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# Supporting Information

# Selective adsorption of Cu(II) from aqueous solution by ion imprinted magnetic chitosan microspheres prepared from steel pickling waste liquor

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The Langmuir adsorption isotherm model is the description of monolayer adsorption on an energetically uniform surface with finite adsorption sites. The linear form of the Langmuir isotherm model is expressed as:

$$\frac{C_e}{Q_e} = \frac{C_e}{Q_{m.cal}} + \frac{1}{Q_{m.cal}K_L} \quad \text{S(1)}$$

where $Q_e$ and $Q_{m.cal}$ are the adsorption capacity at equilibrium (mg $g^{-1}$) and the theoretical adsorption capacity calculated from Langmuir model (mg $g^{-1}$), $C_e$ is the equilibrium concentration (mg $L^{-1}$), $K_L$ is the Langmuir constant related to the energy of adsorption.

Besides, the constant $R_L$ calculated using the Langmuir constant ($K_L$) and the initial concentration was related with the degree of suitability of adsorbent towards adsorbate. The value of $R_L$ indicates the type of the isotherm as follow: $R_L > 1.0$, unfavorable; $R_L = 1.0$, linear; $0 < R_L < 1.0$, favorable; $R_L = 0$, irreversible{Hall, 1966 #207}. the constant $R_L$ can be defined as :

$$R_L = \frac{1}{1 + K_L C_0} \quad \text{S(2)}$$

where $C_0$ was the initial concentration of Cu(II), 350 mg $L^{-1}$.

The Freundlich isotherm model is an empirical equation based on the assumption of heterogeneous adsorption, which is suitable to describe both monolayer and multilayer adsorption. The linear form of the Freudlich isotherm model is described as:

$$\log Q_e = \frac{1}{n}\log C_e + \log K_F \quad \text{S(3)}$$

where $K_F$ and $n$ are Freundlich constants (L $g^{-1}$) adsorption capacity and intensity.

The Temkin isotherm model assumed that the adsorption energy decreases

linearly with the surface coverage, which is used to described chemical adsorption. The Temkin model is commonly presented as:

$$Q_e = B_T \ln C_e + B_T \ln A_T \quad \text{S(4)}$$

where $A_T$ and $B_T$ are constants (mg $g^{-1}$) related to the initial adsorption heat and the surface heterogeneity of the adsorbent, respectively.

The Dubinin-Radushkevich (D-R) isotherm is a semi-empirical equation where adsorption follows a pore filling mechanism with multilayer character. It is commonly used to distinguish chemical adsorption and physical adsorption. the D-R equation is as followed:

$$\ln Q_e = K\varepsilon^2 + \ln Q_{DR} \quad \text{S(5)}$$

where $K$ is D-R constant related to average free energy in adsorption process, $Q_{DR}$ is the theoretical saturation capacity (mg $g^{-1}$), $\varepsilon$ is the Polanyi potential which is defined as:

$$\varepsilon = RT\ln\left(1+\frac{1}{C_e}\right) \quad \text{S(6)}$$

Gibbs free energy of adsorption ($\Delta G^0$) was calculated as follow:

$$\Delta G^0 = -RT\ln K_0 \quad \text{S(7)}$$

where $R$ was the universal gas constant (8.314 J $mol^{-1}$ $K^{-1}$).

$\ln K_0$ was plotted against $1/T$ to calculate $\Delta H^0$ and $\Delta S^0$ from the slope and intercept as follow:

$$\ln K_L = \frac{-\Delta H^0}{RT} + \frac{\Delta S^0}{R} \quad \text{S(8)}$$

where $\Delta H^0$ (J $mol^{-1}$) and $\Delta S^0$ (J $mol^{-1}$ $K^{-1}$) were enthalpy and entropy changes,

respectively.