A comparative study of acidic, basic, and reactive dyes adsorption from aqueous solution onto kaolin adsorbent: Effect of operating parameters, isotherms, kinetics, and thermodynamics

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**Abstract:**

Various studies were reported for the evaluation of the adsorption performance of kaolin clay using single dye types. This paper aimed to evaluate the comparative adsorption capacity of prepared adsorbents from Ethiopian kaolin for different dye types (Basic Yellow 28 (BY 28), Congo Red (CR), and Reactive Red 120 (RR 120)). Because different dye classes may have a significant impact on the removal efficiency by the prepared adsorbent. Moreover, we intended to investigate the interaction effect of adsorbent-sorbate in the adsorption phenomenon for the three different class dyes. The adsorbents from kaolin clay were prepared via mechanical treatment, beneficiation, and calcination (700oC). The effect of operating parameters (pH, adsorbent dose, contact time, dye concentration, and adsorption temperature) was evaluated. Before and after adsorption of the adsorbents was characterized using FTIR spectroscopy. Furthermore, adsorption isotherm, kinetic models, and the thermodynamic processes in the adsorption phenomenon were computed. The percentage removal efficiency of dyes was recorded as 92.08%, 88.63%, and 73.33% for BY 28, CR, and RR 120 dyes, respectively at the experimental condition: adsorbent dosage=1 g/100 mL, solution pH=9 (BY 28), and pH=3 (CR, and RR 120), contact time=60 min, initial dyes concentrations=20 mg/L, and temperature=30 oC. The adsorption of adsorbates onto kaolin adsorbents was well fitted with pseudo-second-order kinetics and Langmuir isotherm models. The thermodynamic parameters indicate that the adsorption process is spontaneous and exothermic for all dyes. The comparative percentage removal of, with the same operational parameters and kaolin adsorbent, was recorded as BY 28 > CR > RR120 resulting from their surface charge and molecular size/ structure dyes properties. We confirm that the adsorption at each operational parameter and peak intensity of FTIR spectra, before and after adsorption, revealed that the different dye types have varied removal efficiency onto the prepared kaolin adsorbent. This is due to that being dominantly influenced by the electrostatic interaction and steric effects at the surface of the sorbent and sorbate characteristics. We deduced that the kaolin clay used as an adsorbent is highly dependent on the dye types and their featured characteristics.

**Biography of Presenter**

Adugna Nigatu Alene is a dedicated professional in the field of chemistry, hailing from Ethiopia. With a Bachelor of Science degree in Chemistry and a Master of Science degree in Organic Chemistry, he has honed his expertise over the course of his nine-year career. Throughout his professional journey, Adugna Nigatu Alene has held various roles including junior teacher, chief and senior technical assistant, and lecturer. Currently, he serves as a lecturer and researcher at Bahir Dar University, Ethiopia, where he imparts his knowledge and conducts ground-breaking research. His specialization lies in the synthesis, purification, structural elucidation, and application of organic compounds. His practical skills extend to materials synthesis, including organometallics, biomaterials, nanoparticles/composites, and biodegradable films. Also, his areas of expertise extend to extraction, isolation/purification, structural elucidation, and biological applications of natural products. His deep understanding of these processes has led to significant contributions in the field. Passionate about advancing the field of chemistry, Adugna Nigatu Alene continues to push boundaries and make meaningful contributions to the scientific community.

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* **Please to attach a recent high-resolution photograph of the presenting author.**

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