SYNTHESIS, CHARACTERIZATION AND APPLICATION OF COPPER OXIDE-ZIRCONIA-TITANIA TERNARY SYSTEM FOR REMOVAL OF METHYLENE BLUE DYE IN WASTE WATER

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DECLARATION AND RECOMMENDATIONS

This thesis is my original work and has not been presented for an award of diploma or conferment of degree in this or any other University

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Recommendations

This thesis has been examined, passed and submitted with our approval as University supervisors.

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DEDICATION

This work is dedicated to my father Stephen Kinuthia, my mother Jane Wanjiru, my siblings and my son Ethan Prince whose moral and emotional support towards excellence in academics gave me the courage and the reason to work hard towards this achievement.

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ABSTRACT

Contamination of water sources due to the increasing industrial processes is a major threat to human health as well other living organisms. Industrial wastes are a major pollutant especially since various industries discharge their waste without any treatment or after minimal treatment. Therefore, there is need to develop remediation technique that is cost-effective, environment friendly and effective in the removal of the industrial waste that ends up in water sources. This study sought to synthesize, characterize and use copper oxide-zirconia-titania ternary oxide for removal of methylene blue dye from waste water. The ternary oxide was prepared by Pechini method. Methylene blue aqueous solution was prepared at Chuka University laboratory. Effects of pH, temperature, concentration of adsorbate, time and dosage amounts on adsorption of methylene blue dye was determined using UltravioletVisible(UV-Vis) spectrophotometer. Characterization of the adsorbent was carried out by Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS), Powder X-ray diffraction (XRD) and Fourier transform Infrared (FT-IR) spectroscopy. SEM micrographs showed particles with non-uniform distribution and different particle sizes. Deposits onto the surface of the larger particles seemed to be uneven and porous which is characteristic of a high surface roughness, suitable for adsorption. FTIR analysis displayed functional groups such as carbonyl groups, hydroxyl groups as well as stretching vibrations of the ZrO2, CuO and TiO2. XRD analysis exhibited a single major peak revealing that the ternary oxide calcined at 500ºC was amorphous. EDS analysis showed that all the chosen areas of the analysis contained the primary elements which were zirconium, titanium, copper and oxygen Adsorption isotherm models (Langmuir, Freundlich) and Temkin and adsorption kinetic studies (pseudo-first order, pseudo-second order) were used for data analysis. The results showed that adsorption was affected by pH, temperature, initial concentration, dosage amounts and contact time. Adsorption experiments followed pseudo second order model with r2 of 0.99987.The adsorption process followed the Langmuir and Temkin isotherms with r2 of 0.90219 and 0.93641 respectively. These findings clearly show copper oxide-zirconia-titania ternary oxides can be employed as novel adsorbents to solve the problems of water and wastewater treatment.