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Lithium Ion Extraction from the High Ration Mg/Li Salt Lake Brine with Ionic Liquid in Triisobutyl Phosphate and Kerosene

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1 Introduction

As the lightest metal with the unique properties of energy production and storage, lithium is regarded as the new century energy metal. Lithium and its compounds were widely used in various industrial fields, especially in lithium battery and nuclear energy (Zhou et al., 2011; Bettge et al., 2012; Rahman et al., 2012; Wang et al., 2001; Somrani et al., 2013; Siame et al., 2011). Due to the recoverable solid mineral resources is decreasing and the exploiting cost is increasing gradually, extracting lithium from salt lake brine has been paid more and more attention. However, some salt lakes located in Qinghai Province, China exhibit high mass ratio of magnesium/lithium, which results in difficult to efficient extraction of lithium.

In this paper, an effective $FeCl_3$-free synergistic extraction system of triisobutyl phosphate (TIBP) as an ectractant, ionic liquid N-propyl-methyl piperidinium bis [(trifluoromethyl)sulfonyl]imide as the coextractant and kerosene as the diluent for lithium ion from high Mg/Li ratio brine was established. The technological parameter of phase ratio (R(O/A)) and pH value on the extraction stage and HCl concentration and R(O/A) on the back extractive step were optimized systematically, and the results presented in Figures 1 to 4. The results of orthogonal experiments ($L_9(3^4)$) on the extraction system was collected in Table 1 and the results of reused of the organic phase for extracting lithium ion was presented in Figure 5. A comparison of extraction behaviors on multilevel cross-flow and multistage counter-current

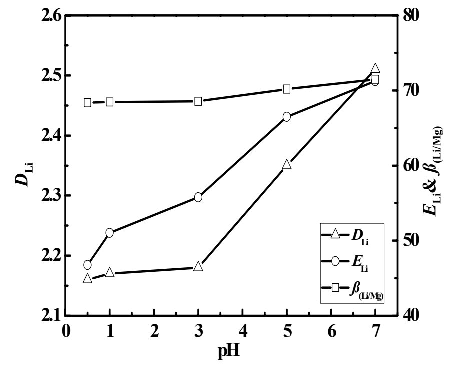

Fig. 1. Influence of solution pH on extraction of lithium

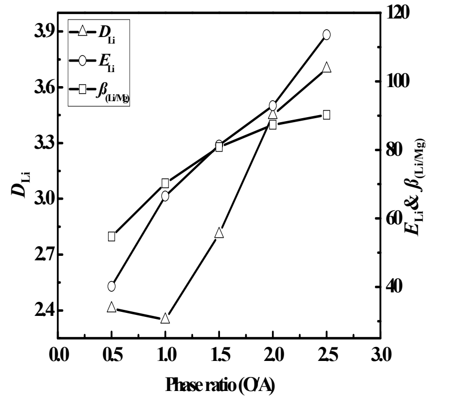

Fig. 2. Influence of R(O/A) value on extraction of lithium

Table 1 Results of orthogonal experiments. [a]

No.	A	B	C	D	E_{Li}
1	5	10	3.0	1.0	47.32
2	5	15	5.0	1.5	64.22
3	5	20	7.0	2.0	72.04
4	10	10	5.0	2.0	87.56
5	10	15	7.0	1.0	69.18
6	10	20	3.0	1.5	79.11
7	15	10	7.0	1.5	83.67
8	15	15	3.0	2.0	87.33
9	15	20	5.0	1.0	68.62
K_1	61.19	72.85	71.26	61.71	
K_2	78.62	73.58	73.47	75.67	
K_3	79.87	73.26	74.96	82.31	
R	18.68	0.73	3.70	20.60	

[a] A and B are the volume percentages of ionic liquid and kerosene in the total organic phase, respectively, C is pH value and D is phase ratio.

