Supplementary Information

Table S1: Isotherm model equations

|  |  |  |
| --- | --- | --- |
| Isotherm | Equation | Parameter |
| Freundlich | $$q\_{e}=K\_{F}C\_{e}^{{1}/{n}}$$ | $$K\_{F},{1}/{n}$$ |
| Langmuir | $$q\_{e}=\frac{q\_{max}K\_{L}C\_{e}}{1+K\_{L}C\_{e}}$$ | $$q\_{max},K\_{L}$$ |
| n-layer BET | $$q\_{e}=q\_{m}\frac{K\_{S}C\_{e}\left[1-\left(n\_{BET}+1\right)\left(K\_{L\_{BET}}C\_{e}\right)^{n\_{BET}}+n\_{BET}\left(K\_{L\_{BET}}C\_{e}\right)^{n\_{BET}+1}\right]}{\left(1-K\_{L\_{BET}}C\_{e}\right)\left[1+\left(\frac{K\_{S}}{K\_{L\_{BET}}}-1\right)K\_{L}C\_{e}-\left(\frac{K\_{S}}{K\_{L\_{BET}}}\right)\left(K\_{L\_{BET}}C\_{e}\right)^{n\_{BET}+1}\right]}$$ | $$q\_{m},K\_{S}, K\_{L\_{BET}},n\_{BET}$$ |
|  |  |  |

Table S2: Non-linear kinetic model equations

|  |  |  |
| --- | --- | --- |
| Isotherm | Equation | Parameter |
| Pseudo-first order (PFO) | $$q\_{t}=q\_{e}\left[1-exp\left(-k\_{1}t\right)\right]$$ | $$q\_{e},k\_{1}$$ |
| Pseudo-second order (PSO) | $$q\_{t}=\frac{k\_{2}q\_{e}^{2}t}{1+k\_{2}q\_{e}t}$$ | $$q\_{e},k\_{2}$$ |
| Elovich | $$q\_{t}=\frac{1}{β}ln\left(α\_{E}β\right)+\frac{1}{β}ln\left(t\right)$$ | $$α\_{E},β$$ |
| Avrami | $$q\_{t}=q\_{e}\left\{1-exp\left[-\left(k\_{AV}t\right)^{n\_{AV}}\right]\right\}$$ | $$q\_{e}, k\_{AV},n\_{AV}$$ |

Table S3: Breakthrough curve model equations

|  |  |  |
| --- | --- | --- |
| Model | Equation | Parameter |
| Thomas | $$\left(\frac{C\_{t}}{C\_{0}}\right)=\frac{1}{1+exp\left(k\_{TH}q\_{TH}\frac{m}{Q}-k\_{TH}C\_{0}t\right)}$$ | $$k\_{TH},q\_{TH}$$ |
| Yoon-Nelson | $$\left(\frac{C\_{t}}{C\_{0}}\right)=\frac{1}{1+exp\left[k\_{YN}\left(τ-t\right)\right]}$$ | $k\_{YN}$, $τ$ |
| Bohart–Adams | $$\left(\frac{C\_{t}}{C\_{0}}\right)=exp\left(k\_{BA}C\_{0}t-\frac{k\_{BA}N\_{0}H}{v}\right)$$ | $$k\_{BA},N\_{0}$$ |
| Yan | $$\left(\frac{C\_{t}}{C\_{0}}\right)=1-\frac{1}{1+\left(\frac{C\_{0}Qt}{q\_{Y}m}\right)^{α\_{Y}}}$$ | $q\_{Y}$, $α\_{Y}$ |

Figure S1: Kinetic curves (a) PFO, (b) PSO, (c) Elovich and (d) Avrami

(a)

(b)

(c)

(d)

Figure S2: Breakthrough curve (a) Effect of flowrate (initial concentration = 100 mg/L and bed height = 2 cm), (b) Effect of bed height (initial concentration = 100 mg/L and flowrate = 0.5 ml/min) (c) Effect of initial MG concentration (flowrate = 2 ml/min and bed height = 2 cm)

(a)

(b)

(c)

Figure S3: Thermodynamic plot