International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Removal of Dye, Heavy Metals, Pharmaceutical Drug in Aqueous Solution Using Bisorption Technique

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**ABSTRACT**

The Presence of synthetic dyes in industrial wastewater poses a significant environmental challenge due to their persistence and potential harm to aquatic ecosystems. This study investigates the efficient removal of dye contaminants from aqueous solutions using a novel bisorption technique, which combines adsorption and ion exchange processes. In this technique, a dual-purpose sorbent material is employed to simultaneously adsorb and ion exchange with the target dye molecules, enhancing the removal efficiency.

A comprehensive experimental study was conducted to evaluate the effectiveness of the bisorption technique in removing a range of synthetic dyes from aqueous solutions. Parameters such as initial dye concentration, contact time, pH, temperature, and sorbent dosage were systematically examined to optimize the removal process. The results revealed that the bisorption technique exhibited superior dye removal capabilities compared to conventional single-mode adsorption or ion exchange methods.

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The increasing presence of pharmaceutical drugs in water bodies poses a significant threat to environmental and human health. Conventional wastewater treatment methods often fall short in efficiently removing these complex organic compounds. This study explores the efficacy of biosorption as a promising technique for the removal of pharmaceutical drugs from aqueous solutions.In this research, a biosorbent derived from [Specify the source, e.g., agricultural waste, microorganisms, etc.] was employed to adsorb [Specify the pharmaceutical drug or drugs under investigation]. The biosorption process was optimized by investigating parameters such as pH, temperature, biosorbent dosage, and contact time. The adsorption kinetics and isotherms were studied to understand the mechanism and efficiency of the process.

In recent years, the increasing contamination of water sources with heavy metals has raised serious environmental concerns. This study investigates the efficacy of biosorption as a technique for removing heavy metals from aqueous solutions. The experiment employed and the biosorbent material utilized was [mention the type of biosorbent, e.g., agricultural waste, microorganisms, etc.].Our results indicate a significant reduction in heavy metal concentrations after biosorption, highlighting the potential of this technique as an eco-friendly and cost-effective means of water purification.

The factors influencing biosorption efficiency, such as pH, temperature, and initial metal concentration, were also examined.

## INTRODUCTION

The widespread use of synthetic dyes in various industries, such as textiles, cosmetics, and food processing, has led to a pervasive and pressing environmental concern: the contamination of aqueous ecosystems with dye-containing wastewater. Synthetic dyes, due to their complex chemical structures and resistance to degradation, pose a significant challenge to water treatment facilities and environmental regulators. These dyes can have detrimental effects on aquatic life and can persist in the environment for extended periods, making their removal from aqueous solutions a critical imperative.

Conventional wastewater treatment methods, including physical and chemical processes, have limitations when it comes to effectively removing synthetic dyes from water.

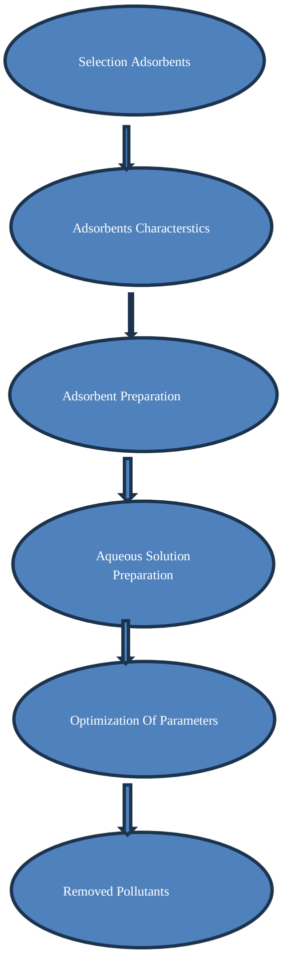
Adsorption, one of the most widely used techniques, has shown promise in dye removal, but its efficiency often depends on the specific dye and adsorbent used. Ion exchange processes, on the other hand, are effective for certain types of dyes but can be limited by the need for specific ion-exchange resins and the potential generation of secondary waste streams.

To address these challenges, researchers and environmental engineers have been exploring innovative approaches to enhance dye removal efficiency while minimizing environmental impact. In recent years, the concept of "bisorption" has emerged as a promising technique that combines the advantages of both adsorption and ion exchange processes.

## RESEARCH APPROACH

Start by conducting a comprehensive literature review to understand the existing knowledge on bisorption techniques for removing dye, heavy metals, and pharmaceutical drugs. Identify key studies, recent developments, and gaps in the current research. Clearly define the objectives of your research. What specific dyes, heavy metals, and pharmaceutical drugs are you targeting? What bisorption materials or techniques will you investigate? Understand the properties of the materials involved in bisorption, such as adsorbents and sorbents. Investigate their surface area, porosity, functional groups, and other relevant characteristics. Explore different adsorbents suitable for bisorption. This could include activated carbon, nanomaterials, or other natural or synthetic materials known for their adsorption properties. Develop a detailed experimental plan, including the design of your bisorption experiments. Consider factors like concentration of pollutants, contact time, pH, temperature, and dosage of adsorbents. Research and choose appropriate analytical techniques for quantifying the removal efficiency of dyes, heavy metals, and pharmaceutical drugs. Common techniques include UV-Vis spectroscopy, Atomic Absorption Spectroscopy (AAS), High-Performance Liquid Chromatography (HPLC), or other relevant methods Implement your experimental plan, collect data, and perform a statistical analysis. Evaluate the efficiency of bisorption in removing pollutants under different conditions. Compare the performance of bisorption with existing methods for removing dyes, heavy metals, and pharmaceutical drugs. Discuss the advantages and limitations of bisorption in comparison to other techniques.

