World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:10, No:04, 2016

Statistical Optimization of Adsorption of a Harmful Dye from Aqueous Solution

Authors : M. Arun, A. Kannan

Abstract : Textile industries cater to varied customer preferences and contribute substantially to the economy. However, these textile industries also produce a considerable amount of effluents. Prominent among these are the azo dyes which impart considerable color and toxicity even at low concentrations. Azo dyes are also used as coloring agents in food and pharmaceutical industry. Despite their applications, azo dyes are also notorious pollutants and carcinogens. Popular techniques like photo-degradation, biodegradation and the use of oxidizing agents are not applicable for all kinds of dyes, as most of them are stable to these techniques. Chemical coagulation produces a large amount of toxic sludge which is undesirable and is also ineffective towards a number of dyes. Most of the azo dyes are stable to UV-visible light irradiation and may even resist aerobic degradation. Adsorption has been the most preferred technique owing to its less cost, high capacity and process efficiency and the possibility of regenerating and recycling the adsorbent. Adsorption is also most preferred because it may produce high quality of the treated effluent and it is able to remove different kinds of dyes. However, the adsorption process is influenced by many variables whose inter-dependence makes it difficult to identify optimum conditions. The variables include stirring speed, temperature, initial concentration and adsorbent dosage. Further, the internal diffusional resistance inside the adsorbent particle leads to slow uptake of the solute within the adsorbent. Hence, it is necessary to identify optimum conditions that lead to high capacity and uptake rate of these pollutants. In this work, commercially available activated carbon was chosen as the adsorbent owing to its high surface area. A typical azo dye found in textile effluent waters, viz. the monoazo Acid Orange 10 dye (CAS: 1936-15-8) has been chosen as the representative pollutant. Adsorption studies were mainly focused at obtaining equilibrium and kinetic data for the batch adsorption process at different process conditions. Studies were conducted at different stirring speed, temperature, adsorbent dosage and initial dye concentration settings. The Full Factorial Design was the chosen statistical design framework for carrying out the experiments and identifying the important factors and their interactions. The optimum conditions identified from the experimental model were validated with actual experiments at the recommended settings. The equilibrium and kinetic data obtained were fitted to different models and the model parameters were estimated. This gives more details about the nature of adsorption taking place. Critical data required to design batch adsorption systems for removal of Acid Orange 10 dye and identification of factors that critically influence the separation efficiency are the key outcomes from this research.

Keywords : acid orange 10, activated carbon, optimum adsorption conditions, statistical design
Conference Title : ICCEEE 2016 : International Conference on Chemical, Ecological and Environmental Engineering
Conference Location : Lisbon, Portugal
Conference Dates : April 14-15, 2016