Supplementary Material

Facile preparation of iron-manganese oxide @ diatomite composite
with effective remove of vanadium from wastewater

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1. Adsorption kinetics

Figure S1. Pseudo-first order model for the adsorption of V (V) by adsorbents.

2. Adsorption isotherm

In this work, the Dubinin-Radushkevich (D–R) isotherm model and Temkin isotherm model were also applied to depict the adsorption properties between the adsorbed V (V) species and the adsorbents. The D–R isotherm model (Eq. S1) and Temkin isotherm model (Eq. S2) can be described as follows:

\[ \log Q_e = \log Q_{\text{max}} - B \varepsilon^2 \]  
\[ Q_e = A_T + B_T \ln C_e \]

Where; \( Q_e \) and \( Q_{\text{max}} \) are the equilibrium and maximum adsorption capacities (mg/ g), respectively; \( C_e \) (mg/L) is the vanadium concentration at equilibrium and \( B \) (mol\(^2\)/kJ\(^2\)) is the D–R constant, \( \varepsilon = RT \ln(1 + 1/C_e) \); \( A_T \) refers to the maximum binding energy and \( B_T \) is the Temkin isotherm constant. The V (V) adsorption isotherms and the fitted curves of the two kinds of models at different temperatures by MnFe\(_2\)O\(_4@\)DE are shown in Figure S2 (a) and (b). Besides, the adsorption isotherm
parameters can be calculated from the fitted plot of $Q_e$ versus $C_e$ and summarized in Table S1.

![Figure S2. Dubinin–Radushkevich (a) and Temkin (b) isotherms by nonlinear models for V (V) onto MnFe$_2$O$_4$@DE](image)

Table S1. Parameters of D-R and Temkin isotherms for V (V) adsorption.

<table>
<thead>
<tr>
<th>T/(K)</th>
<th>D-R</th>
<th>Temkin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Q_{max}$(mg/g)</td>
<td>B(mol$^2$KJ$^{-2}$)</td>
</tr>
<tr>
<td>288</td>
<td>8.56</td>
<td>2.795</td>
</tr>
<tr>
<td>298</td>
<td>11.26</td>
<td>0.247</td>
</tr>
<tr>
<td>308</td>
<td>14.30</td>
<td>0.039</td>
</tr>
<tr>
<td>318</td>
<td>16.98</td>
<td>0.026</td>
</tr>
</tbody>
</table>

Based on the $R^2$ values ($R^2 \leq 0.904$) of D-R model, it is clear that the experimental data are not well fitted with D-R isotherm model. $R^2$ values ($0.928 \leq R^2 \leq 0.975$) of Temkin model are relatively high, indicating that there might be chemical adsorption in the adsorption process of V(V) by MnFe$_2$O$_4$@DE composite$^{[1]}$.

References