



## Adsorption, Kinetic, Equilibrium and Thermodynamic studies on the removal of basic dye Rhodamine-B from aqueous solution by the use of natural adsorbent perlite

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### Abstract

This paper presents the feasibility of removal of basic dye Rhodamine-B from aqueous solutions by using a low cost natural adsorbent perlite. Batch adsorption experiments were carried out as a function of pH, contact time, initial concentration of the adsorbate, adsorbent dosage and temperature. Dye adsorption equilibrium was rapidly attained after 50 minutes of the contact time, and it was described by the Langmuir and Freundlich adsorption isotherms over the entire concentration ranges from 20-100 mgL<sup>-1</sup>. Adsorption data's are used for modelling, from the first and second order kinetic equation and intra-particle diffusion models. Thermodynamic parameters such as  $\Delta H^\circ$ ,  $\Delta S^\circ$ , and  $\Delta G^\circ$  were calculated, which indicated that the adsorption was spontaneous and exothermic nature, which was evident by decreasing the randomness of the dye at the solid and liquid interface. Adsorbent used in this study, characterized by FT-IR and SEM before and after the adsorption of Rhodamine-B. The characteristic results and dimensionless separation factors ( $R_s$ ) showed that perlite can be employed as an alternative to commercial adsorbents in the removal of Rhodamine-B from aqueous solution and waste water.

**Keywords:** Rhodamine-B, perlite, adsorption isotherm, kinetics, minerals

### 1. Introduction

During the last few decades the mobility and distribution of dyes in water have been studied extensively due to their toxic effects to humans, animals, plants and the aquatic organisms. Many of the industries, such as dyestuffs, textile, paper, leather, foodstuffs, cosmetics, rubber and plastics are using enormous quantity of synthetic dyes in order to give colour for their products and consume substantial volumes of water. As a result, they generate a considerable amount of coloured wastewater. Textile and dyeing industry are among important sources for the continuous pollution of the aquatic environment. Because they produce approximately 5% of them end up in effluents. The textile and dyeing industries effluents are discarded into rivers, ponds and lakes; they affect the biological life various organisms [1-3]. Dye-containing effluents are undesirable wastewaters because they contain high levels of chemicals, suspended solids, and toxic

# Adsorption Kinetic Equilibrium And Thermodynamic Studies

**Yeong Yin Fong, Lam Man  
Kee, Norwahyu Jusoh, Chuah Chong  
Yang**

## **Adsorption Kinetic Equilibrium And Thermodynamic Studies:**

Adsorption: Fundamental Processes and Applications Mehrorang Ghaedi, 2021-03-19 Adsorption Fundamental Processes and Applications Volume 33 in the Interface Science and Technology Series discusses the great technological importance of adsorption and describes how adsorbents are used on a large scale as desiccants catalyst supports in the separation of gases the purification of liquids pollution control and in respiratory protection Finally it explores how adsorption phenomena play a vital role in many solid state reactions and biological mechanisms as well as stressing the importance of the widespread use of adsorption techniques in the characterization of surface properties and the texture of fine powders Covers the fundamental aspects of adsorption process engineering Reviews the environmental impact of key aquatic pollutants Discusses and analyzes the importance of adsorption processes for water treatment Highlights opportunity areas for adsorption process intensification Edited by a world leading researcher in interface science **Forschung für**

**zukünftige Mobilität** Jürgen Krah, 2018-07-12 Der interdisziplinäre Arbeitskreis Analytische Chemie und Kraftstoffforschung des TAC der Hochschule Coburg besteht aus Doktoranden und Studierenden der Studiengänge Physikalische Technik Technische Physik Bioanalytik Maschinenbau Elektrotechnik und Analytical Instruments Measurement and Sensor Technology AIMS Die Studierenden lernen bei der Bearbeitung von biokraftstoffbezogenen Forschungsfragen sowohl das wissenschaftliche Arbeiten als auch den Umgang mit chemischer Analytik und Sensorik Vom Prinzip des forschenden Lehrens profitieren Studierende und Doktoranden in gleichem Maße Zum Ende des Sommersemesters 2016 fand das 8. Biokraftstoffsymposium statt Im Rahmen dieser Veranstaltung konnten die Studierenden und Doktoranden sowie Gäste aus Wissenschaft und Wirtschaft aktuelle Forschungsergebnisse präsentieren Der vorliegende Tagungsband berichtet über die Ergebnisse des 8. Biokraftstoffsymposiums aus dem Juli 2016 **Green Adsorbents for Pollutant Removal** Grégorio

