**(88)**

# Adsorption Modification of Carbonate Rock Powder in Sri Lanka for the Removal of Contaminated Waste from Industrial Dye

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## Abstract

The presence of dyes in industrial effluents is a major cause of water pollution. Textile wastewaters generated from different stages of textile processing contains a huge amount of pollutants that are very harmful to the environment if released without proper treatment. However, the main challenge is to eliminate the color of wastewater, which is due to the remaining dyes. Textile industries are responsible for the discharge of large quantities of dyes into natural waterways due to inefficiencies in dyeing techniques. Though the industries use treatment techniques, dyes cannot be completely removed by means of conventional treatments. There are several studies carried to investigate the dye removal techniques using natural materials. Therefore in this study carbonate rocks are highly available in Sri Lanka has been selected as the filter material which having high adsorption capacity. The carbonate powder having agglomeration properties it needed to be treated with secondary material. The processing of carbonate is done by using Natural Red Earth which is available abundantly along the North-Western coastal belt of Sri Lanka. Carbonate samples were collected from the Naula area where containing pure white carbonate rock with less impurities. The Natural Red Earth samples were taken around the Aruwakkalu area. Then the both carbonate and natural red earth samples were ground into fine particles less than 50 µm size diameter and sieved using US standard sieve to get a sample with uniform size distribution. The main objectives of this research are to investigate surface properties and adsorption characteristics of natural carbonate powder prepared by Sri Lankan marble (dolomite) and to develop surface characteristics of carbonate powder under necessary amendments for the removal of industrial dyes from contaminated water. Characterisation of both materials was studied by using X-ray fluorescence, X-ray diffraction, Fourier Transfer Infra-Red spectrometer analysis and Elusion test methods. Batch adsorption experiments were carried out to study the effect of optimum condition of operational parameters such as pH, shaking time with adsorbent, the initial concentration of textile dye and dosage of the adsorbent on the dye removal efficiency by the soil mixture. The adsorption rate data were analysed using the intra-particle diffusion model, pseudo first order and the pseudo second order kinetic models to determine adsorption rate constants. The isotherms of adsorption data were analysed by various adsorption isotherm models such as Langmuir, Freundlich and Temkin. The results obtained from X-ray fluorescence analysis confirmed that there is no detection of heavy metals and Fourier Transfer Infra-Red spectrometer analysis suggested that the change in functional groups may have caused the adsorption of dye molecules. According to the results highest adsorption capacity observed for dye solutions when the contact time was 120 minutes, at pH 12 with 10 g of soil mixture, of 1 ppm dye solution. Under optimum conditions removal efficiency of the soil mixture was 96.67%. Kinetic data suggests the Pseudo first order kinetic model fit best for Red dye and it confirmed that a physisorption occurs at the rate determining step. The pseudo second order model for Dye mixture shows chemisorption at the rate determining step of the reaction between the dye mixtures and adsorbent. The adsorption data for both Red dye and Dye mixture fitted well with the Langmuir isotherm at pH 12 with correlation coefficients greater than 0.9, suggesting mono-layer coverage of dye.

***Keywords:*** Limestone, Natural red earth, Industrial dye, Adsorption, Kinetics