Supplementary data for:

Competitive removal of Cd (II) and Pb (II) by biochars produced from water hyacinths: performance and mechanism

Yang Ding[a,b], Yunguo Liu[a,b,*], Shaobo Liu[c,d,*], Zhongwu Li[a,b], Xiaofei Tan[a,b], Xixian Huang[a,b], Guangming Zeng[a,b], Yaoyu Zhou[a,b], Bohong Zheng[c], Xiaoxi Cai[a,b]

[a]College of Environmental Science and Engineering, Hunan University, Changsha 410082, PR China.

[b]Key Laboratory of Environmental Biology and Pollution Control (Hunan University), Ministry of Education, Changsha 410082, PR China.

[c]School of Architecture and Art Central South University, Central South University, Changsha 410082, P. R. China.

[d]School of Metallurgy and Environmental, Central South University, Changsha 410083, P.R. China

* Corresponding author: Tel.: +86 731 88649208; Fax.: +86 731 88822829

E–mail: hnliuyunguo@163.com (Y.G. Liu).

* Corresponding author: Tel.: +86 731 88830923; Fax.: +86 731 88710171

E–mail: liushaobo23@aliyun.com (S.B. Liu).

Table S1 BET characteristics of water hyacinths biochar produced at 450 ^{o}C

Adsorbent	BET surface area ($m^2\ g^{-1}$)	Pore volume ($cm^3\ g^{-1}$)	Average pore (nm)
BC450	51.15	0.06667	5.222

Table S2 Thermodynamic parameters for the adsorption of the mixture of Cd and Pb by BC450

Pollutants	lnk_e			ΔG^0 (kJ mol^{-1})			ΔH^0 (kJ mol^{-1})	ΔS^0 (J mol^{-1} K^{-1})
	25 °C	30 °C	40 °C	25 °C	30 °C	40 °C		
Cd	1.218	1.224	1.425	-3.018	-3.084	-3.710	11.51	48.49
Pb	1.839	2.045	2.050	-4.558	-5.153	-5.338	9.375	47.21

Table S3 Comparison of the maximum Cd (II) or Pb (II) adsorption capacity of various adsorbents

Adsorbents	Heavy metals	Adsorption capacity (mg g^{-1})	References
Granular activated carbon	Cd	11.1	1
Phaseolus aureus hulls activated carbon	Cd	15.7	2
Apricot atone activated carbon	Cd	33.57	3
Bagasse activated carbon	Cd	38.03	4
water hyacinth biochar	Cd	77.5	This study
Phaseolus aureus hulls activated carbon	Pb	21.8	2
Apricot atone activated carbon	Pb	22.85	3
Coconut shell activated carbon	Pb	26.50	5
Tamarind wood activated carbon	Pb	134.22	6
water hyacinth biochar	Pb	168	This study