Crini, Eric Lichtfouse, 2018-06-27 This is the first volume on adsorption using green adsorbents and is written by international contributors who are the leading experts in the adsorption field The first volume provides an overview of fundamentals and design of adsorption processes For people who are new to the field the book starts by two overview chapters presenting the principles and properties of wastewater treatment and adsorption processes The book also provides a comprehensive source of knowledge on acid base properties of biosorbents It discusses fractal like kinetic models for fluid solid adsorption reports on the chemical characterization of oxidized activated carbons for metal removal and the use of magnetic biosorbents in water treatment Furthermore the thermodynamic properties of metals adsorption by green adsorbents and biosorption of polycyclic aromatic hydrocarbons and organic pollutants are reviewed and finally the recent trends and impact of nanomaterials as green adsorbent and potential catalysts for environmental applications are summarized The audience for this book includes students environmentalists engineers water scientists civil and industrial personnel who wish to specialize in adsorption technology Academically this book will be of use to students in chemical and environmental engineering who

wish to learn about adsorption and its fundamentals It has also been compiled for practicing engineers who wish to know about recent developments on adsorbent materials in order to promote further research toward improving and developing newer adsorbents and processes for the efficient removal of pollutants from industrial effluents It is hoped that the book will serve as a readable and useful presentation not only for undergraduate and postgraduate students but also for the water scientists and engineers and as a convenient reference handbook in the form of numerous recent examples and appended information Advances in Composite Materials Development Dumitra Lucan,2019-09-11 The progress of technology is a permanent challenge in developing new materials with superior properties in terms of quality and reliability The demand for increased performance continues to focus materials development efforts on exploring new concepts or new generations of composite materials The chapters contained in this book represent many examples of research results dedicated to obtaining characterizing and mathematically modeling composite materials especially metal matrix composites with superior properties having a wide range of applications The book is addressed to researchers and materials specialists teachers and students at science and material engineering faculties and all those interested in advances in science and technology of new materials

**Heavy Metals** Hosam El-Din M. Saleh,Refaat Aglan,2018-06-27 Fundamental societal changes resulted from the necessity of people to get organized in mining transporting processing and circulating the heavy metals and their follow up products which in consequence resulted in a differentiation of society into diversified professions and even societal strata Heavy metals are highly demanded technological materials which drive welfare and progress of the human society and often play essential metabolic roles However their eminent toxicity challenges the field of chemistry physics engineering cleaner production electronics metabolomics botany biotechnology and microbiology in an interdisciplinary and cross sectorial manner Today all these scientific disciplines are called to dedicate their efforts in a synergistic way to avoid exposure of heavy metals into the eco and biosphere to reliably monitor and quantify heavy metal contamination and to foster the development of novel strategies to remediate damage caused by heavy metals **Methods for Bioremediation of Water and Wastewater Pollution** Inamuddin,Mohd Imran Ahamed,Eric Lichtfouse,Abdullah M. Asiri,2020-10-05 This book presents advanced techniques for wastewater treatment and the chapters review the environmental impact of water pollution the analysis of water quality and technologies for the preservation of water resources Also outlined in this volume is the bioremediation of heavy metals dyes bisphenols phthalates cyanobacteria in contaminated water and wastewater Another focus of this book is the use of natural remediation techniques such as bacterial biofilms and enzymes Fresh Water Pollution Dynamics and Remediation Humaira Qadri,Rouf Ahmad Bhat,Mohammad Aneesul Mehmood,Gowhar Hamid Dar,2019-07-17 Freshwater is a finite resource and is being deteriorated directly and indirectly by anthropogenic pressures Preserving the quality and availability of freshwater resources is becoming one of the most pressing environmental challenges on the international horizon To ensure the preservation as well as availability of freshwater resources there is a

