Energy Consumption Analysis of Hydrogel Beads Composites Derived from Sodium Alginate- Cetyltrimethylammonium Bromide toward Congo Red Dye Adsorption

Mochammad Nuruddin, S.T., M.Si. *as a counsellor*

Helmi Baharuddin Susanto

Study Program of Renewable Energy Engineering

Majoring of Engineering

ABSTRACT

The complex process for treating industrial wastewater frequently necessitates the employment of efficient treatment techniques to eliminate harmful contaminants before discharge, such as congo red (CR) dye. In this study, adsorption methods were utilized to eliminate CR by employing hydrogel bead composites derived from sodium alginate (SA) and cetyltrimethylammonium bromide (CTAB). Various concentrations of CTAB, including 0.1 wt%, 1 wt%, and 3 wt%, denoted as SC1, SC2, and SC3 respectively, were examined. The results demon- strated that SC3 has higher swelling percentage and lowest carboxyl group (COOH). Experiments were carried out under different pH levels, CR concentrations, and adsorption durations for removal of CR. The maximum CR adsorption capabilities of SC1, SC2, and SC3 obtained were as 141.08 mg/g, 144.50 mg/g and 153.24 mg/g for SC1, SC2 and SC3, respectively. The Freundlich and pseudo-second-order models demonstrate the best fit for both isotherm and kinetic analysis across all samples, suggesting a multilayer adsorption process and chemi- sorption mechanism. Reusability studies revealed strong performance, underscoring the hydrogel beads' potent adsorption capability for CR dye. The total electricity consumption used in this research process is 142 kWh. 74% coming from the oven and 22% from shaking water baths, then 4% from other tools with small electricity consumption.

Keywords*: Cetyltrimethylammonium bromide, Congo red dye adsorption, Energy Consumption, Hydrogel bead, Sodium alginate.*