Electronic Supporting information

Study on Separation of ReO_4^-, a Substitute for TcO_4^-, Using Functional Ionic Liquid Impregnated Extraction Chromatography Resins

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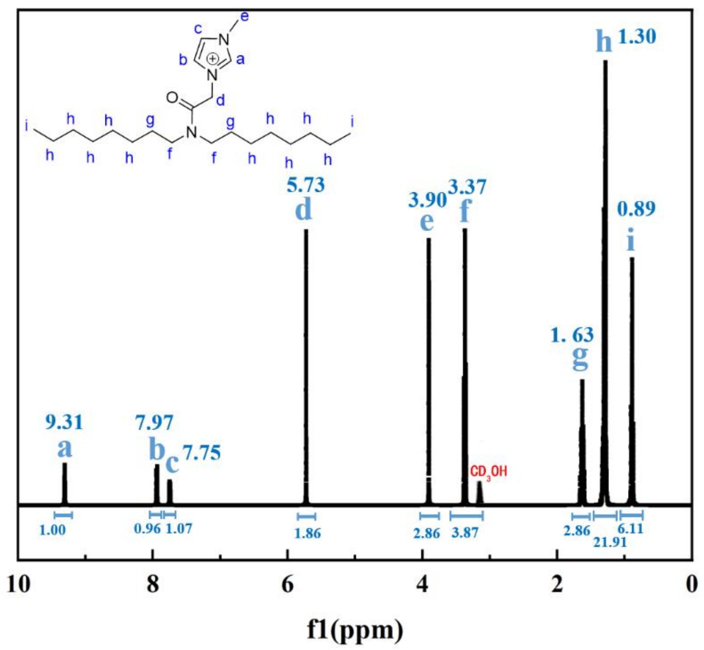

