SUPPLEMENTARY INFORMATION

Preparation of neutral red functionalized Fe₃O₄@SiO₂ and its application for magnetic solid phase extraction of trace Hg(II) from environmental water samples

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Pseudo first order and pseudo second order models

The pseudo first order and pseudo second order models can be expressed by Eqs. (S1) and (S2) [1], respectively:

\[
\ln \left( \frac{q_e - q_t}{q_e} \right) = -k_1 t \quad \text{(S1)}
\]

\[
\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{t}{q_e} \quad \text{(S2)}
\]

Here, in Eq. (S1), \( k_1 \) is the pseudo first order rate constant \((\text{min}^{-1})\) of the adsorption, and \( q_e \) and \( q_t \) (mg g\(^{-1}\)) are the amounts of metal ion adsorbed at equilibrium time and at time \( t \), respectively. The values of \( \ln(q_e - q_t) \) were calculated from the experimental data and used to plot against \( t \) (min). In Eq. (S2), \( k_2 \) is the pseudo second order rate constant of the adsorption. The values of \( q_e \) and \( k_2 \) could be calculated from slope and intercept of the linear plot of \( t/q_t \) vs. \( t \). The kinetic parameters acquired from fitting results were summarized in Table S1.

<table>
<thead>
<tr>
<th>( C_0 ) mg L(^{-1} )</th>
<th>q(_e) (exp) (mg g(^{-1}))</th>
<th>Pseudo first order kinetics</th>
<th>Pseudo second order kinetics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( k_1 )</td>
<td>( q_e, \text{cal} )</td>
</tr>
<tr>
<td>2</td>
<td>1.93</td>
<td>0.004</td>
<td>0.226</td>
</tr>
</tbody>
</table>

Langmuir and Freundlich adsorption isotherm models

The Langmuir isotherm [2] is given as:

\[
\frac{C_e}{q_e} = \frac{C_e}{q_m} + \frac{1}{q_m K_L} \quad \text{(S3)}
\]

where \( q_e \) is the equilibrium amount of Cd(II) adsorbed on the absorbent (mg g\(^{-1}\)), \( q_m \) is the maximum adsorption capacity of Cd(II) on the adsorbent (mg g\(^{-1}\)), \( C_e \) describes the equilibrium concentration of Cd(II) (mg L\(^{-1}\)), and \( K_L \) (L mg\(^{-1}\)) is a Langmuir adsorption constant related to the adsorption energy.

The Freundlich model [2] can be presented by

\[
\ln q_e = \ln K_F + \frac{1}{n} \ln C_e \quad \text{(S4)}
\]

where \( q_e \) and \( C_e \) have the same meanings with those in the Langmuir model, and \( K_F \) and \( n \) are
Freundlich constants related to the maximum adsorption capacity and the adsorption intensity, respectively.

Table S2. Langmuir and Freundlich parameters for Hg(II) adsorption by Fe\textsubscript{3}O\textsubscript{4}@SiO\textsubscript{2}-NR

<table>
<thead>
<tr>
<th>T(°C)</th>
<th>(K_L \text{ (L mg}^{-1}))</th>
<th>(q_m \text{ (mg g}^{-1}))</th>
<th>(R^2)</th>
<th>(K_F)</th>
<th>(n)</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.05</td>
<td>83.71</td>
<td>0.997</td>
<td>5.62</td>
<td>1.91</td>
<td>0.971</td>
</tr>
</tbody>
</table>

References

[1] R.R. Shan, L.G. Yan, K. Yang, Y.F. Hao, B. Du, Adsorption of Cd(II) by Mg–Al–CO\textsubscript{3} and magnetic Fe\textsubscript{3}O\textsubscript{4}/Mg–Al–CO\textsubscript{3} layered double hydroxides: Kinetic, isothermal, thermodynamic and mechanistic studies, J. Hazard. Mater. 299 (2015) 42-49.