Geophysical Research Abstracts
Vol. 21, EGU2019-12818, 2019
EGU General Assembly 2019

Polymer-clay composite sorbents for water treatment: a meta-analysis of the past decade

Yael Mishael (1) and Itamar Shabtai (2)

(1) Soil and Water, Hebrew University, Rehovot, Israel (yael.mishael@mail.huji.ac.il), (2) Soil and Crop Sciences Section, Cornell, USA (is288@cornell.edu)

The contamination of water resources with a multitude of organic and inorganic chemical compounds is a public health and environmental problem of global proportion. Pollutant removal is often achieved by adsorption to activated carbon, but activated carbon is expensive and relatively inefficient in the presence of background solutes, e.g., natural organic matter and electrolytes. Therefore, novel sorbents are designed and tested to provide efficient and inexpensive alternatives to the generic sorbents currently used in water treatment applications.
Polymer-clays are one promising class of organic-inorganic composites employed as sorbents for pollutant removal. Their appeal is based on the premise that superior sorbent materials can be designed by combining the properties of both mineral and polymeric components – low cost, mechanical stability, large surface area, and high sorption affinity. Ever since the first report of a polymer-clay composite sorbent [1], the field has greatly evolved. Smart, multi-component composite sorbents based on numerous minerals, polymers and additional modifiers have been synthesized and characterized by advanced techniques and studied for the adsorption of many classes of pollutants.
Several reviews have summarized the advances achieved in the field and highlighted the most impactful studies, e.g., [2]. However, the literature is lacking a comprehensive, quantitative synthesis and analysis of adsorption data, i.e. equilibrium, kinetic, and thermodynamic parameters needed to identify which composite components and properties are predicted to be most suitable for different water treatment applications and pollutant classes. Additionally, composite performance in realistic scenarios, i.e. treating “real” waters, used in column filtration, and subjected to sorbent regeneration, should be clarified. Such insights will help us focus our efforts on the most promising options that advance our common interests.
Here, we have performed a meta-analysis of approximately 150 studies published in the years 2008-2018, which reported on composites based on clay minerals or Fe-oxides modified with synthetic or natural polymers. From each study, we extracted information on 1) composite components and properties, 2) pollutant charge and class, e.g., heavy metal, oxyanion, dye, and 3) adsorption metrics, e.g., Langmuir or Freundlich coefficients, kinetic coefficients, and thermodynamic parameters. We also recorded whether regeneration, column filtration, or adsorption from complex matrix (natural waters, natural organic matter, etc.) were attempted.
Based on this data we will identify the trends in the field during this period, correlate composite contents and properties with their adsorption efficiency for different pollutant classes and, accordingly, suggest promising and underexplored directions for future research.

References

[1] C. Breen, R. Watson, Polycation-exchanged clays as sorbents for organic pollutants: Influence of layer charge on pollutant sorption capacity, J. Colloid Interface Sci. 208 (1998) 422–429.
[2] E. Unuabonah, A. Taubert, Clay-polymer nanocomposites (CPNs): Adsorbents of the future for water treatment, Appl. Clay Sci 99 (2014) 83-92.