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Removal of Pharmaceuticals from High-Strength Wastewater by Adsorption on Commercial Granular Activated Carbon: Study of the Operating Conditions

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The increased need for pharmaceuticals and personal care products has resulted in a rise in the volume of wastewater produced by drug manufacturing facilities. The manufacturing methods employed in producing pharmaceuticals result in the generation of significant amounts of heavily contaminated wastewater. These pollutants, if released into nature, can pose significant risks to both the environment and human health [1]. Sulfa drugs, aniline-derived compounds and solvents are among the organic matters that are used or generated during drug synthesis and are subsequently introduced into the wastewater pipeline during the vessel wash and system shutdown operation [2,3].

Many of pharmaceuticals from this industry are considered emerging contaminants, and their concentrations in surface water are limited by national, federal, or provincial regulations. The toxic effects and non-biodegradable nature of these chemicals highlight the urgent need for proper wastewater treatment techniques to mitigate their harmful impact [4,5]. Conventional wastewater treatment methods, such as biological and chemical treatments, are not sufficient for removing pharmaceuticals, as they can be costly, time-consuming, and inefficient in removing these micropollutants [6,7].

To address the removal of emerging contaminants from wastewater prior to discharge into the environment, advanced treatment technologies such as advanced oxidation processes, activated carbon adsorption, and membrane filtration need to be implemented [8]. Among advanced treatment methods, adsorption by activated carbon is beneficial and preferred over other techniques due to the operation simplicity, no by-product production, low process cost, and high efficiency in the removal of micropollutants from water [9,10]. Nevertheless, the application of this process to the wastewater domain is limited due to the high concentration of pollutants in industrial wastewater. Therefore, the use of activated carbon adsorption for the removal of pharmaceuticals from high-strength industrial wastewater requires further exploration to optimize its effectiveness [11,12].

In this study, it is desired to investigate the effect of pH and activated carbon dosage on the removal of six selected pharmaceuticals from a medium-high strength synthetic wastewater, which in terms of properties, resembles the actual effluent of drug manufacturing facilities. To meet the objectives of this study, a specific amount of commercial granular activated carbon was mixed with synthetic wastewater, and the total organic carbon (TOC), which represents the total amount of pharmaceuticals in the wastewater, was measured. The batch adsorption studies showed that the removal increases by increasing the dosage of activated carbon and that higher removal can be achieved at acidic pH. The results of this study will create a baseline to optimize the adsorption process by adjusting the pH and mass of activated carbon required for a certain degree of removal.

Keywords: Pharmaceuticals removal; activated carbon adsorption; wastewater treatment; operating conditions; aniline removal; high-strength wastewater

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