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Application of Dibenzo-21-Crown-7 for Cesium Extraction from Geothermal Water

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Cesium as a kind of alkali metals has widely been used in catalysis, medicine, biology, magnetic fluid power and other high-tech fields (Liao and Yang, 2012; Cao et al., 2011; Wang et al., 2011). Although there was abundant of geothermal water resource in China which was rich in cesium, there was no report on industrialized production. Hence, separation and extraction of cesium resource from geothermal water and preparation of valuable products have important significance for comprehensive utilization of brine.

Results from Du and Chen (2004) and Shoichi et al. (2005) showed that crown ether dibenzo-21- crown-7 (DB21C7) has a high identification on cesium ion for the diameter of cesium ion, which is similar to the aperture of DB21C7. And then, Du and Chen (2004) also reported that DB21C7 has higher selectivity on cesium ion than lithium and potassium ions. In other word, cesium ion can be separated out from geothermal water by DB21C7 as an extractant.

In this paper, DB21C7 has been successfully synthesized with the method of two-step through the intermediate. On the one hand, the affect factors including reaction time, temperature and the ratio of reactants for the synthetic yield of the intermediate double [2-(2-hydroxyl phenoxy) ethyl] ether under the nitrogen gas environment was investigated. On the other hand, the influences of the refluxing time and reaction temperature in the process of synthetic DB21C7 were also studied systematically. The physicochemical structure and molecular weight of DB21C7 was identified combined with the infrared spectrometer (IR), ultraviolet spectrophotometer (UV) and mass spectrometer (MS) after several times of purification. The influences of reaction temperature and refluxing time on the yield of DB21C7 were tabulated in Table 1, and the infrared spectrum of DB21C7 was showed in Figure 1.

From Table 1, it can be concluded that the highest

Table1 Influences of reaction temperature and time on the yield of DB21C7

Number	Time/h	Temperature/℃	Yield/%
1	15	100	32.65
2	15	110	56.40
3	15	115	28.73
4	25	100	51.34
5	25	110	57.00
6	25	115	43.45
7	35	100	18.98
8	35	110	20.45
9	35	115	16.54

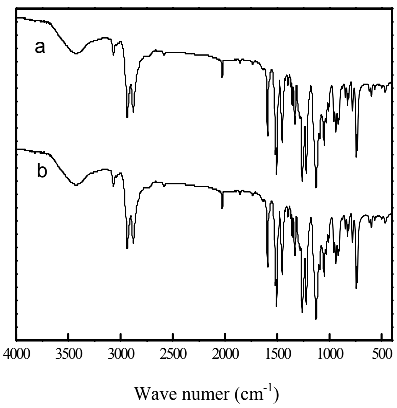

Fig. 1. Infrared spectra of DB21C7.
a, Infrared spectra of synthetic products; b, Standard infrared spectrogram of DB21C7. IR: 1220 cm^{-1}. ^{1}HNMR: (400 MHz, $CDCl_3$) 3.86 ~4.20(m, 20H, -OCH_2CH_2-), 6.87~7.0(s, 8H, benzene). MS: *m/e* 404.0621 (404.4424 Calculated for $C_{26}H_{28}O_7$.) .

productivity of target product DB21C7 was 57% under the conditions of refluxing time as 25 h and reaction temperature at 110°C.

Experimental results demonstrated that the synthetic method of DB21C7 was feasible and pure DB21C7 was obtained successfully.

In addition, experiments on using DB21C7 as a extractant and room temperature ionic liquid as the synergist for cesium ion extraction from geothermal water was found and established in this paper, and the influences of lithium and potassium ions concentration on the

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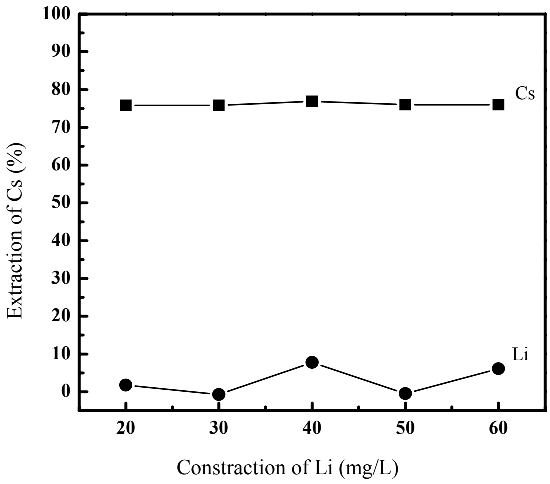

Fig. 2. Influence of lithium concentration on the extraction rate of cesium.

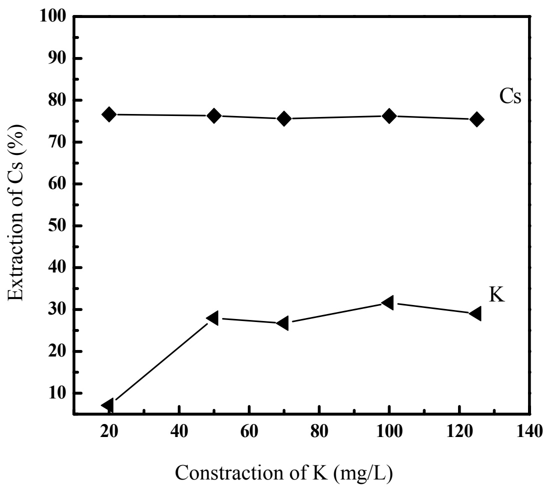

Fig. 3. Influence of potassium concentration on the extraction rate of cesium.

extraction efficiency of cesium ion was also studied for lithium, potassium and cesium ions, which were coexisted in the geothermal water. And the effects of lithium and potassium ions on the extraction rates were shown in Figures 2 and 3.

In Figure 2, it can be seen clearly that the extraction rate of cesium ion has nearly not changed when the concentration of lithium ion was between 20 and 60 mg/L, and the extraction rate of lithium was far below cesium. And Figure 3 showed that the extraction rate of cesium ion only has a slight decrease with the concentration of potassium ions increasing from 20 to 125 mg/L, but unfortunately that the extraction rate of potassium increased at the meanwhile. In spite of this, it also can be concluded that cesium ion can be separated out with lithium and potassium ions from the geothermal water.

Key words: Intermediate, Dibenzo-21-crown-7, Synthesis, Extraction

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