Preparation of activated carbon derived from leather waste by \( \text{H}_3\text{PO}_4 \) activation and its application for basic fuchsin adsorption

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ABSTRACT

Leather activated carbon (LAC) was prepared from the leather waste by \( \text{H}_3\text{PO}_4 \) impregnated at 105°C for 3 h and activated at 450°C for 1 h in a muffle furnace. Based on LAC, Mn-modified leather activated carbon (LAC-Mn) was also studied. The two adsorbents were characterized by scanning electron microscopy, pore distribution, \( \text{N}_2 \) adsorption/desorption isotherms, Fourier transform infrared spectroscopy, and X-ray photoelectron spectroscopy. Several factors, such as contact time, dosage, and pH were studied, which indicated that cation exchange, hydrophobicity, and \( \pi \)-electron-donor–acceptor interaction were likely the adsorption mechanisms for basic fuchsin adsorption. Meanwhile, adsorbent effects of LAC and LAC-Mn were highly pH dependent, which reached maximum under alkaline conditions. The adsorption kinetic followed the pseudo-second-order kinetic model with high correlation coefficients \( (R^2 > 0.99) \), which means intra-particle diffusion process was not the only mechanism involved. Thermodynamics showed that the Langmuir isotherm equation can describe adsorption isotherms, and the maximum adsorption capacity of activated carbon increased from 139.28 to 182.48 mg/g after being modified by Mn(II). The adsorption process was a spontaneous and endothermic process.

Keywords: Adsorption; Basic fuchsin; Mechanism; Leather activated carbon; Modified by Mn(II)

1. Introduction

Dyes have been widely applied in many industries, such as printing, leather tanning, optical communication, etc. Thus, nowadays a large amount of dye wastewater is produced, which is not only toxic to all life-forms [1] but also badly affect the appearance of surface water. Basic fuchsin, a complex red phenyl methane dye, is often used in biological experiments as a biological stain, which is the most powerful nuclear dye and is also used in textile industry [2]. It is also applied as coloring agent in paper printing and textile dyeing.

Activated carbon is well known because of its highly developed porous structure and high adsorption capacity. However, its high cost limits the application of activated carbon in large-scale treatments. Nowadays, some researchers have searched for cheaper material as the precursor, including date pits [3], agricultural solid wastes [4], silk cotton hull [5], Indian Rosewood sawdust [6], oak sawdust [7], etc.*Corresponding author.