Tailoring of Activated Carbon Surfaces for Pollutant Removal from Water and Wastewaters

by

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ABSTRACT

This research proposes that activated carbon can be modified by altering its physico-chemical properties to enhance its effectiveness in removing a broad range of synthetic organic compounds (SOCs, e.g. Trichloroethylene (TCE)) in the presence of competing adsorbates (e.g. Natural Organic Matter (NOM)).

NOM lowers the carbon efficiency to adsorb micropollutants/SOCs by competing directly for adsorption sites and blocking the pores in carbons. It is imperative to find ways to mitigate preloading in order to improve the GAC capacity to adsorb organic contaminants. The main objective of this work was improving the GAC capacity for SOC adsorption especially in the presence of NOM, investigate the mechanisms involved in NOM and SOC competition and explain the adsorption process using GACs, activated carbon fibers (ACFs), model carbonaceous adsorbents, carbon nanotubes (CNTs).

GAC was heat treated under N_2 which altered the surface chemistry and porosity of the carbon, thereby influencing the TCE and NOM uptake. Treatment temperatures showed effects, while treatment time did not play a role. A carbon having a high primary micropore volume and a high mesopore volume will adsorb higher TCE uptake even in the presence of high NOM uptakes when compared to microporous carbon having insufficient mesopore volume. Another approach was to prevent the entry of the NOM by using an enmeshment material and ensure a molecular sieve effect by the adsorbent.

The modified carbons were characterized using N_2 adsorption, water vapor adsorption, and acid-base titrations. Adsorption studies were carried out using as-received and modified carbons to investigate their efficiency to adsorb TCE from three natural waters. Results show that a low surface acidity, high hydrophobicity, a large primary micropore volume with adequate mesopore volume is essential to ensure a high adsorption capacity of TCE in the presence of NOM.

Factors other than size, such as shape, polarity and chemistry possibly also play an important role in keeping the NOM molecules away from entering the pores of the adsorbent. The low MW fraction is not the only fraction containing the fouling fraction. Components larger than the 1K Da fraction in the TMK NOM also contain some preloading fraction.