need to understand the ecology of the freshwater systems pollution problems their impacts restoration techniques to be opted and the conservation measures In this backdrop the present book on Freshwater Pollution Dynamics and Remediation has been compiled The book provides an understanding about the present state of art pollution impacts including the changes in the environmental quality as well as the shift in the aquatic biological communities of the fragile freshwater ecosystems Besides the impact of deteriorating quality of the freshwater ecosystems on the animal and human health is also discussed in detail This book provides a comprehensive account of the techniques based on updated research in biotechnology bio remediation phyto remediation and nano bioremediation The role of biosorbers and biofilms as a remediation tool has also been detailed The book is a ready reference for researchers scientists and educators who are involved in the freshwater pollution remediation and management studies The book editors with an expertise in diverse research fields in freshwater ecosystems have congregated the most inclusive research accounts on the freshwater pollution and remediation and thus developed a repository of diverse knowledge on the subject

**Sustainable Resource Management** Wenshan Guo,Huu Hao Ngo,Rao Y. Surampalli,Tian C. Zhang,2021-04-20 Sustainable Resource Management Learn how current technologies can be used to recover and reuse waste products to reduce environmental damage and pollution In this two volume set Sustainable Resource Management Technologies for Recovery and Reuse of Energy and Waste Materials delivers a compelling argument for the importance of the widespread adoption of a holistic approach to enhanced water energy and waste management practices Increased population and economic growth urbanization and industrialization have put sustained pressure on the world s environment and this book demonstrates how to use organics nutrients and thermal heat to better manage wastewater and solid waste to deal with that reality The book discusses basic scientific principles and recent technological advances in current strategies for resource recovery from waste products It also presents solutions to pressing problems associated with energy production during waste management and treatment as well as the health impacts created by improper waste disposal and pollution Finally the book discusses the potential and feasibility of turning waste products into resources Readers will also enjoy A thorough introduction and overview to resource recovery and reuse for sustainable futures An exploration of hydrothermal liquefaction of food waste including the technology s use as a potential resource recovery strategy A treatment of resource recovery and recycling from livestock manure including the current state of the technology and future prospects and challenges A discussion of the removal and recovery of nutrients using low cost adsorbents from single component and multi component adsorption systems Perfect for water and environmental chemists engineers biotechnologists and food chemists Sustainable Resource Management also belongs on the bookshelves of environmental officers and consultants chemists in private industry and graduate students taking programs in environmental engineering ecology or other sustainability related fields

**Bioremediation** Sanjay K. Sharma,2019-10-24 Bioremediation A Sustainable Approach to Preserving Earth s Water discusses the latest research in

green chemistry practices and principles that are involved in water remediation and the quality improvement of water The presence of heavy metals dyes fluoride dissolved solids and many other pollutants are responsible for water pollution and poor water quality The removal of these pollutants in water resources is necessary yet challenging Water preservation is of great importance globally and researchers are making significant progress in ensuring this precious commodity is safe and potable This volume illustrates how bioremediation in particular is a promising green technique globally Features Addresses bioremediation of all the major water pollutants Approaches the chemistry of water and the concept of water as a renewable resource from a green chemistry aspect Discusses environmental chemistry and the practice of industrial ecology Explains the global concern of adequate high quality water supplies and how bioremediation can resolve this Explores sustainable development through green engineering

**Sustainable Processes and Clean Energy Transition** Yeong Yin Fong, Lam Man Kee, Norwahyu Jusoh, Chuah Chong Yang, 2023-06-25 The book presents the proceedings of the International Conference on Sustainable Processes and Clean Energy Transition 2022 Topics covered include Biomass and Biofuel Green Processes and Materials and Safety and Energy Systems

