

Sustainable Materials and Technology

Akil Ahmad
Mohammed B. Alshammari *Editors*

Nanofiltration Membrane for Water Purification

 Springer

Sustainable Materials and Technology

Series Editors

Mohammad Jawaid, Laboratory of Biocomposite Technology, Universiti Putra Malaysia, INTROP, Serdang, Selangor, Malaysia

Anish Khan, Centre of Excellence for Advanced Materials, King Abdulaziz University, Jeddah, Saudi Arabia

Sustainable Materials and Technology (SMT) book series publishes research monographs (both edited and authored volumes) showcasing the latest developments in the field and comprehensively covering topics such as:

- Recycling of waste into useful material and their energy applications
- Catalytic action of Nano oxides for efficient carbon reforming process
- Sustainable technologies for plastic transformation
- Bifunctional nanoparticles for sustainable water splitting applications
- Sustainable dyeing and printing
- New materials from waste
- Sustainable Manure Management and Technology: Potentials, Uses and limitations
- Sustainable Mechanical Engineering Approach
- Sustainable biochemistry for the improvement of health
- Sustainable development of Mechanical recycling of automotive components
- Sustainable-waste recycling and conversion in useful materials for different applications
- Sustainable development of inexpensive Nano-photo catalysts
- Sustainable development of recycling of discarded lithium ion batteries
- Modern sustainable cement and concrete
- Sustainable adsorbent for hazardous removal
- Sustainable superior electromagnetic shielding materials
- Excellent sustainable nanostructured materials for energy storage device
- Sustainable development of heavy metal detoxification from water
- Carbon dioxide utilization for sustainable energy
- Sustainable development in green syntheses of materials
- Environment friendly and sustainable cloth for garments application
- Sustainable design and application of eco-materials
- Nanoparticles for sustainable environment applications
- Sustainable remediation of industrial contaminated water towards potential industrial applications
- Biomaterials for sustainable bioremediations

Akil Ahmad · Mohammed B. Alshammari
Editors

Nanofiltration Membrane for Water Purification

Editors

Akil Ahmad
Prince Sattam Bin Abdulaziz University
Al-Kharj, Saudi Arabia

Mohammed B. Alshammari
Prince Sattam Bin Abdulaziz University
Al-Kharj, Saudi Arabia

ISSN 2731-0426

ISSN 2731-0434 (electronic)

Sustainable Materials and Technology

ISBN 978-981-19-5314-9

ISBN 978-981-19-5315-6 (eBook)

