Performance of Regenerated Activated Carbons on Pesticides Removal from the Aqueous Phase

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Abstract: Adsorbents presenting high adsorption capacity, fast adsorption rate, easy regeneration, and a good possibility for reusability are ideal for removing 4-chloro-2-methyl-phenoxyacetic acid (MCPA) or other pesticides from wastewater. Here, the effects of regeneration treatments on adsorption– desorption cycles are examined using two commercial activated carbons (ACs) (Merck and Norit 1240 X). MCPA adsorption was fast on Merck and Norit ACs in powder form (6 h) but on Norit AC, in granular form, adsorption was too slow, and the equilibrium time was reached only after 288 h. MCPA adsorption kinetic data were analyzed by applying pseudo-first-order, pseudo-second-order, and Weber–Morris models. The pseudo-second-order model fit better to all data, and the Weber–Morris representation allows confirming that on Norit 1240 X, in granular form, the pore diffusion was the limiting factor concerning the MCPA adsorption. Merck and Norit 1240 X (in powder and granular form) ACs loaded with MCPA were submitted to different regeneration process by washing with distilled water, ethanol, HNO_3 , and NaOH solutions and washed with NaOH solutions or ethanol followed by a thermal treatment. The ACs regenerated with ethanol performed well in the subsequent adsorption–desorption cycles. All ACs had more than 99% desorbed MCPA after the first cycle of washing with ethanol. The washing with NaOH solution was less efficient. The regeneration process, consisting of washing the sample with a solution of NaOH and subsequent heating at 573 K, was very effective. After this regeneration procedure, the amount of MCPA adsorbed on Norit 1240 X AC was even higher than the amount adsorbed in the first adsorption cycle. At present, washing methods for adsorbent regeneration are not used at an industrial level. However, research for environmentally friendly regeneration methods is necessary to achieve the objectives of the circular economy.
Keywords: activated carbon regeneration; pesticide removal; reuse; circular economy