**Handbook of Functionalized Nanomaterials** Vineet Kumar, Chaudhery Mustansar Hussain, 2021-08-23 Handbook of Functionalized Nanomaterials Environmental Health and Safety discusses the reactive properties of FNMs used in a range of applications and their toxic impact on the environment Nanomaterials have unique properties that can make them highly reactive This reactivity can cause unwanted interactions with living cells an increase in oxidative stress or damage to genetic material resulting in damage to the environment and local wildlife This negative impact is often further increased after surface functionalization of nanomaterials with other materials which offer unique properties of their own To ensure environmental safety and ecological balance rigorous toxicity testing of functionalized nanomaterials FNMs is necessary This book discusses the toxicological uncertainties of FNMs and the limitations of FNMs in a range of applications Later chapters propose methods to reliably assess the harm that functionalized nanomaterials can cause to the environment and wildlife as well covering recent developments in the field of environmental health safety The book concludes with a discussion on the future prospects of safe functionalized nanomaterials Offers a novel integrated approach bridging the gap between FNMs and environmental health and safety Analyses the reactive properties of FNMs and their toxicological potential Provides an in depth look at the impact of functionalized nanomaterials on the environment

**Bioprocess Engineering** Pau Loke Show, Chien Wei Ooi, Tau Chuan Ling, 2019-06-13 Bioprocess Engineering Downstream Processing is the first book to present the principles of bioprocess engineering focusing on downstream bioprocessing It aims to provide the latest bioprocess technology and explain process analysis from an engineering point of view using worked examples related to biological systems This book introduces the commonly used technologies for downstream processing of biobased products The covered topics include centrifugation filtration membrane separation reverse osmosis chromatography biosorption liquid liquid separation and drying The basic principles and

mechanism of separation are covered in each of the topics wherein the engineering concept and design are emphasized This book is aimed at bioprocess engineers and professionals who wish to perform downstream processing for their feedstock as well as students

**Advances in Water and Wastewater Treatment** Pranav Deepak Pathak,Himanshu J. Patel,Anuja R. Jadhav,2024-12-06 Wastewater management and treatment are pressing issues that require both cheap and effective solutions for a sustainable world especially in rural areas Conventional treatments using traditional materials are very costly and sometimes provide undesirable results This new book discusses the various techniques and methodologies for the utilization of advanced materials for water and wastewater treatment It examines the feasibility of advanced materials that can be used to remove various contaminants from water and wastewater for more effective results The book covers techniques involving adsorption by advanced adsorbents membrane filtration advanced oxidation techniques constructed wetlands activated sludge processes ion exchange sustainable circular economy development electrocoagulation photocatalytic oxidation and much more

**Porous Materials for Environmental Applications** Antonio Gil,Miguel A. Vicente,2020-06-17 The development of porous materials has attracted the attention of the research community for years Porosity characteristics have specific impacts on the material properties and materials that are applied in many areas such as pollutant removal CO<sub>2</sub> capture energy storage catalytic oxidation and reduction processes the conversion of biomass to biofuels and drug delivery Examples of porous materials are activated carbons clays and zeolites The aim of this book is to collect the recent advances and progress regarding porous materials and their applications in the environmental area

*Green Chemistry for Dyes Removal from Waste Water* Sanjay K. Sharma,2015-02-25 The use of synthetic chemical dyes in various industrial processes including paper and pulp manufacturing plastics dyeing of cloth leather treatment and printing has increased considerably over the last few years resulting in the release of dye containing industrial effluents into the soil and aquatic ecosystems The textile industry generates high polluting wastewaters and their treatment is a very serious problem due to high total dissolved solids TDS presence of toxic heavy metals and the non biodegradable nature of the dyestuffs in the effluent The chapters in this book provide an overview of the problem and its solution from different angles These problems and solutions are presented in a genuinely holistic way by world renowned researchers Discussed are various promising techniques to remove dyes including the use of nanotechnology ultrasound microwave catalysts biosorption enzymatic treatments advanced oxidation processes etc all of which are green Green Chemistry for Dyes Removal from Wastewater comprehensively discusses Different types of dyes their working and methodologies and various physical chemical and biological treatment methods employed Application of advanced oxidation processes AOPs in dye removal whereby highly reactive hydroxyl radicals are generated chemically photochemically and or by radiolytic sonolytic means The potential of ultrasound as an AOP is discussed as well Nanotechnology in the treatment of dye removal types of adsorbents for removal of toxic pollutants from aquatic systems Photocatalytic oxidation process for dye degradation under both UV and

