SORPTION OF LEAD (Pb^{2+}) FROM AQUEOUS SOLUTIONS USING CHARS OBTAINED IN THE PYROLYSIS OF FORESTRY PINE, RUBBER TIRES AND PLASTICS

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EXTENDED ABSTRACT

Introduction

Carbonaceous solid products resulting from thermochemical processes (pyrolysis, gasification), commonly known as chars, are emerging as low-cost sorbents of metallic contaminants, being their effectiveness already demonstrated in several studies (Inyang et al., 2012; Fuente-Cuesta et al., 2012; Kołodyńska et al., 2012; Quek and Balasubramanian, 2009; Devecia and Kar, 2013).

Given the fact that the commercial viability of pyrolysis and gasification plants for the treatment and valorisation of waste streams are increasingly being demonstrated, it is expected that large amounts of solid chars will be available in a near future, as by-products or as main products (pyrolysis-carbonization).

Chars may possess several characteristics which turn them effective as heavy metals sorbents: aromatic carbon matrix with relatively porous structures, the presence of functional groups or inorganic inclusions in the surface providing active sites to interact with metallic species (Inyang et al., 2012; Fuente-Cuesta et al., 2012; Kołodyńska et al., 2012; Quek and Balasubramanian, 2009; Devecia and Kar, 2013; Lu et al., 2012).

Lead (Pb^{2+}) is considered as a priority substance in the field of European water policy (EU, 2000; EU, 2008) which means that measures shall be taken by the Member States to eliminate or reduce the water pollution caused by this pollutant in order to fulfill the emission/discharge limits legislated for this compound.

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References

Devecia H., Kar Y. (2013). “Adsorption of hexavalent chromium from aqueous solutions by bio-chars obtained during biomass pyrolysis”. *Journal of Industrial and Engineering Chemistry,* 19,190–196.

EU (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

EU (2008). Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy.

Fuente-Cuesta A., Diaz-Somoano M., Lopez-Anton M, A., Cieplik M., Fierro J, L, G., Martínez-Tarazona M, R. (2012). “Biomass gasification chars for mercury capture from a simulated flue gas of coal combustion”. *Journal of Environmental Management,* 98, 23-28.

Inyang M., Gao B., Yao Y., Xue Y., Zimmerman A, R., Pullammanappallil P., Cao X. (2012). “Removal of heavy metals from aqueous solution by biochars derived from anaerobically digested biomass”. *Bioresource Technology*, 110, 50–56.

Kikuchi Y., Qian Q., Machida M., Tatsumoto H. (2006). “Effect of ZnO loading to activated carbon on Pb(II) adsorption from aqueous solution”. *Carbon,* 44,195–202.

Kołodyńska D., Wnętrzak R., Leahy J, J., Hayes M, H, B., Kwapiński W., Hubicki Z. (2012). “Kinetic and adsorptive characterization of biochar in metal ions removal”. *Chemical Engineering Journal,* 197, 295–305.

Lu H., Zhang W., Yang Y., Huang X., Wang S., Qiu R. (2012). “Relative distribution of Pb2+ sorption mechanisms by sludge-derived biochar”. *Water Research,* 46, 854-862.

Machida M., Kikuchi Y., Aikawa M., Tatsumoto H. (2004). “Kinetics of adsorption and desorption of Pb(II) in aqueous solution on activated carbon by two-site adsorption model”. *Colloids and Surfaces A: Physicochemical and Engineering Aspects,* 240, 179–186.

Mohan D., Pittman Jr. C, U., Bricka M., Smith F., Yancey B., Mohammad J., Steele P, H., Alexandre-Franco M, F., Gómez-Serrano V., Gong H. (2007). “Sorption of arsenic, cadmium, and lead by chars produced from fast pyrolysis of wood and bark during bio-oil production”. *Journal of Colloid and Interface Science,* 310, 57–73.

Qiua Y., Cheng H., Xu C., Sheng G, D. (2008). “Surface characteristics of crop-residue-derived black carbon and lead(II) adsorption”. *Water Research,* 42, 567 – 574.

Quek A., Balasubramanian R. (2009). “Low-Energy and Chemical-Free Activation of Pyrolytic Tire Char and Its Adsorption Characteristics”. *Journal of the Air & Waste Management Association*, 59:6, 747-756.

Raveendran K. and Ganesh A. (1998). “Adsorption characteristics and pore-development of biomass pyrolysis char”. *Fuel,* 77, 769-781.

Roy C., Chaala A., Darmstadt H. (1999). “The vacuum pyrolysis of used tires. End-uses for oil and carbon black products”. *Journal of Analytical and Applied Pyrolysis,* 51, 201–221.

Shrestha G., Traina S, J. and Swanston C, W. (2010). “Black Carbon’s Properties and Role in the Environment: A Comprehensive Review”. *Sustainability*, 2, 294-320.