

## **Preface**

Freshwater resources are threatened due to modern industrialisation and the increasing water utilisation rate. Water contamination is caused by chemical contaminants from different industries, including the food, leather, textile, and colouring sectors. One of the most critical issues is the removal of synergistic dye, frequently used in these industries. Colour contaminants are difficult to remove from wastewater due to their high stability, complex chemical structure, and poor biodegradability. The extraction of colour from effluents is one of the most intricate challenges encountered by the textile finishing, dye manufacturing, and pulp and paper industries. All these industries are significant water consumers and consequently contribute to water pollution. Most of these dyes are highly hazardous upon contact with the human body. Many techniques are available to remove the dye, such as photocatalysis, adsorption, ion exchange, electrolysis, membrane separation, coagulation, and ozonation. The disadvantages of each method are high operation cost, reusability, and easy operation. Therefore, the top priority list in the study field is low-cost, environmentally friendly, and simple operating ways. Among these methods, adsorption is very promising due to its simple operating system, low operating cost, and eco-friendly behaviour for dye removal.

Researchers have been developing various adsorbents to remove pollutants from wastewater, including activated carbon, biochar, metal oxides, binary layered double hydroxides (LDHs), and biochar-based LDHs. However, these materials often face challenges such as low adsorption capacity and limited recyclability. This study synthesises ternary LDHs, discussing various materials and synthesis methods. The present study describes various materials and different synthesis methods. Different degradation methods are discussed. The experimental section depicts several instruments, characterisation, and analytical techniques. It describes the details of the reagents, chemicals, and their solutions with other specifications in the kinetic study of the degradation of dyes.

The present study focuses on optimising the parameters of ternary layered double hydroxides, which are subsequently used to remove textile dyes from aqueous solutions. Ternary LDHs, including  $\text{CoAlFe-CO}_3$ ,  $\text{MgZnFe-CO}_3$ , and  $\text{MgNiAl-CO}_3$ , are synthesised to remove Congo Red (CR)  $\text{MgZnAl-CO}_3$  is synthesised to remove Methyl Orange (MO) and from aqueous solutions. For surface modification, the LDH is calcined

using heat treatment. After treatment, the material's surface area and porosity increase, enhancing its ability to remove pollutants. The adsorption capacities for Congo Red (CR) are 82.92 mg/g for CoAlFe-CO<sub>3</sub> LDH, 89.76 mg/g for MgZnFe-CO<sub>3</sub> LDH, and 181.81 mg/g for MgNiAl-CO<sub>3</sub> LDH. For the calcined forms, MgZnFe-CO<sub>3</sub> LDH has an adsorption capacity of 205.76 mg/g, while calcined MgNiAl-CO<sub>3</sub> LDH reaches 480.81 mg/g. Regarding Methyl Orange (MO), the uncalcined and calcined MgZnAl-CO<sub>3</sub> LDH have adsorption capacities of 220.56 mg/g and 869.56 mg/g, respectively. The recyclability of some materials is also checked, and they show remarkable recyclability. The calcined MgZnAl-CO<sub>3</sub> LDH showed for MO removal up to the 6<sup>th</sup> cycle, and the calcined MgNiAl-CO<sub>3</sub> LDH for CR removal showed up to the 14<sup>th</sup> cycle. The operating cost of the adsorption process is much less than that of another process. These results confirm that synthesis ternary LDH is very efficient for textile dye removal.