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The preparation of ZnO impregnated biochars from agrowaste for water remediation

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Statement of the Problem: Lack of access to clean drinking water is affecting billions and finding ways to cost-effective decontamination is essential. The filtration of water appears to be effective and economically viable way for water decontamination. The activated carbon filters show good results for removing chlorine, sediment particles and VOCs but struggle with mineral salts and dissolved inorganic substances. The combination of activated carbon or biochar with metal oxides such as ZnO could lead to improved performance.

Aim: The purpose of this study is to prepare and characterize composites of ZnO and biochar for water purification.

Methodology & Theoretical Orientation: The biochars were prepared by pyrolysis of agrowastes (corn cob, coffee husk) at 600°C for 2 h under nitrogen flux (150 ml/min). The biochars impregnation was done by precipitation of colloid $Zn(OH)_2$ and subsequent ultrasonication. The Zn content was determined using X-ray fluorescence. The textural parameters of the composites were determined by physisorption and the structure was analyzed using X-ray diffraction method. The adsorption kinetic experiments of Pb(II) were conducted.

Findings: The ZnO/biochar composite from corn cob showed almost 16-times higher content of Zn than the one from coffee husk and Zn was present as crystalline ZnO. Compared with unmodified biochars, the adsorption of Pb(II) was 4.5 times and 2 times more in both the ZnO/biochar composites, with coffee husk, and corn cob respectively. But the absolute highest adsorption of Pb(II) was observed for ZnO/biochar composite from corn cob.

Conclusion & Significance: The presence of ZnO significantly improved the adsorption of Pb(II) in both coffee husk and corn cob biochars. The most promising material appears to be the ZnO/biochar composite from corn cob. The use of ZnO impregnation on biochar appears to be a successful method to boost adsorption of heavy metals from water.

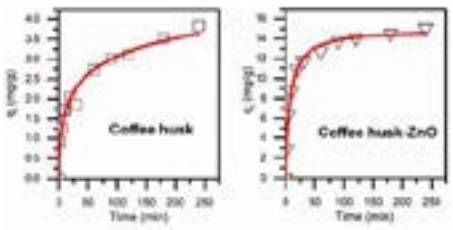

Figure 1: The adsorption kinetic experiment of Pb(II). The impregnation of biochar with ZnO significantly increased adsorbed amount of Pb(II).

Recent Publications

1. Ahmed M B et al. (2016) Progress in the preparation and application of modified biochar for improved contaminant removal from water and wastewater. Bioresource Technology 214:836-851.
2. Long L et al. (2017) Synthesis, characterization and mechanism analysis of modified crayfish shell biochar possessed ZnO nanoparticles to remove trichloroacetic acid. Journal of Cleaner Production. 166:1244-1252.
3. Yan J et al. (2018) Adsorptive removal of As(V) by crawfish shell biochar: Batch and column tests. Environmental Science and Pollution Research International 25(34):34674-34683.
4. Yuvaraja G et al. (2018) Application of ZnO nanorods as an adsorbent material for the removal of As(III) from aqueous solution: Kinetics, isotherms and thermodynamic studies. International Journal of Industrial Chemistry 9(1):17-25.
5. Cruz G J F et al. (2018) Composites of ZnO nanoparticles and biomass based activated carbon: Adsorption, photocatalytic and antibacterial capacities. Water Science and Technology 2017(2):492-508

Biography

Jaroslav Lang pursued his PhD from Technical University of Ostrava (Czech Republic) in 2018. He is currently a Junior Researcher at the Institute of Environmental Technology of the same university and also works as Postdoctoral Researcher at National University of Engineering (Peru). His major research interests are synthesis and preparation of photocatalysts and adsorbents for pollution remediation.

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