Supporting Information

Facile preparation of S-doped magnetite hollow spheres for highly efficient sorption of uranium (VI)

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Adsorption kinetics

Adsorption kinetics studies of S-doped MHS were investigated by two models as pseudo first-order model and the pseudo second-order model. The pseudo first-order model could indicate the initial stage of adsorption process, which is expressed by the following equation:

\[
\ln (q_e - q_t) = ln q_e - k_1 t \tag{1}
\]

where \( k_1 \) is the rate constant of pseudo-first-order adsorption, \( q_e \) and \( q_t \) (mg g\(^{-1}\)) is the amount of uranium adsorbed at equilibrium and at time (t), respectively.

For the pseudo-second-order the equation is given as:

\[
t / q_t = 1 / k_2 \cdot q_e^2 + t / q_e \tag{2}
\]

where \( k_2 \) is the rate constant of pseudo-second-order adsorption.

![Fig. S1 Pseudo-first-order kinetics and pseudo-second-order kinetics for removal of uranium by S-](image)

Fig. S1 Pseudo-first-order kinetics and pseudo-second-order kinetics for removal of uranium by S-
Table S1 Pseudo-first-order and pseudo-second-order constants and values of $R^2$ for S-doped MHS.

<table>
<thead>
<tr>
<th>Kinetic model</th>
<th>$T$</th>
<th>$C_0$</th>
<th>$Q_{e,exp}$</th>
<th>$Q_{e,cal}$</th>
<th>$k_1$(min$^{-1}$)</th>
<th>$k_2$ (g/mg min)</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudo-first order</td>
<td>25</td>
<td>110.0</td>
<td>455.9</td>
<td>198.9</td>
<td>0.0117</td>
<td>0.0002</td>
<td>0.9540</td>
</tr>
<tr>
<td>Pseudo-second order</td>
<td>25</td>
<td>110.0</td>
<td>455.9</td>
<td>476.2</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.9990</td>
</tr>
</tbody>
</table>

**Adsorption isotherm model**

In the study of adsorption equilibrium isotherm, the Langmuir model and Freundlich model were chosen. The linear equation of Langmuir model is expressed as:

$$
\frac{C_e}{q_e} = \frac{1}{b \cdot q_m} + \frac{C_e}{q_m}
$$

where $C_e$ (mg L$^{-1}$) is the equilibrium concentration of UO$_2^{2+}$ remained in solution, $q_e$ (mg g$^{-1}$) is the amount of solution adsorbed per unit mass of the adsorbent, $q_m$ (mg g$^{-1}$) is the maximum adsorption capacity, $b$ is the Langmuir adsorption equilibrium constant.

The Freundlich model in linear form is based on the assumption that the adsorption process on heterogeneous surface with different adsorption energies. This model is expressed by

$$
\ln q_e = \ln k + \frac{1}{n} \ln C_e
$$

where $k$ and $n$ are the Freundlich constants related to the adsorption capacity and adsorption intensity, respectively. They are determined from the intercept and slope of the linear plot of $\ln q_e$ vs. $\ln C_e$.
Fig. S2 Langmuir and Freundlich isotherms for removal of uranium by S-doped MHS.

Table S2 Isotherm constants and values of $R^2$ for S-doped MHS.

<table>
<thead>
<tr>
<th>T(K)</th>
<th>$Q_m$ (mg Ug$^{-1}$)</th>
<th>$b$ (L mg$^{-1}$)</th>
<th>$R^2$</th>
<th>$K$ (L g$^{-1}$)</th>
<th>$n$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>298</td>
<td>833.3</td>
<td>0.0323</td>
<td>0.6011</td>
<td>36.43</td>
<td>1.371</td>
<td>0.8192</td>
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<td>308</td>
<td>833.3</td>
<td>0.0405</td>
<td>0.5602</td>
<td>44.32</td>
<td>1.391</td>
<td>0.7461</td>
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<td>318</td>
<td>769.2</td>
<td>0.0567</td>
<td>0.6886</td>
<td>58.62</td>
<td>1.527</td>
<td>0.7287</td>
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<tr>
<td>328</td>
<td>769.2</td>
<td>0.0634</td>
<td>0.7302</td>
<td>64.54</td>
<td>1.653</td>
<td>0.7112</td>
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