

ABSTRACT

Organic dyes such as congo red are often found in industrial waste and are mutagenic, carcinogenic, toxic and increase COD values in aquatic environments. Zeolite is a porous material commonly utilized as an adsorbent due to its high surface area, thermal stability, and resistance to harsh conditions. Natural zeolite is widely applied due to its abundance, low cost, and environmentally friendly characteristics. However, natural zeolite has limited effectiveness for anionic dyes due to its negatively charged surface. To enhance its adsorption capacity, zeolite was modified with chitosan. Composites were synthesized with variations in the mass ratio between natural zeolite and chitosan (25:75%; 50:50%; and 75:25%). The resulting composites were characterized using several techniques FTIR to identify functional groups; PSA to determine particle size distribution; SAA to determine surface area, pore volume, and pore size; and SEM to observe surface morphology. An adsorption study was conducted using the batch method to evaluate the composite's ability to adsorb congo red dye. The experiments were carried out at various initial dye concentrations (60, 75, 90, 105, 120, 135, and 150 mg/L) with a contact time of 60 minutes. The research results showed that zeolite-chitosan composites with various ratios were successfully synthesized. FTIR analysis confirmed the presence of Si-O-Si/Si-O-Al, Si-O, Al-O, N-H, and -OH absorption bands in all composites. PSA analysis indicated dominant particle size of 205.1 μm (chitosan), 181.9 μm (Z-Cs 25:75%), 149.9 μm (Z-Cs 50:50%), 114.4 μm (Z-Cs 75:25%), and 33.47 μm (activated natural zeolite). SAA results showed the surface areas of activated natural zeolite, Z-Cs 25:75%, Z-Cs 50:50%, and Z-Cs 75:25% were 84.00, 0.41, 10.84, and 9.64 m^2/g , respectively. SEM analysis revealed changes in the morphology of natural zeolite after chitosan addition, where some pores and surfaces were covered by chitosan. The highest adsorption capacity for each adsorbent was obtained at an initial *congo red* concentration of 150 mg/L. The Z-Cs 50:50% composite exhibited the highest adsorption capacity of 60.32 mg/g, followed by Z-Cs 25:75% (56.04 mg/g), Z-Cs 75:25% (48.85 mg/g), and natural zeolite (16.84 mg/g).

Keywords : Adsorption, Chitosan, Composite, Congo red, Mass ratio, Natural zeolite