Abstract

Fresh water quality has been degraded in recent decades due to increased urbanization. To fulfil the increasing need for products, the development of industrial and agricultural operations is currently taking place at an accelerated rate, which results in the release of an immense quantity of toxins, such as dyes, into water bodies. Consequently, the employment of Layered Double Hydroxides (LDH) as adsorbents was chosen based on their major physicochemical properties, which included textural, structural, morphological, and chemical composition. In recent years, the utilization of LDH as adsorbents against a plethora of organic and inorganic pollutants in aquatic matrices has drawn great attention among chemist. Therefore, this thesis focuses on the synthesis of LDH-based adsorbent for use in waste water remediation. The thesis is divided into seven chapters, which are briefly summarized below.

Chapter I provides an introduction and a literature review of the thesis. This chapter describes the classification of dyes, its structural properties and their harmful impacts on both human beings and aquatic organisms. It also discusses various dye remediation techniques along with special emphasis on adsorption technology, and reviews different LDH-based adsorbents applied in water decontamination. The overview of LDH synthesis methods, critical influencing factors, and adsorption mechanisms are also highlighted in **Chapter I**.

In **Chapter II**, designing of the new adsorbent material containing tetravalent Zr metal oxide layered double hydroxide (LDH) composite for the removal of anionic dye was reported. The modification of LDH was conducted via urea hydrolysis method by using zirconium salts as a precursor material. The as-synthesized adsorbents were characterized with different instrumental techniques such as PXRD, FT-IR, FESEM-EDX, XPES, BET and TGA. The adsorption efficiency of the as synthesized material represented as ZrO_2/MgAl-LDH was investigated for the decontamination of congo red (CR) dye from aqueous medium. The influence of several experimental factors on the adsorption equilibrium studies such as pH, temperature, initial dye concentration, contact time, adsorbent dosages and interfering ions are examined under optimized conditions. The result of the study affirms ZrO_2/MgAl-LDH as a potential candidate for effective decontamination of waste water.

Abstract

In **Chapter III**, the adsorption property of the CuAl-LDH was enhanced by modifying with anionic surfactant sodium dodecyl sulphate and the synthesized material CuAl/SDS-LDH was applied for the examination of methyl red removal from its aqueous solution. This chapter includes a full description of the results derived from kinetic, isotherm, and thermodynamic experiments used for methyl red adsorption. The result of this work infers that the synthesized sorbents CuAl-LDH and CuAl/SDS-LDH can immensely remove the targeted organic pollutant over a broad range of dye concentrations. This opens the way for its application in environmental cleanup.

Chapter IV describes synthesis of the new composite adsorbent CHA/CoAl-LDH between coconut husk ash (CHA) and CoAl-LDH, and investigated the adsorptive removal of organic dye malachite green (MG) from the aqueous media. Systematic batch experiments were conducted to determine isotherm and kinetic parameters. The plausible adsorption mechanism such as electrostatic, H-bonding, n-π, π-π, pore diffusion etc., was briefly illustrated. The findings of the results also revealed high monolayer adsorption capacity, reusability and a widening of adsorption ability for both cationic and anionic dyes, which makes it a promising adsorbent.

In **Chapter V** the sorption capability of methylene blue dye by coconut husk modified NiAl-LDH, denoted as CHA/NiAl-LDH is demonstrated. The various adsorption parameters were evaluated and discussed. The results of this work, paves the way towards the developments of composite material between agriculture waste biomass ash and LDH clay for environment remediation.

In **Chapter VI**, we report the adsorption effect of organic dyes (congo red and methyl orange) over hierarchically porous ternary CaNiAl-LDH. Material characteristics affirmed with the formation of circular and flower-like LDH. The thermodynamic studies also suggest the endothermic and spontaneity of the sorption process. The reusability studies also confirmed that CaNiAl-LDH can be reused up to fourth cycle. Therefore, the proposed material CaNiAl-LDH can be advocated as a highly effective low-cost adsorbent for the treatment of water contaminants. **Chapter VII** describes about the overall summary and conclusion drawn out from the present study, and also the probable future scope in this field is also mentioned.