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Topic of Research: Modification of metal oxide nanoparticles for the removal of water pollutants from aqueous solution through adsorption

Summary of Abstract

Dye is a colourful substance that is used extensively in the textile, printing, rubber, cosmetic, plastic, and leather industries to colour their goods. Most commercial dyes are chemically stable and are difficultto be removed from wastewater. Therefore, a treatment process should be conducted beforethe wastewater containing dyes releases into the water environment.To remove dyes from coloured wastewater, a variety of techniques have been utilized, including coagulation/flocculation, biological treatment,photocatalysis, filtering, electrochemical, membrane processing, adsorption, etc.

Therefore, the aim of the research is to synthesize a variety of environmentally friendly and inexpensive adsorbentsto remove dyes from aqueous solution of dye through adsorption.These environmentally friendly andinexpensive adsorbents includeplant-based materials, seeds, leaves, essential oil, etc., and their modified forms.In this work, an attempt has been made to develop an 'organic-inorganic',modifiedmultifunctional nano adsorbent and anti-microbial agent.

The thesis comprises the following six chapters:

Chapter 1 entitled **"Introduction and Literature Review"** is an introductory chapter that deals with water pollution, types of water pollution, dye pollution, and its toxicity, treatment technologies of wastewater, the adsorption process, literature review, and a list of various adsorbents utilized for dye remediation through adsorption.

Chapter 2 entitled**"Materials and Methods"**discuss the synthesis of modified nanomaterials, chemical, and materials used along with the adopted methodology. Also, discussed about the instruments involved in the analysis of the physio-chemical properties of the nanomaterials. The Experimental procedure and mathematical equations involved in the adsorption study are also discussed in this chapter.

Chapter 3 entitled **"Synthesis, characterization, and application of Flax seed based magnetic hybrid nanocomposite (MFS)"**describesthe preparation of novel iron oxide-flax seeds-based hybrid nanocomposite, referred to as magnetic flax-seeds, and its application in the removal of Malachite green (MG) dye from wastewater through adsorption. The Magnetic composite was investigated for the adsorption utility of malachite green by optimizing various parameters.

Chapter 4 entitled**"Synthesis, characterization, and application of multifunctional Origanumvulgare based manganese ferrite nanocomposite $MnFe_2O_4$ /OV"**describes the formationof multifunctional*Origanum vulgare* plant-based nanocomposite material, $MnFe_2O_4$/OV, via one-pot synthetic technique.The CV and CR were used to testify to the composite's potential for adsorption under the influence of several optimization conditions. The Langmuir maximum adsorption capacity $Q_{max}$is in the range 14.06–14.59 mgg^{-1} for CV and 34.45-23.93 mgg^{-1} for CR at pH 7 within 90 min contact time in the temperature range of 30-50 °C.The $MnFe_2O_4$/OV exhibited excellent photocatalytic performance, leading to 43% and 72% degradation within 3 hours at rate constants of 2.0 x 10^{-3} min^{-1} and 6.0 x 10^{-3} min^{-1} for crystal CV and CR, respectively.Also, *E.coli* and *S.Aureus* bacteria have shown growth suppression activity when exposed to $MnFe_2O_4$/OV.

Chapter 5 entitled **"Synthesis, characterization and application of Eugenol based magnetic iron oxide nanoparticles Fe_3O_4@EO"**describes the synthesis of Eugenol functionalized magnetite nanoparticles, Fe_3O_4@EO, via facile co-precipitation route. The prepared Fe_3O_4@EO nanoparticles were investigated for the adsorption of BBR dye and antibacterial activity. Additionally, the Fe_3O_4@EO exhibited superparamagnetic behavior, as established from the VSM measurements. Langmuir's maximum adsorption capacity $Q_{max}$was found to be 111.11 $mgg^{-1}$for BBR adsorption onto theFe_3O_4@EO.The minimal inhibitory concentration and zone of inhibition tests revealed that Fe_3O_4@EO was more resistant to the *E. coli* strain than *S. aureus*.

Chapter 6 entitled **"Synthesis, characterization and application of Eugenol based magnetic manganese-ferrite nanoparticles $MnFe_2O_4$@EO"** describes the formation of magnetic$MnFe_2O_4$ @EO via simple co-precipitation method for the treatment of NB and BBR dye from polluted water through adsorption.The impact of pH, temperature, $MnFe_2O_4$@EO dosage, contact time, and initial dye concentrations on the adsorption performance was studied.. Also, Eugenol functionalized $MnFe_2O_4$ showed antibacterial activity against *E.coli* and *S.aureus*.