent, which made a great contribution for extracting lithium. The effects of extraction temperature, extraction time, amount of perchlorate, and mass ratio of magnesium and lithium on Li^+ extraction rate were investigated. The results showed that the equilibrium extraction rates for Li^+ were 34.0%, 38.9% and 42.1% in a single extraction under the condition of $n(ClO_4^-)/n(Li^+)$=1:1 and 40ºC, 20ºC and 0ºC, respectively, as shown in Figure 1. In the meantime, the separation coefficient of lithium to magnesium reached 20.2 at 0 ºC, exceeding which of tri-n-butyl phosphate (TBP) (Yang et al., 2012). Reversed phase extraction was conducted with water in V_w/V_o=1:1 and 20ºC, the stripping rate of Li^+ reached 76.5%, and the mass ratio of magnesium to lithium in the aqueous phase decreased from 59.8 to 4.5, presenting a good separation effect.

The ^{31}P NMR spectra of TAP under different conditions were determined using 85% H_3PO_4 as external standard. It could be seen from Figure 2 that the chemical shifts of TAP moved to the upfield before and after extraction, and the difference reached 0.4249 ppm. This showed that there existed a certain degree of interaction between metal ions and the phosphoryl oxygen of TAP. The change related to the spherical symmetry of extractive structure. While the chemical shift of phosphorus in organic phase nearly recovered to initial state again after reversed phase extraction.

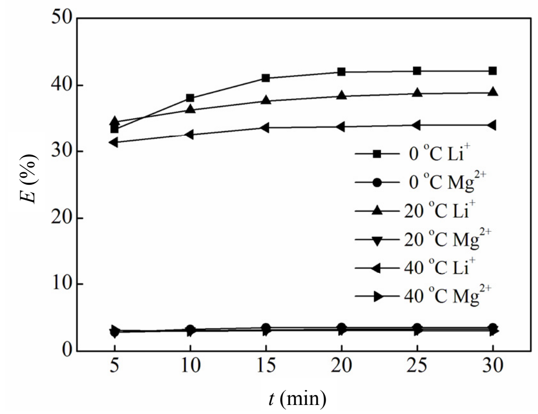

Fig. 1. Extraction rates of Li^+ and Mg^{2+} at different temperatures.

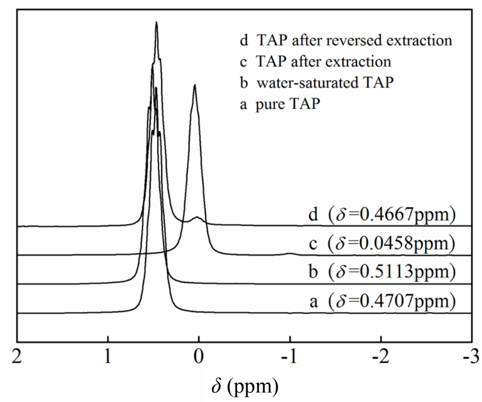

Fig. 2. ^{31}P NMR spectra of TAP under different conditions.

TAP has a lower solubility in the aqueous phase and a larger density difference with water, which is better than TBP for extraction in the aspect of physical properties (Suresh et al., 2009). The combination of TAP and $NaClO_4$ is an effective and notable system of extracting lithium from brine with high ratio of magnesium to

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lithium, compared with the method of TBP and $FeCl_3$ (Zhou et al., 2013).

Key words: tri-n-amyl phosphate, perchlorate, solvent extraction, separation of lithium from magnesium

Acknowledgements

This work was supported by the National Natural Science Foundation of China(21276215).

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