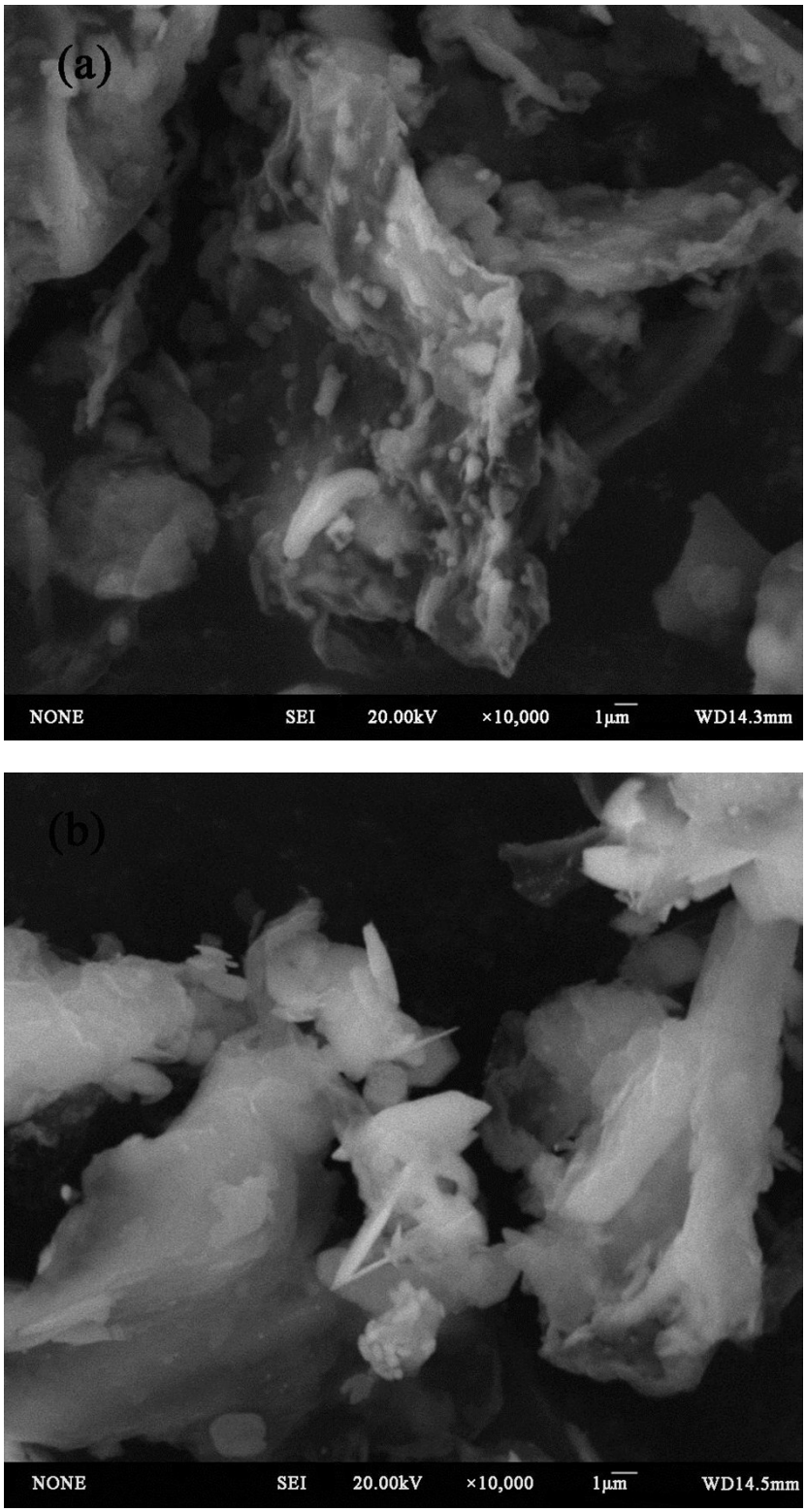

Fig. S1. Scanning electron micrographs of BC450 (a) before and (b) after adsorption.

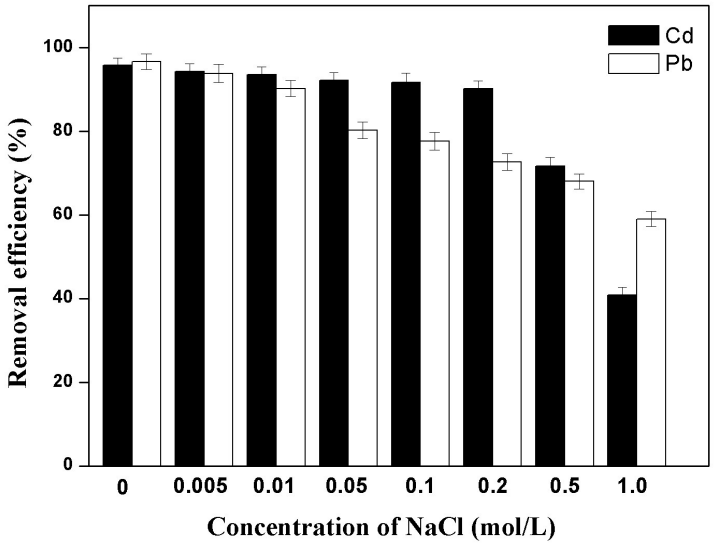

Fig. S2. Effect of different concentrations of NaCl on Cd and Pb removal in single system by BC450 (solution volume: 50 mL; adsorbent dose: 0.1 g; initial concentration: 100 mg L^{-1}; pH: 5.0; contact time: 24h).