<https://doi.org/10.1007/978-981-19-5315-6>

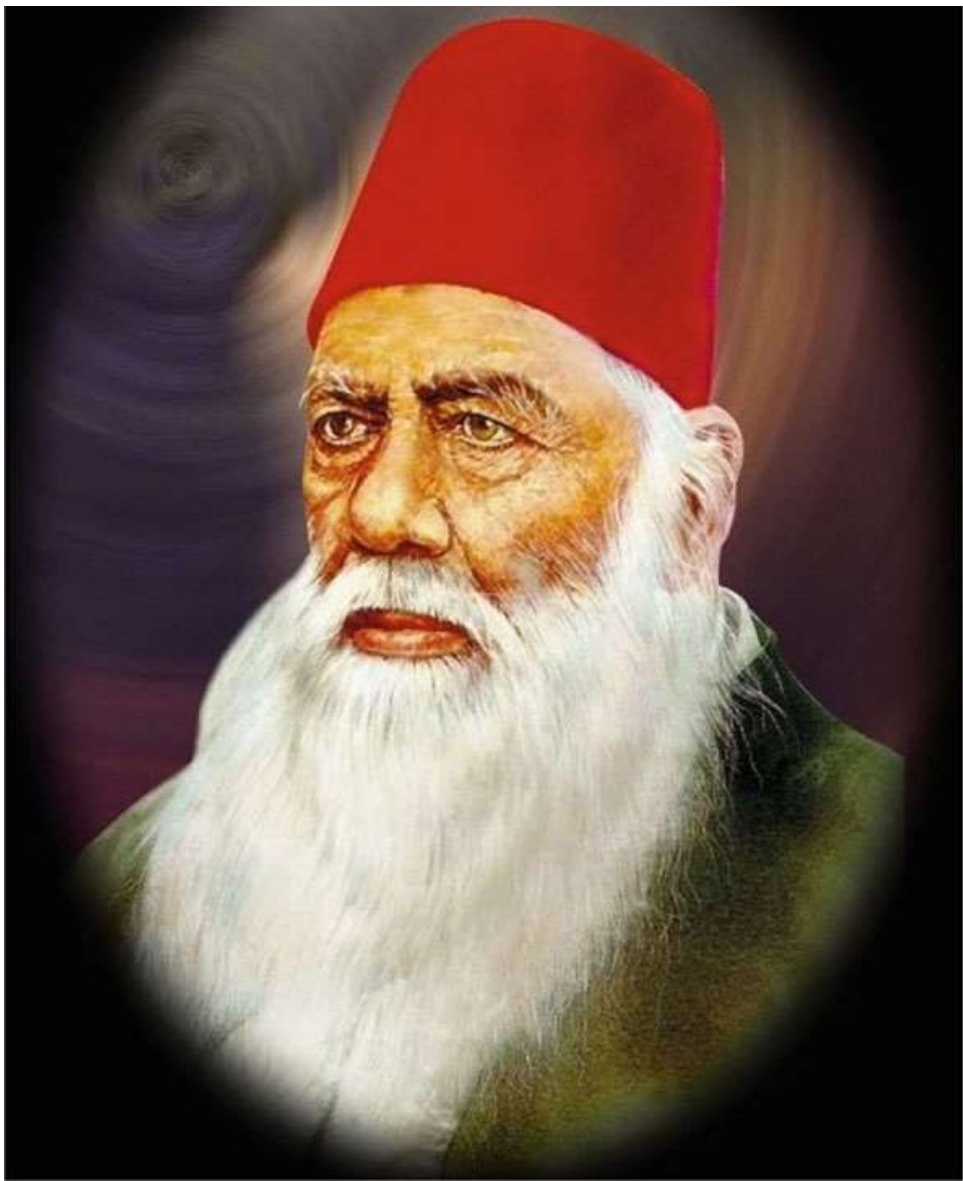
© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2023

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd. The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore



Dedicated to Sir Syed Ahmad Khan (1817–1898)

An Educationist and Reformer for Indian Muslims

Sir Syed Ahmad Khan was born in the well-known city of India, Delhi, on October 17, 1817. He had a strong belief that any national or religious cause can be promoted only on a strong foundation through scientific temperament. With this thought, he started the Aligarh movement and later established a college called Muhammadan Anglo-Oriental (MAO) College in Aligarh, India. After this great personality's departure in 1898, all the mourners turned the procession into a political demonstration urging for the grant of university status to his college in Aligarh, India, in fulfilling the cherished dreams of the visionary. This university is now a world-famous university and known as Aligarh Muslim University. This is a sure sign to attest to the power of the influence welded by this great and visionary personality. Whatever he dreamed now flourished in making the slumbering people rise with a resurgent spirit that they could now fearlessly face the situations of their times and hope for a promising future.

Preface

At the present time, most of the developing and underdeveloped countries are facing drinking water problems due to increasing world population and industrial expansion. With increasing anthropogenic and industrial activities, most of the industrial discharges like organic and inorganic pollutants enter into the water bodies and contaminate the system. Therefore, there is an urgent concern worldwide to search the new water resources and purification techniques to treat wastewater to reuse in daily life.

Among all the studied water purification techniques like adsorption, flocculation, precipitation, ion exchange, etc., there have been growing interests in the advancement of nanofiltration membrane as sustainable approach which are effective and efficient for the removal of toxic pollutants even in trace amount from wastewater. Apart from other techniques, the nanofiltration membrane is considered as a simple, sustainable, economical and extensively used technique which plays a significant role in waste purification. The preparation, characterization and design of nanofiltration membranes play a vital role to make them more effective and efficient in the application of water purification.