visible light application of solar light and solar photoreactor in dye degradation      Biotechnology in Action: Unveiling Nature's Potential 2 Murat ÖZDAL, Sümeyra GÜRKÖK, 2024-11-01 CONTENTS MICROBIAL BIOPESTICIDES AND USAGE AREAS zlem BAKIR BO A Esabi Ba aran KURBANOLU BIOLOGICAL CONTROL OF APHIDS Haluk Kemal NARMANLIO LU THE BENEFICIAL ROLES OF MICROBIAL BIOFILMS ON THE ALLEVIATION OF PLANT ABIOTIC STRESSES Sedat AM OVERVIEW OF PROBIOTICS FROM A BIOTECHNOLOGICAL PERSPECTIVE Murat ZDAL MICROBIAL FERMENTATION PRODUCTION AND BIOTECHNOLOGICAL APPLICATIONS Eda DEL K Burcu Emine TEFON ZT RK UNVEILING NATURE S POTENTIAL IN BIOFUELS EXPLORING TYPES GENERATIONS PRETREATMENT METHODS CHALLENGES AND RECENT ADVANCES IN PRODUCTION TECHNOLOGIES S meyra G RK K Aashoqullah SAJAAD Abdul wakil AYAN BACTERIAL DEGRADATION OF PLASTICS Berfin ERO LU Burcu Emine TEFON ZT RK HYPERACCUMULATOR PLANTS AND THEIR USE IN PHYTOREMEDIATION Zuleyha ASLAN ERGENEKON Meryem SENGUL KOSEOGLU UNVEILING NATURE S POTENTIAL IN ENZYMES INDUSTRIAL ENZYMES AND THEIR APPLICATION AREAS Y ksel D L Aysun YILMAZ Fatma AKBA AYDIN Asiye HEM NL Burak ALAYLAR S meyra G RK K REVOLUTIONIZING INDUSTRIAL PROCESSES IN HARSH CONDITIONS WITH THERMOPHILIC ENZYMES Derya EFE Hakan KARAO LU Z leyha AKPINAR EMANET ANTIOXIDANT ENZYMES IN BIOTECHNOLOGY Yonca YUZUGULLU KARAKUS Elif KALE BAKIR Semih I IK APPLICATION OF CHITIN IN BIOTECHNOLOGY Erg n ERGENEKON mer K ksal ERMAN CELL TARGETED DRUG DELIVERY SYSTEMS Selma SEZEN Feyza BURUL Ufuk OKKAY EXOSOMES POTENTIAL APPLICATIONS ON DRUG DELIVERY SYSTEMS Buket BAKAN TOPICAL BIOMATERIALS TO PROMOTE WOUND HEALING Selma SEZEN Feyza BURUL Medine G LL CE Ufuk OKKAY BRYOPHYTES IN BIOTECHNOLOGY Zuleyha ASLAN ERGENEKON Tulay EZER MOLECULAR DOCKING A POWERFUL TOOL FOR BIOTECHNOLOGY RESEARCH Mehmet KARADAYI Yusuf G L AH N eyima AKSU Ekrem G LL CE THE LATEST TRENDS IN BACTERIOCINS IN BIOTECHNOLOGY INNOVATIVE APPLICATIONS AND THE FUTURE Selin DO AN Taha Yasin KO G k e KARADAYI Medine G LL CE BIOSORPTION AN EFFECTIVE AND SUSTAINABLE APPROACH FOR SYNTHETIC DYE REMOVAL Ekrem G LL CE Yusuf G L AH N eyima AKSU Mehmet KARADAYI BACTERIOPHAGES FROM HISTORICAL THERAPEUTIC AGENTS TO CONTEMPORARY REDISCOVERY AND BIOTECHNOLOGICAL APPLICATIONS lk Zeynep UREYEN ESERTA APLICATION OF BIOTECHNOLOGICAL APPROACHES IN ELECTRONIC DEVICE APPLICATIONS Tuba AKICI CAN      Advanced Materials for Pharmaceutical Wastewater Treatment P.V. Nidheesh, Aydin Hassani, 2024-09-04 Effluents generated from the pharmaceutical industry contain organic and inorganic contaminants that create potential threats to human health and the environment Pharmaceuticals cannot be effectively removed by conventional wastewater treatment plants owing to the complex composition high concentration of organic contaminants high salinity and biological toxicity of pharmaceutical wastewater This book provides an overview of the production and environmental impacts of pharmaceutical compounds and their advanced treatment methods with a focus on advanced