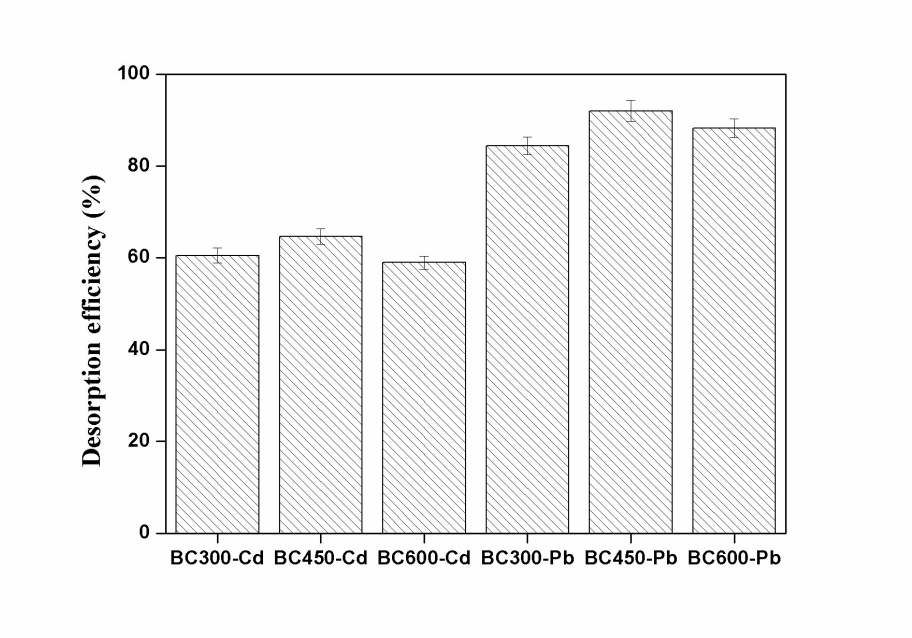

Fig. S3. Desorption of BC450 for heavy metals removal; (solution volume: 50 mL; adsorbent dose: 0.1 g; initial concentration: 500 mg L^{-1}; contact time: 24 h).

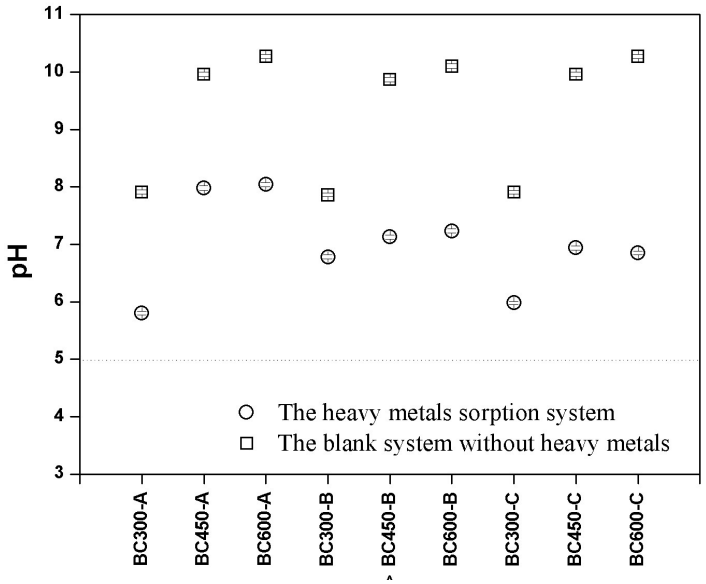

Fig. S4. The pH values of the mixed solution of biochars with and without heavy metals after equilibration shaking 24 h. The initial pH of Cd, Pb and the mixture were 5.0; A presented Cd; B presented Pb; C presented the mixture of Cd and Pb.

Reference

1. K. Periasamy and C. Namasivayam, *Ind. Eng. Chem. Res.*, 1994, 33, 317–320.
2. M. M. Rao, D. Ramana, K. Seshaiah, M. Wang and S. C. Chien, *J. Hazard. Mater.*, 2009, 166, 1006–1013.
3. M. Kobya, E. Demirbas, E. Senturk and M. Ince, *Bioresour. Techonol*., 2005, 96, 1518–1521.
4. D. Mohan and K. P. Singh, *Water. Res.*, 2002, 36, 2304–2318.
5. M. Sekar, V. Sakthi and S. Rengaraj, *J. Colloid. Interf. Sci*., 2004, 279, 307–313.
6. C. Singh, J. Sahu, K. Mahalik, C. Mohanty, B. R. Mohan and B. Meikap, *J. Hazard. Mater.,* 2008, 153, 221–228.