Supplementary Material

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

Junying Song, Zhanbin Huang*, Fengzhi Yang

School of Chemical and Environmental Engineering, China University of Mining and Technology (Beijing), Beijing 100083, P. R. China

Junying Song, Tel: +86 15650702961  E-mail:qdsongjunying@163.com

Zhanbin Huang (Corresponding author),  Tel: +86 18911005280
E-mail:zbhuang2003@163.com

Fengzhi Yang, Tel: +86 18811523809  E-mail: yfz1008@163.com

*Corresponding author: Tel: +86 18911005280 (Zhanbin Huang).
E-mail:zbhuang2003@163.com
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:

\[
\log Q_e = \log Q_{\text{max}} - B\varepsilon^2 \quad \text{(Eq. S1)}
\]

\[
Q_e = A_T + B_T\log C_e \quad \text{(Eq. S2)}
\]

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 \( B \) (mol²/kJ²) 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 MnFe₂O₄@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)

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

**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></th>
<th></th>
<th></th>
<th>Temkin</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Q_{max}$(mg/g)</td>
<td>B(mol$^2$KJ$^{-2}$)</td>
<td>$R^2$</td>
<td></td>
<td>$A_T$</td>
<td>$B_T$</td>
<td>$R^2$</td>
</tr>
<tr>
<td>288</td>
<td>8.56</td>
<td>2.795</td>
<td>0.904</td>
<td></td>
<td>4.246</td>
<td>0.943</td>
<td>0.928</td>
</tr>
<tr>
<td>298</td>
<td>11.26</td>
<td>0.247</td>
<td>0.886</td>
<td></td>
<td>6.128</td>
<td>1.204</td>
<td>0.975</td>
</tr>
<tr>
<td>308</td>
<td>14.30</td>
<td>0.039</td>
<td>0.821</td>
<td></td>
<td>9.132</td>
<td>1.366</td>
<td>0.949</td>
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<tr>
<td>318</td>
<td>16.98</td>
<td>0.026</td>
<td>0.859</td>
<td></td>
<td>11.563</td>
<td>1.785</td>
<td>0.934</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**