

ABSTRACT

This research is based on the high amount of synthetic dye waste generated by the textile industry, one of which is congo red. The reduction of congo red dye waste can be achieved through the adsorption method using silica gel, which has a porous structure, a large specific surface area, and good thermal stability. Although it has many advantages, silica gel also has drawbacks as an adsorbent because it only possesses active sites in the form of silanol groups (Si-OH), which results in low effectiveness against congo red. This limitation can be overcome by modifying silica with chitosan. The purpose of chitosan modification is to increase the number of active sites. Through chitosan modification, the active amine groups (-NH₂) functional groups in chitosan are expected to strongly interact electrostatically with the sulfonate (-SO₃⁻) groups of congo red dye, which can enhance its adsorption capacity toward congo red. This study aims to synthesize silica gel and silica-chitosan composites using rice husk ash as a raw material through the sol-gel method, obtain the characterization data of the synthesized silica gel and silica-chitosan, and determine the adsorption capacity of the silica-chitosan composite toward congo red dye. The research consists of five stages: preparation of rice husk ash, synthesis of silica gel from rice husk ash via the sol-gel method, synthesis of silica-chitosan composites by varying the volume ratio of sodium silicate solution (containing 124.489 g/L of silica) and 2% chitosan solution at ratios of 1:1, 2:1, and 3:1 (15mL:15mL; 30mL:15mL; and 45mL:15mL) via the sol-gel method, material characterization using Fourier Transform Infrared (FTIR) spectroscopy, Gas Sorption Analyzer (GSA), and adsorption testing of congo red dye with variations in time and initial dye concentration using UV-Vis spectrophotometry. The results show that silica gel from rice husk ash was successfully synthesized using the sol-gel method, and silica-chitosan can be synthesized from sodium silicate by adding 2% chitosan solution. Silica gel exhibits the main functional groups of Si-OH and Si-O-Si, while the silica-chitosan composite contains Si-OH, Si-O-Si, and N-H functional groups. The best adsorption capacity for congo red was shown by the 1:1 silica-chitosan adsorbent, which has a type IV adsorption-desorption isotherm with an H3 hysteresis loop, a surface area of 42,285 m²/g, a total pore volume of 0,172 cc/g, and an average pore diameter of 8,116 nm. The adsorption capacity for congo red reached 55,32 mg/g at a concentration of 150 mg/L with a contact time of 60 minutes.

Keywords: Adsorption, Congo Red, Chitosan, Silica