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ORIGINAL RESEARCH

A semi-conducting polypyrrole/coffee grounds waste composite for rhodamine B dye adsorption

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Abstract

A composite based on coffee grounds waste (CGW) coated with the semi-conducting polypyrrole (PPy) was prepared by pyrrole polymerization using potassium persulfate as oxidant. The composite was characterized by FTIR spectroscopy, cyclic voltammetry, UV/vis spectroscopy, scanning electron microscopy (SEM) and TGA analysis. SEM analysis showed homogeneous coating of coffee fibers with spherical nanoparticles of PPy with diameters in the range of 200–300 nm. Aqueous adsorption experiments of rhodamine B dye (RhB) onto the as-prepared composite were performed. The effect of pH and initial dye concentration (C_0) on the adsorption behavior was studied. The results showed that this material was an efficient adsorbent of RhB dye at alkaline pH. The adsorption experiments were set at $C_0 = 200$ mg/L and initial pH values of 2.0, 3.25 and 9.0, the adsorption capacities were 7.22, 13.8, and 19.0 mg of dye/g of the composite, respectively. Nonetheless, when pH was maintained at 9.0 throughout adsorption time, the adsorption capacity increased to 32 mg of dye/g of the composite. When performing adsorption tests using pure CGW, dye adsorption was insignificant at any pH level. Adsorption isotherm for RhB at controlled pH of 9.0 was well described by the Redlich–Peterson model and by the typical Langmuir adsorption model with a theoretical maximum adsorption capacity (q_{max}) of 50.59 mg of dye/g of composite.

Keywords Adsorption · Coffee grounds waste · Composite · Polypyrrole · Rhodamine B dye

Introduction

Water pollution with hazardous compounds has drawn global attention in the last decades due to its toxicity, abundance, and persistence. This pollution is attributed to population growth and intensive domestic activities, expanding industrial and agricultural production [1]. According to the United Nations World Water Development Report of 2017, about 80% of global wastewater is discharged without any treatment. The inadequate infrastructure in developing countries and the absence of technical capacity and financial resources explain the inefficiency of wastewater management [2]. One of the most polluting industries of water is the textile; where near to 200,000 tons of dyes are annually lost to effluents during the dyeing and finishing processes, due to the inefficiency of the dyeing process [3]. Usually, the treatment of dye polluted effluent can be done by adsorption, coagulation/flocculation, oxidation/ozonation, reverse osmosis, membrane filtration, biological degradation, electrochemical processes and photodegradation [4]. However, adsorption process is one of the most adopted treatment for

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