Text S1

Adsorption kinetics in this study

The adsorption kinetics of PN and HLO-PN were fitted with pseudo-first-order model, pseudo-second-order model and intraparticle diffusion model, respectively.

$$\ln(q_e - q_t) = \ln q_e - k_1 t \quad (1)$$

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

$$q_t = k_i t^{0.5} + C \quad (3)$$

where q_e (mg/g) and q_t (mg/g) are adsorption capacity at equilibrium and at time t (min), respectively. k_1 (/min), k_2 ((g/mg)/min) and k_i are kinetic rate constants for the pseudo-first-order, the pseudo-second-order model and sorption rate constant, respectively. C is constant.

Text S2

Adsorption isotherm models in this study

The adsorption isotherms of phosphate by PN and HLO-PN were fitted with Langmuir model, Freundlich model, D-R model and Temkin model, respectively.

$$\frac{C_e}{q_e} = \frac{1}{q_m K_L} + \frac{C_e}{q_m} \quad (4)$$

$$\ln q_e = \frac{1}{n}\ln C_e + \ln K_F \quad (5)$$

$$\ln q_e = \ln q_m - \frac{1}{2E^2}[RT\ln(1+1/C_e)]^2 \quad (6)$$

$$q_e = \frac{RT}{b}\ln(K_T \cdot C_e) \quad (7)$$

where q_e is the equilibrium adsorption capacity of an adsorbent (mg/g); q_m is the maximum adsorption capacity adsorbent, Ce (mg/L) is the equilibrium concentration of P(V) in aqueous phase; K_L (L/mg) is a binding constant, K_F and n are Freundlich constants related to adsorption capacity and adsorption intensity, respectively.

Text S3

Adsorption thermodynamics in this study

The adsorption thermodynamic formula of phosphorus can be described as:

$$\Delta G = -RT\ln K \quad (8)$$

$$\ln K = \frac{\Delta S}{R} - \frac{\Delta H}{RT} \quad (9)$$

where R (8.314 J·mol^{-1}·K^{-1}) is the universal gas constant, and T (K) represents the absolute temperature. K is a dimensionless constant.
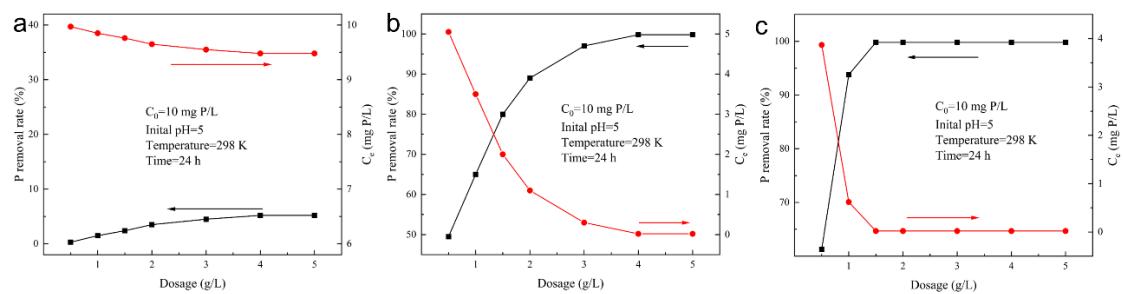
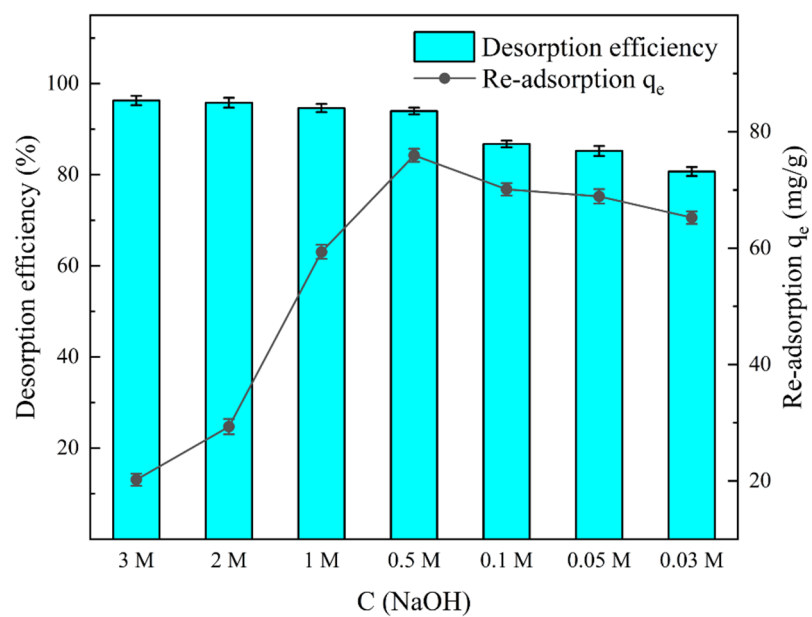Fig.S1. Influence of (a) PS, (b) PN and (c) HLO-PN dosage on phosphate removal rate