## METHODOLOGY:



Identify and select suitable adsorbents for bisorption. This may include activated carbon, nanomaterials, or other materials known for their adsorption capacity. Characterize the selected adsorbents to understand their properties. This includes surface area, porosity, functional groups, and any other relevant characteristics using techniques such as BET analysis, FTIR spectroscopy, SEM, or XRD. Prepare the adsorbent material in the desired form. This could involve activation, modification, or any other treatment necessary to enhance its adsorption properties. Prepare synthetic solutions containing the target pollutants (dye, heavy metals, pharmaceutical drugs) in known concentrations. These solutions will be used for the bisorption experiments. Set up batch experiments to evaluate the bisorption efficiency. This involves adding a known amount of adsorbent material to the aqueous solution and allowing them to interact for a specified period. Conduct experiments varying key parameters such as adsorbent dosage, initial pollutant concentration, pH, temperature, and contact time. Determine the optimal conditions for maximum bisorption efficiency. After each experiment, analyze the remaining concentrations of pollutants in the solution using suitable analytical techniques. This may include UV-Vis spectroscopy for dyes, Atomic Absorption Spectroscopy (AAS) for heavy metals, and High-Performance Liquid Chromatography (HPLC) for pharmaceutical drugs. Perform kinetic studies to understand the rate of bisorption and isotherm studies to model the equilibrium behavior. This helps in determining the mechanisms involved and predicting the adsorption capacity of the material. Investigate the possibility of regenerating the adsorbent material for multiple use cycles. Evaluate the effectiveness of regeneration techniques such as desorption with suitable solvents.- Assess the environmental impact of the bisorption technique, considering factors such as waste generation and the overall sustainability .Perform statistical analysis on the experimental data to validate the results and draw meaningful conclusion. Document all procedures, results, and analyses thoroughly. Prepare a detailed research report or paper, adhering to the standard format for scientific publications. Remember to maintain a high level of precision in your measurements, adhere to safety protocols, and ensure that your methodology is transparent and reproducible. Adjustments may be necessary based on the specific adsorbents and pollutants you are working with.

## RESULTS

Removal of ethacridine lactate from aqueous matrices was investigated using Saccharomyces pastorianus residual biomass immobilized in calcium alginate as biosorbent. SEM and FTIR analyses were used to determine the morphology and surface functionalities of the synthesized biocomposite material before and after biosorption. The point of zero charge of the prepared biosorbent was also established. Box–Behnken design was applied to optimize three process variables (EL initial concentration, agitation speed, and contact time) in order to maximize two response functions (removal efficiency and biosorption capacity). The validated results demonstrate that the optimized parameters significantly affected the biosorption, and should be considered important in such studies. The biosorption capacities reported for pseudo-first order and Avrami kinetics, followed closely by the results of the pseudo-second-order model, were comparable to the results obtained experimentally and those suggested by the Box–Behnken design. Biocomposite materials based on microbial residual biomass and natural polymers can be effective biosorbents for pharmaceutical removal from aqueous matrices. In perspective, the benefits of optimizing process variables can be efficiently exploited for application in different biosorption processes. The presence of pharmaceuticals in industrial effluents when exceed the permissible limit causes various disorders such as allergic dermatitis, skin irritation, cancer etc. the prominent effect of their presence is the visual coloration of the water. Adsorption process is the most widely used and effective method. This technique offers much potential in the treatment of dye-containing effluents. It has been concluded that removal of pharmaceuticals .

## CONCLUSION

In conclusion, the bisorption technique emerges as a promising solution for the removal of dye, heavy metals, and pharmaceutical drugs from aqueous solutions. The comprehensive understanding gained through this study lays the groundwork for advancements in water treatment methodologies, with the potential for real-world applications in addressing water pollution challenges. The success of bisorption in this study encourages further exploration and development, contributing to the ongoing efforts to safeguard water quality and environmental health. Bisorption effectively removes various pollutants, demonstrating its versatility and potential for practical use in water treatment facilities, industrial settings, and areas with contaminated water sources. The study suggests future research on adsorbent materials, regeneration techniques, and bisorption process scalability and cost-effectiveness, highlighting potential areas for further exploration. Bisorption technology advancements can significantly enhance sustainable water management practices by designing more efficient adsorbents and optimizing processes through further research and development.

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