Supplementary Information

Layered zinc hydroxide as an adsorbent for phosphate removal and recovery from wastewater

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Effect of adsorbent dose on phosphate adsorption

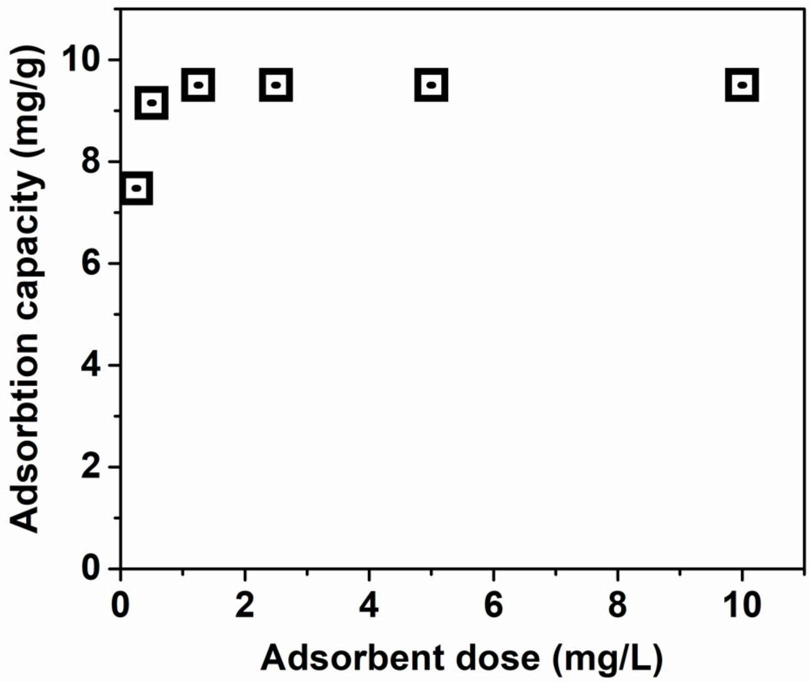

Figure S1. Effect of LZH dose on phosphate adsorption. Initial phosphate concentration= 5 ppm. Contact time= 2 hrs.

Kinetic models

The pseudo-first order[1] equation is expressed as follows:

$$\log\left(q_e - q_t\right) = \log\left(q_e\right) - \frac{k_1 t}{2.303} \quad \text{(S1)}$$

where, q_e and q_t ($mg.g^{-1}$) depict the phosphate adsorption capacity at equilibrium and at time t (min), respectively, and k_1 (min^{-1}) depicts the pseudo-first order rate constant. The parameters q_e and k_1 can be calculated from the slope and intercept of the plot of log (q_e-q_t) versus t.

The pseudo-second order [2] equation is expressed as follows:

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{t}{q_e}$$

(S2)

where, q_t (mg.g^{-1}) is the amount of phosphate adsorbed at a certain time t (min), q_e (mg g^{-1}) is the amount of phosphate adsorbed at equilibrium, and k_2 (g. mg^{-1}.min^{-1}) is the pseudo-second-order reaction rate. From the intercept and slope of the (t/q_t) vs. t plot, k_2 and q_e can be calculated, respectively.

The Weber and Morris intra-particle diffusion model[3] is expressed as follows:

$$q_t = k_p t^{0.5} + C \qquad \text{(S3)}$$

where, q_t (mg.g^{-1}) is the amount of phosphate adsorbed at time t (min), k_p is the intraparticle diffusion rate constant (mg.g.min$^{0.5}$) and C is a constant. The values of k_p and C can be determined from the intercept and slope of the linear plot of q_t versus $t^{0.5}$.

Isotherm models

The nonlinear form of the Langmuir isotherm is expressed in the equation as follows:

$$q_e = \frac{X_m b C_e}{1 + b C_e} \qquad \text{(S4)}$$

where, q_e and C_e are the amount of phosphate adsorbed per unit mass of adsorbent material (mg g^{-1}) and the equilibrium concentration of phosphate (mg L^{-1}), respectively. X_m and b are Langmuir constants representing the monolayer capacity (mg g^{-1}) and equilibrium constant, respectively.

The dimensionless constant (R_L), generally known as the separation factor, was calculated also. as shown below[4]:

$$R_L = \frac{1}{1 + bC_0} \tag{S5}$$

where, C_0 is the highest initial phosphate concentration (mg L^{-1}).

The non-linear form of the Freundlich model is expressed as:

$$q_e = K_f \, C_e^{1/n} \tag{S6}$$

where, q_e and C_e are the amount of phosphate adsorbed per unit mass of adsorbent material (mg.g^{-1}) and the equilibrium concentration of phosphate (mg.L^{-1}), respectively. K_f and n are Freundlich constants related to the adsorption capacity and intensity, respectively.

Initial and final pH values for the pH experiments

Table S1. Initial and final pH values after phosphate adsorption on LZH.

pH (initial)	pH (final)
3.08	5.88
4.06	5.93
4.97	6.12
5.95	6.18
6.98	6.38
7.97	6.72
9.03	6.73
9.88	5.88

References

[1] J. F. Corbett, *Journal of Chemical Education* **1972**, *49*, 663.

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[3] W. J. Weber and J. C. Morris, *Journal of the Sanitary Engineering Division* **1963**, *89*, 31-60.

[4] J.-Q. Jiang, C. Cooper and S. Ouki, *Chemosphere* **2002**, *47*, 711-716.