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Supplementary Information

Amine-terminated modified succinic acid-magnetite nanoparticles for effective removal of malachite green dye from aqueous environment

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Text S1. Adsorption isotherm

To specify the maximum adsorption capacity of MSA@TEPA toward MG dye and also to study the mechanism of binding between MG dye and MSA@TEPA, nonlinear isotherm, Langmuir [1] Eq. S1, Freundlich [2] Eq. S2, and Dubinin–Radushkevich (D-R) [3] (Eq. S3-S5) isotherm models were used.

$$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \quad (S1)$$

$$q_e = K_F \, C_e^{1/n} \quad (S2)$$

$$q_e = q_m \, e^{-K_{D-R}\,\varepsilon^2} \quad (S3)$$

$$\varepsilon = RT\ln(1 + \frac{1}{C_e}) \quad (S4)$$

$$E = \frac{1}{\sqrt{2K_{D-R}}} \quad (S5)$$

Here, K_{D-R} (mol^2/kJ^2) is the D-R constant relating to adsorption energy, while KL (L/mg) is the Langmuir binding constant. KF is the Freundlich constant (mg^{1-n}. Ln/g); Ce is the concentration of MG dye (mg/L) at equilibrium; n is the heterogeneity factor; E(kJ/mol) is the activation energy, and ε is the Polanyi potential.

Text S2. Adsorption kinetic

To understand the MG adsorption mechanism on the MSA@TEPA surface, the experimental data were assessed using nonlinear kinetic models: pseudo-first-order (PFO) [4] Eq. S6, pseudo-second-order (PSO) Eq. S7, and Elovich [5] Eq. S8 .

$$q_t = q_e(1 - e^{-k_1 t}) \quad (S6)$$

$$q_t = \frac{q_e^2 k_2 t}{1 + q_e k_2 \, t} \quad (S7)$$

$$q_t = \frac{1}{\beta}\ln(1 + \alpha\beta t) \quad (S8)$$

where qe and qt are the adsorption capacities (mg/g) at equilibrium and at time t (min), respectively; k_1 and k_2 the constants for PFO and PSO models, respectively, α (mg/g min) is the initial adsorption rate; β (mg/g) is the desorption constant during any one experiment.

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