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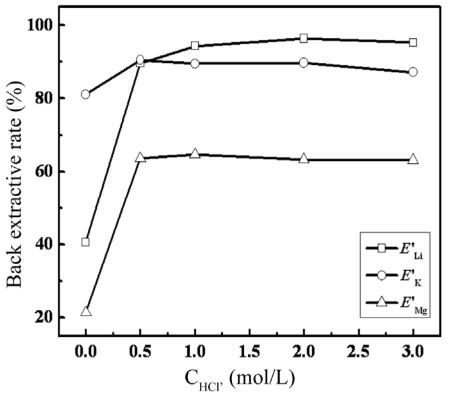

Fig. 3. Effect of the acidity of HCl(aq) on back extraction

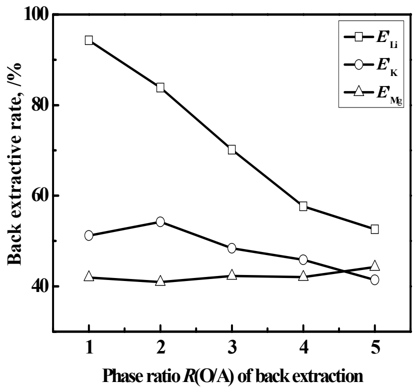

Fig. 4. Influence of R(O/A) on back extraction

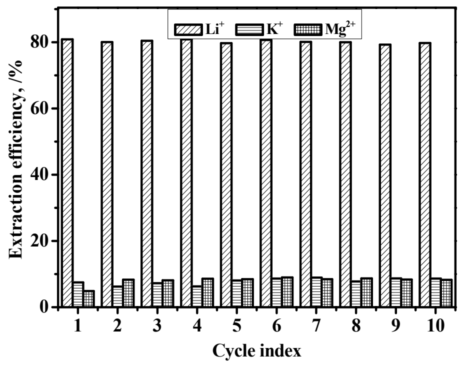

Fig. 5. The results of reused of the organic phase

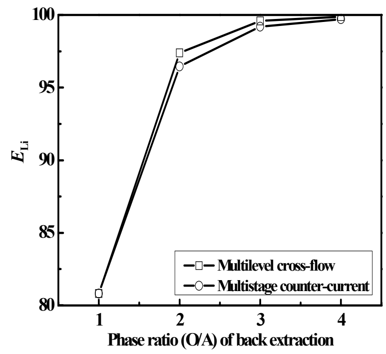

Fig. 6. Comparison of multilevel cross-flow and multistage counter-current for lithium ion extraction from the simulated brine

extraction process for lithium ion under the same conditions was showed in Figure 6.

2 Conclusion

In this work, ionic liquid plus triisobutyl phosphate and kerosene system for lithium ion extraction from high concentration of Mg/Li ratio salt lake brine were investigated. The optimal technological parameter of R(O/A) and pH value on the extraction step and the effect of the HCl solution concentration and R(O/A) on the back extraction step were obtained successfully. The single-pass extraction rate of Li^+ was 80.81% at the optimal extraction conditions, and the single-stage back extraction efficiency of Li^+ was 83.85% with 1 mol/L HCl in 1 mol/L NaCl medium as stripping agent at R(O/A)=2. Almost total Li^+ was effectively extracted out either after four level cross-flow or four stage counter-current extraction processes, however, the multilevel cross-flow extraction process may be better than the multistage counter-current extraction process for lithium ion on the view of high efficiency.

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References

Bettge, M., Seung, Y.R., Maclaren, S., Burdin, S., Petrov, I., Yu, M.F., Sammann, E., and Abraham, D.P., 2012. Hierarchically textured LixMn2−yO4 thin films as positive electrodes for lithium-ion batteries. Journal of Power Sources, 206: 288–294.

Rahman, M.M., Wang, J.Z., Zeng, R., Wexler, D., and Liu, H.K, 2012. LiFePO4-Fe2P-C composite cathode: an environmentally friendly promising electrode material for lithium-ion battery. Journal of Power Sources, 206: 259–266.

Somrani, A., Hamzaoui, A.H., and Pontie, M., 2013. Study on lithium separation from salt lake brines by nanofiltration (NF) and low pressure reverse osmosis (LPRO). Desalination, 317: 184–192.

Siame, E., and Pascoe, R.D., 2011. Extraction of lithium from micaceous waste from china clay production. Minerals Engineering, 24: 1595–1602.

Wang, X.L., Li, J.L., and Zhang, M.J., 2001. Energetic metal of the 21th century: the use of metal lithium in nuclear fusion. Gold Journal, 3: 249–252.

Zhou, Z.Y, Qin, W., and Fei W.Y., 2011. Extraction equilibria of lithium with tributyl phosphate in three diluents. Journal of Chemical and Engineering Data, 56: 3518–3522.