

REVIEW OF ADSORPTION OF DYES/HEAVY METALS USING COMPOSITES

A Mini Project Report

In Partial Fulfilment of the Requirement for Award of Degree of
Bachelor of Technology of the 2nd Year in Chemical Engineering

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CERTIFICATE

Certified that the Major Project Report entitled "*review of adsorption of dyes/heavy metals using composites*" submitted by Vaibhav Awasthi (23021136), Srishti jaiswal (23021133), Pragati Pathak (23021123) of B.Tech. 4th Semester, in partial fulfillment of the requirements for the award of degree in Bachelor of Technology (B. Tech) in Chemical Engineering, is according to the students their own investigation carried out by them in the Department of Chemical Engineering, School of Studies of Engineering & Technology, GGV, during the session 2024-25.

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Abstract: Industrial effluent heavy metal ions and dyes represent a serious threat to water quality and human health globally. In this literature review, adsorption-based filtration technologies for the removal of these contaminants are discussed, with emphasis on recent developments. We discuss three exemplar studies: Filice et al. (2022) on polymer-coated filters, Bazan-Woźniak et al. (2022) on activated carbon from marigold waste, and Myat et al. (2019) on quicklime adsorbents. Materials, mechanisms, performance, and applications of each study are explored extensively. Adsorption is generally seen to be an effective and versatile technique overall: Filice et al. obtained ~90% methylene blue removal and >99% Fe^{3+} capture using sulfonated-copolymer-coated polypropylene filters. Bazan-Woźniak et al. showed outstanding dye adsorption performances (as high as ~622 mg/g for malachite green) on chemically activated carbon made from marigold biomass. Myat et al. demonstrated considerable Congo red removal ($\geq 82\%$ at static conditions) by using cost-effective quicklime powder. We contrast these methodologies with respect to adsorbent synthesis, characterization (BET surface area, SEM/EDX, FTIR, etc.), experimental set-up (batch vs. filtration, pH management), and modeling (isotherms, kinetics). Discussion includes adsorption processes (electrostatic attraction, ion exchange, pore-filling) and efficiency-influencing factors. Lastly, we discuss practical significance, limitations (e.g. regeneration, multi-contaminant competition), and suggest directions such as hybrid adsorption–membrane systems and emerging bio-based adsorbents. This review offers an integrated picture of adsorption-filtration technologies for metal and dye remediation as a platform to further study and develop.

Keywords: Adsorption; heavy metals; dyes; water treatment; activated carbon; sulfonated polymer; isotherms; kinetics