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Pharmaceuticals Removal Using Partially Saturated Carbon Surfaces with Laccase Enzyme

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Abstract : Trace organic compounds, specifically pharmaceutical ones, due to their increasing usage have been detected in various water bodies, endangering the ecosystems. Nowadays the treatment for these pollutants leans towards the application of hybrid technologies. This study is focused on the application of a simultaneous adsorption and biodegradation system for pharmaceutical removal using commercial granulated activated carbon (AC), which is the adsorbent agent after being chemically activated with HCl 1M, called functionalized activated carbon (FAC). Oxidative enzyme Laccase was produced from Trametes versicolor. To immobilize the enzymes into the FAC surface, the enzyme was contacted with the support at a rate of 10 mg protein/ mg of FAC at pH 7, at 4°C of temperature and gentle agitation, allowing the production of supports that had 20%, 50%, and 80% of the FAC surface free of the enzyme, called EFAC 20, EFAC 50 and EFAC 80, respectively. A factorial experiment (22) was carried out, with three central replica points, considering as variables: free surface for adsorption (80%, 50% and 20%) and the concentration of pharmaceutical compounds. (50, 125 and 200 mg L^{-1}). This experiment was designed to study the behavior of these supports exposed to ibuprofen (IBU) and acetaminophen (APH). All experimental procedures were carried out at room temperature, keeping a pH level of 7 and a stirring speed of 150 rpm. Supports containing 80% of the free surface (EFAC80) after 216 h of exposure show the best results for pharmaceutical removal at 50 and 200 mg L^{-1}. For APH, there is a 6% variation in the adsorption capacity for both 50 and 200 mg L^{-1}. However, for IBU, these variations were 2% and 1% for concentrations of 50 and 200 mg L^{-1}, respectively. This study shows the importance of not only removing the pollutant but also degrading it. As shown in the results of all cases in the presence of the enzyme, the process allowed to rise the removal capacity, implying that active sites are emptied gradually because of this degradation, enabling these sites to keep interacting successively.

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