CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

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Project Number

38416

Project Title

A Green, Low-Cost Solution for the Removal and Recovery of Dye from Industrial Wastewater (A Second Year Study)

Abstract

Objectives/Goals

Dyes are used in many industries. Because the process of cleaning dye out of wastewater is expensive, a cost-effective, eco-friendly method is needed. The purpose of this project was to test the effect of temperature on adsorption and pH on adsorption and desorption of dye by spent tea leaves (STL) and to find the maximum adsorption capacity and percent desorbed by performing continuous studies. The hypothesis was that a higher temperature and pH would lead to more adsorption and a lower pH would lead to more desorption.

Methods/Materials

STL was prepared by washing, drying, grinding, and sieving tea residue. A column adsorption filter system was used for all tests. Four temperatures (31, 39, 50, and 58 °C) and five pHs (4, 6, 7, 8, 10) were tested for adsorption. Five pHs (2, 4, 6, 8, 10) of distilled water were tested for desorption. Continuous adsorption studies were conducted with three different concentrations (1, 2, 3 mg/mL) by running the dye solution through the STL until it was exhausted. Continuous desorption studies were conducted by running pH 2 distilled water solution through exhausted STL. Three trials were conducted for all tests. Samples were analyzed using a homemade spectrophotometer.

Results

Adsorption capacity increased from room temperature to 39 °C by 10.4 mg/g and remained constant from 39 to 58 °C. Adsorption capacity remained constant from pH 4 to 6 and increased by 12.64 mg/g from pH 6 to 10. Maximum percent desorbed of 26.78% was achieved at pH 2. Percent desorbed decreased from 0.38% to 0.27% from pH 4 to pH 10. Maximum adsorption capacity increased while time decreased as concentration increased but was not affected by pH for continuous adsorption studies. Continuous desorption led to 94.44% of dye being desorbed using pH 2 distilled water.

Conclusions/Discussion

Maximum adsorption capacity of 228.36 mg/g was achieved using 0.6 g of STL and flow rate of 1.46 mL/min for continuous adsorption studies with 3 mg/mL dye solution. Maximum adsorption capacity increased by 139% from a single cycle to a continuous adsorption study. Desorption studies led to 94.44% recovery of dye; so, there is a potential for reuse of dye and STL. It can be concluded from the two-year study that this column adsorption filter system using STL can be scaled to an industrial level and used as an effective, low-cost, eco-friendly solution for not only the removal but also the recovery of dye from wastewater.

Summary Statement

Studied factors affecting adsorption and desorption of dye by STL using a column adsorption filter system to find maximum adsorption capacity and maximum percent desorbed.

Help Received

My mom supervised this experiment. My parents bought the supplies for this experiment. My teacher let me borrow supplies from school.