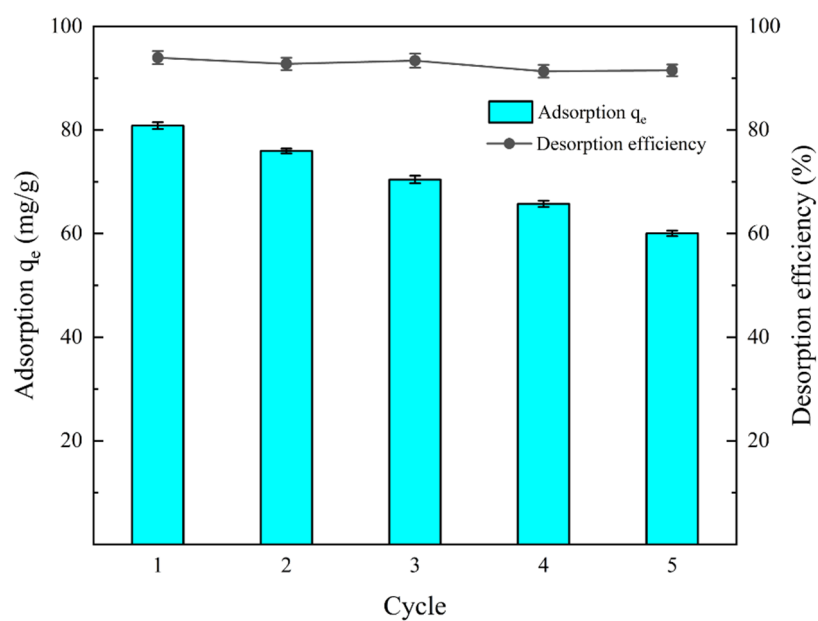Fig.S2. Effect of NaOH concentration on HLO-PN desorption and re-adsorption of phosphate

Fig.S3. Adsorption capacity and desorption efficiency of HLO-PN for five times of adsorption-

desorption

Table S1 Specific surface area, porosity and average pore size of the adsorbent

Adsorbents	Specific surface area m^2/g	Porosity cm^3/g	Average pore size nm
PN	21.55	0.084	22.84
HLO-PN	40.58	0.174	16.79

Table S2 Pseudo-first-order and pseudo-second-order kinetic   parameters of phosphate adsorption by PN and HLO-PN

Adsorbents	qe,exp mg/g	Pseudo-first-order kinetic			Pseudo-second-order kinetic		
		qe,cal mg/g	K1 min-1	R2	qe,cal mg/g	K2 g/(mg·min)	R2
PN	43.21	40.08	1.667	0.9833	43.44	0.054	0.9902
HLO-PN	80.85	76.35	3.248	0.9754	81.16	0.067	0.9962

Table S3 Kinetic parameters of in-particle diffusion of phosphate adsorbed by PN and HLO-PN

Adsorbents	In-particle diffusion model					
	K_1 mg/h$^{1/2}$/g	C_1	R_1^2	K_2 mg/h$^{1/2}$/g	C_2	R_2^2
PN	33.285	0.796	0.99128	1.821	34.516	0.88268
HLO-PN	70.976	5.156	0.94678	2.775	69.851	0.97198

Table S4 Langmuir and Freundlich isotherm parameters of phosphate adsorption by PN and HLO-PN

Adsorbents	T	Langmuir isotherm model			Freundlich isotherm model		
		q_m	K_L	R^2	n_F	K_F	R^2
	°C	mg/g	L/mg			$(mg/g)(L/mg)^{1/n}$	
	15	39.83	0.112	0.9792	4.64	12.00	0.8947
PN	25	49.01	0.159	0.9785	4.82	15.89	0.8611
	35	54.05	0.251	0.9599	5.31	19.76	0.8130
	15	84.54	0.057	0.9870	3.85	18.88	0.8848
HLO-PN	25	90.28	0.112	0.9621	4.88	28.79	0.9428
	35	92.57	0.265	0.9673	5.59	35.53	0.9467

Table S5 Temkin and D-R isotherm parameters of phosphate adsorption by PN and HLO-PN

Adsorbents	T	Temkin isotherm model			D-R isotherm model		
		b	K_T	R^2	q_m	E	R^2
	°C	kJ/mol	L/g		mg/g	kJ/mol	
	15	0.543	20.249	0.8947	28.19	3.539	0.7706
PN	25	0.473	31.506	0.8644	32.82	4.286	0.7405
	35	0.469	61.639	0.8318	35.39	5.123	0.7279
	15	0.264	1.653	0.9587	61.25	3.658	0.8190
HLO-PN	25	0.271	45.340	0.9229	67.59	4.519	0.8087
	35	0.283	102.866	0.9585	72.13	5.401	0.8233