Fig. S1 ^{1}H-NMR FOR EM-1

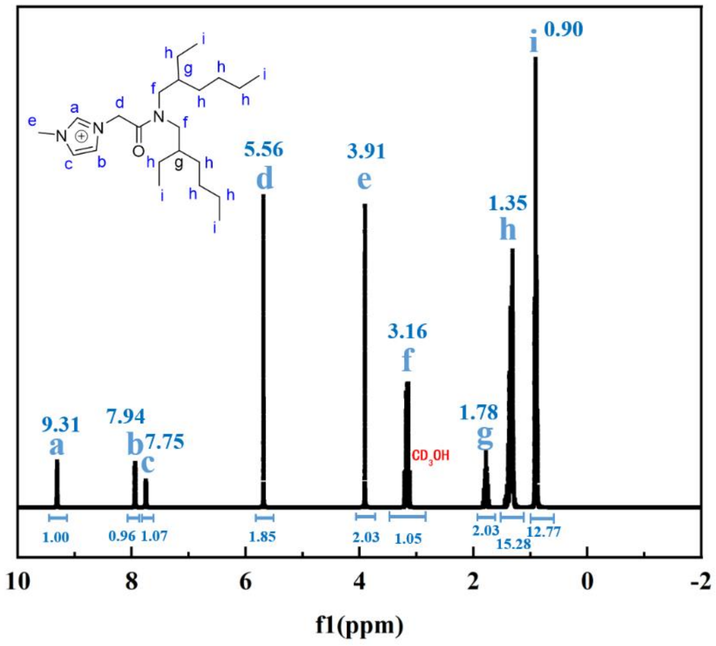

Fig. S2 ^{1}H-NMR FOR EM-2

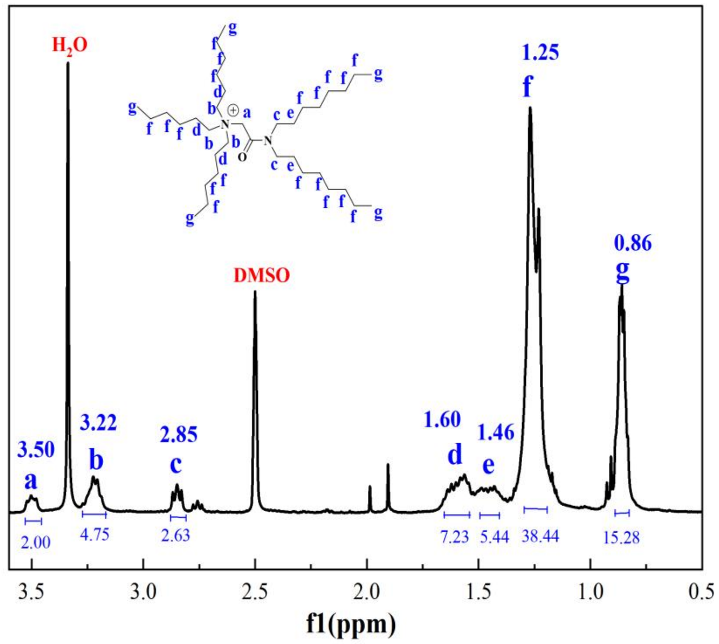

Fig. S3 ^{1}H-NMR FOR EA-1

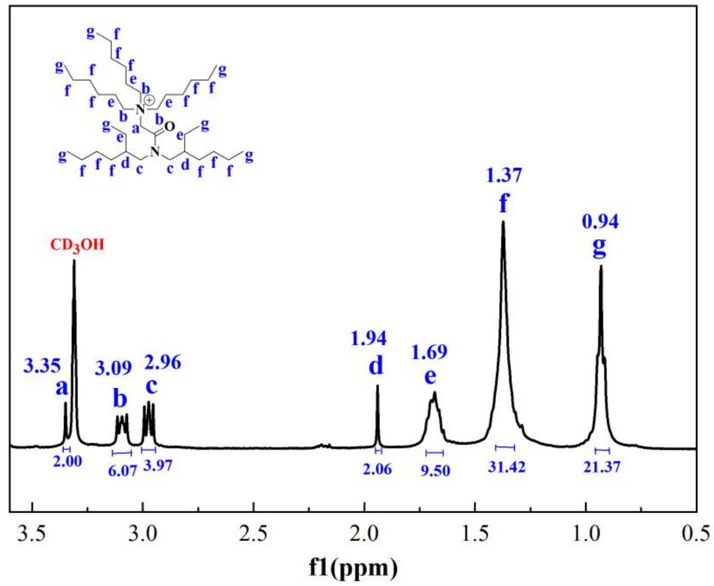

Fig. S4 ^{1}H-NMR FOR EA-2

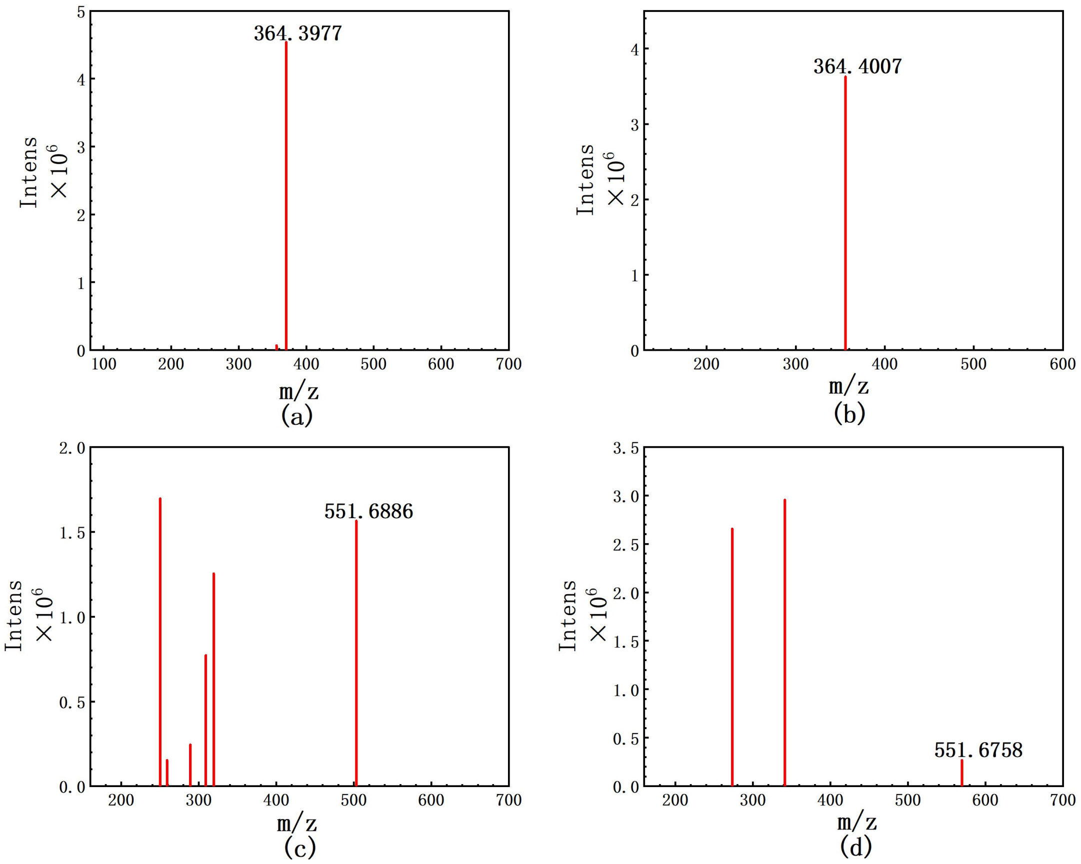

Fig. S5 (a)Cation electrospray mass spectrometry of EM-1 (b)Cation electrospray mass spectrometry of EM-2 (c)Cation electrospray mass spectrometry of EA-1 (d)Cation electrospray mass spectrometry of EA-2

Adsorption kinetic model

Kinetic studies of adsorption processes are mainly used to describe how fast or slow an adsorbent adsorbs a substance and to explore the adsorption mechanism by fitting the data with a kinetic model.

Pseudo-first-order model

In a pseudo-first-order kinetic reaction, the arrival of the adsorbed substance from the solution to the surface of the adsorbent is controlled by a diffusion step, and there is only one binding site on the surface of the adsorbent. This can be represented by equation (1).

Pseudo-second-order model

Pseudo-second-order kinetic reactions assume that the rate of adsorption is controlled by a chemisorption mechanism that involves the sharing or transfer of electron pairs between the adsorbed substance and the adsorbent. The arrival of the adsorbed substance from the solution to the surface of the adsorbent is controlled by the chemisorption mechanism, and there are two binding sites on the surface of the adsorbent. Consistency with the pseudo-second-order model suggests that the adsorption kinetics are mainly controlled by chemical reactions rather than substance migration steps. This can be represented by (2).

$$\ln\left(q_e - q_t\right) = \ln q_e - k_1 t \qquad (1)$$

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{t}{q_e} \tag{2}$$

