

Modelling and optimisation of coagulation of highly concentrated industrial grade leather dye by response surface methodology

Abstract

High consumption of process water and water scarcity has motivated industry to reuse their wastewater. Membrane processes are vital to produce water for reuse from dyeing baths in the tanning industry. In this regard, synthetic dye was recognised as the major foulant. To minimise the membrane fouling, coagulation/flocculation process is an important pre-treatment. Due to the complex nature of the process involving dyes-coagulant, the modelling is challenging. In this study, statistical experimental design and response surface methodology, RSM, have been applied to optimize removal of C.I. Acid Black 210 dye from highly concentrated solutions by means of a coagulation/flocculation process. Aluminium sulphate was used as the coagulant. Central composite design (CCD) using as input variables the experimental temperature, the concentration of aluminium sulphate and the initial pH of the solution have been considered. Based on the design of experiment the quadratic response surface models have been developed to link the output response, which is the dye removal factor, with the input variables via mathematical relationships. The constructed response model has been tested using the analysis of variance (ANOVA). A Monte Carlo simulation method has been conducted to determine the optimum operating conditions. The obtained optimal point corresponds to a temperature of 40 °C, a concentration of aluminium sulphate of 0.82 g/L and an initial pH value of 5.61. The maximal value of the dye removal obtained under optimal process conditions has been confirmed experimentally.