materials used for removing pharmaceutical contaminants from wastewater Provides an overview of the current state of advanced research and applications of materials for pharmaceutical wastewater treatment Discusses various adsorbents photocatalysts and electrodes with a special focus on carbon materials Covers advanced material synthesis and fabrication Features case studies and chapters that are fully application oriented This book is essential reading for researchers and practitioners in materials science and engineering environmental science and engineering chemical engineering and water treatment who are seeking to develop and implement advanced technologies for waste minimization and mitigation **Algal Technologies for Wastewater Treatment and Resource Recovery** Raul Muñoz, Hardy Temmink, Anthony M. Verschoor, Peter van der Steen, 2019-07-26

Over 80% of globally produced wastewater receives little or no treatment before it is disposed into the environment Therefore it is urgent to develop new wastewater treatment technologies that are sustainable in the broad sense of the word i.e. not only produce high quality effluents but also minimise energy expenses recover energy and nutrients and apply technology that is appropriate in relation to the availability of skilled personnel This book compiles the main outcomes of recent efforts to improve the design of waste stabilisation ponds and confirms the superior performance of high rate algal ponds as a result of process intensification Anaerobic digestion devoted to biogas production continues to be the preferred strategy for the energy valorisation of the algal biomass co digestion with multiple high C/N ratio substrates gathering significant attention over the past years The potential of algal biomass as a biosorbent for heavy metal removal Cu Ni F maintains its share in the research field of water bioremediation while research on nutrient removal has focused on providing new insights on the mechanism of nitrogen and phosphorus removal from wastewater in algal bacterial systems Finally it is worth noticing that breakthroughs in complementary fields of research such as nanotechnology or lighting technology are gradually being implemented in algal biotechnology with new products such as nanoparticles for water disinfection or photobioreactors illuminated by low intensity LED panels In Focus a book series that showcases the latest accomplishments in water research Each book focuses on a specialist area with papers from top experts in the field It aims to be a vehicle for in depth understanding and inspire further conversations in the sector ACRID 2017 Edward Chikuni, Joseph Mutale, Ogbonnaya Okoro Muchael, Peter Manyere, 2018-06-04 The Conference Theme was Moving Africa forward through Engineering Technology and Innovation The conference brought together academics researchers and industrialists from many disciplines in particular those that have the most impact on Africa's Development Most conferences on the continent have covered limited disciplines and therefore the opportunity has been lost sharing information results and knowledge in a way which can solve the many contentious issues most of which can be solved through a multidisciplinary approach **Infrared Spectroscopy** Marwa El-Azazy, Khalid Al-Saad, Ahmed S. El-Shafie, 2023-02-01 Infrared Spectroscopy Perspectives and Applications is a compendium of contributions from experts in the field of infrared IR spectroscopy This assembly of investigations and reviews provides a comprehensive overview of the fundamentals as well as the

groundbreaking applications in the field Chapters discuss IR spectroscopy applications in the food and biomedicine sectors and for measuring transport through polymer membranes characterizing lignocellulosic biomasses detecting adulterants and characterizing enamel surface advancements This book is an invaluable resource and reference for students researchers and other interested readers

The book delves into Adsorption Kinetic Equilibrium And Thermodynamic Studies. Adsorption Kinetic Equilibrium And Thermodynamic Studies is an essential topic that needs to be grasped by everyone, ranging from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Adsorption Kinetic Equilibrium And Thermodynamic Studies, encompassing both the fundamentals and more intricate discussions.

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