In this book, a summary of recent information about membrane hydrophilicity, water flux, removal efficiency, characterization, design and mechanisms involved during the separation process are discussed in detail. This book helps academicians, scientists, researchers and working people in industries to understand the mechanism of nanofiltration membrane as a sustainable and promising technique in the field of wastewater treatment. This book provides a wide knowledge of nanofiltration technique to the water purification audiences concerning the recent development with various illustrations, methods and results for graduate students, scientists, academicians, researchers and industrialists. Readers from wastewater and water purification may take help as a quick reference by exploring the research literature on the subject field with commercial value-added research applications of nanofiltration membrane. This book offers significant coverage of the commercial status, trends and performance of nanofiltration membrane technique.

We are greatly thankful to all qualified researchers, scholars and leading experts to contribute their valuable work. The chapters provided cutting-edge up-to-date

research findings on nanofiltration technique. We collected all the information given by eminent authors on nanofiltration and related membrane research from Turkey, India, Indonesia, Saudi Arabia, etc., and, finally, compiled this project in a fruitful way.

Al-Kharj, Saudi Arabia

Akil Ahmad
Mohammed B. Alshammari

Acknowledgements The editors wish to appreciate the support of the Department of Chemistry, College of Science and Humanities in Al-Kharj, Prince Sattam Bin Abdulaziz University, Al-Kharj-11942, Saudi Arabia.

Contents

1	Introduction and Basic Principle of Nanofiltration Membrane Process	1
	Vemula Madhavi and Thotakura Ramesh	
2	Synthesis and Characterization of Nanofiltration Membrane	17
	Chetan Kumar, Dinesh Kumar, and Ritu Painuli	
3	Pretreatments Before the Nanofiltration Technique	37
	Sevde Korkut, Vahid Vatanpour, and Ismail Koyuncu	
4	Graphene Oxide Based Nanofiltration Membrane for Wastewater Treatment	55
	Pooja V. Devre, Chandrashekhar S. Patil, and Anil H. Gore	
5	Nano-filtration Application in the Textile Industry for Wastewater Treatment	69
	Mrinal Kanti Adak, Krishna Kumar, Ajit Das, and Debasis Dhak	
6	Dye Removal from Industrial Water Using Nanofiltration Membrane	83
	Pragati Chauhan, Mansi Sharma, Sapna Nehra, Rekha Sharma, and Dinesh Kumar	
7	Volatile Organic Compounds Removal by Nanofiltration from Groundwater	119
	Mansi Sharma, Pragati Chauhan, Sapna Nehra, Rekha Sharma, and Dinesh Kumar	
8	Desalination Through Nanofiltration Technique	141
	Mansi Sharma, Namonarayan Meena, Pragati Chauhan, Sapna Nehra, Ram Babu Pachwarya, Rekha Sharma, and Dinesh Kumar	

9	Modified Nanofiltration Membrane for Wastewater Treatment	157
	Pragati Chauhan, Mansi Sharma, Sapna Nehra, Ram Babu Pachwarya, Rekha Sharma, and Dinesh Kumar	
10	Performance of Ceramic Nanofiltration Membranes in Water Purification	185
	S. Lakshmi Sandhya Rani and R. Vinoth Kumar	
11	Fouling Mechanisms in Nanofiltration Membranes	197
	K. V. V. Satyannarayana, S. Lakshmi Sandhya Rani, Chellaboyina Bharath Mathaji, and R. Vinoth Kumar	
12	Nanofiltration Technology Applied for Peat and Wetland Saline Water	217
	M. Elma, A. Rahma, F. R. Mustalifah, A. Rahman Wahid, D. R. Lamandau, S. Fatimah, M. S. Huda, M. A. Alsiren, Nasruddin, N. K. D. A. Saraswati, P. F. A. Simatupang, M. Firdaus, and Abdurrahman	
13	Removal of Pollutants from Wastewater Through Nanofiltration: A Review	247
	Saheed Mustapha, Jimoh Oladejo Tijani, Titus Chinedu Egbosiuba, Amigun Azeezah Taiwo, Saka Ambali Abdulkareem, Abdulmumuni Sumaila, Muhammed Muhammed Ndamitso, and Usman Nurudeen Ayodesi	