Where q_e (mg/g) is the mass of ions adsorbed per unit mass of the resin in adsorption equilibrium with ions adsorbed in solution, q_t (mg/g) is the mass of ions adsorbed per unit mass of resin from the time of contact between the resin and the solution to the moment t, t (min) is the time consumed for the adsorption process, and k_1, k_2 are the kinetic constants of adsorption.

Adsorption isotherm

Adsorption capacity refers to the maximum amount of adsorption per unit of adsorbent at a certain temperature and a certain concentration of the adsorbed substance. We studied two common isothermal models for adsorption: the Langmuir and Freundlich models.

Langmuir's theory suggests that there is an outward residual valence force on atoms or molecules at the surface of a solid and that outside molecules or ions are affected by this residual valence force. The range of this force is comparable to the diameter of the molecule so that only monomolecular layer adsorption can occur on the surface of the adsorbent. Moreover, this adsorption is dynamic and reversible, and there is no interaction between the adsorbed molecules or ions.

The Langmuir model can be represented by equation (3),

$$\frac{C_i}{q_i} = \frac{1}{q_m} C_i + \frac{1}{q_m K_L} \tag{3}$$

where q_i (mg/g) is the amount adsorbed by the resin at equilibrium, C_i (mg/L) is the concentration of the remaining ions at equilibrium, q_m (mg/g) is the theoretical maximum saturated adsorption, and K_L (L/mg) is the Langmuir parameter.

The Freundlich model can be expressed in equation (4),

$$q_i = K_f C_e^{\frac{1}{n}} \tag{4}$$

where q_i (mg/g) is the amount adsorbed by the resin at equilibrium, C_i (mg/L) is the concentration of the remaining ions at equilibrium, K_f denotes the saturated adsorption capacity of the resin (mg/g), and n is the Freundlich parameter.