Smart Nanomaterials Technology

Showkat Ahmad Bhawani
Mohammad Jawaid *Editors*

Nanomaterials for Separation of Hazardous Contaminants from Wastewater

Springer

Editors
Showkat Ahmad Bhawani
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak
Kota Samarahan, Malaysia

Mohammad Jawaid
Department of Chemical and Petroleum Engineering, College of Engineering
United Arab Emirates University
Al Ain, United Arab Emirates

ISSN 3004-8273 ISSN 3004-8281 (electronic)
Smart Nanomaterials Technology
ISBN 978-981-95-6078-3 ISBN 978-981-95-6079-0 (eBook)
https://doi.org/10.1007/978-981-95-6079-0

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

Contents

Magnetic Nanocomposites and Their Applications in the Removal of Toxic Contaminants from Wastewater

Naseem Ahmad, Saimah Khan, Sanjana Yadav, Umme Salma, Nafish Fatima, Kashif Raees, Mohammad Shahadat, and Nafees Ahmad

Abstract The growing presence of water contaminants, such as organic pollutants and heavy metals, poses substantial environmental, and public health risks due to their toxicity and carcinogenic nature. Magnetic nanocomposites have emerged as effective materials for wastewater treatment, offering advantages like high surface area, magnetic responsiveness, and versatile functionalization capabilities. This chapter explores the synthesis techniques, such as co-precipitation, sol–gel, and green synthesis approaches, emphasizing their role in tailoring nanocomposites for enhanced performance and applications of magnetic nanocomposites in removing toxic contaminants from wastewater. Adsorption, photocatalytic degradation, and ion-exchange mechanisms are also highlighted in this chapter mentioning their effectiveness in removing toxic contaminants. Furthermore, it addresses the challenges associated with their practical application, including material stability, reusability, and potential environmental risks.

Keywords Magnetic nanocomposites · Heavy metals · Micropollutants · Adsorption · Advanced oxidation processes (AOPs)

N. Ahmad · S. Khan · S. Yadav · U. Salma · N. Fatima · N. Ahmad (✉)
Department of Chemistry, Integral University, Lucknow, India
e-mail: siddiquenafees123@gmail.com

K. Raees · M. Shahadat (✉)
Department of Chemistry, Chandigarh University, Mohali, Punjab, India
e-mail: mdshahadat93@gmail.com

N. Ahmad · S. Khan · S. Yadav · U. Salma · N. Fatima · K. Raees · M. Shahadat · N. Ahmad
Department of Textile and Fiber Engineering, Indian Institute of Technology, New Delhi, India

Institute of Oceanography and Environment, Universiti Malaysia Terengganu, Kuala Nerus, Terengganu, Malaysia

S. A. Bhawani and M. Jawaid (eds.), *Nanomaterials for Separation of Hazardous Contaminants from Wastewater*, Smart Nanomaterials Technology,
https://doi.org/10.1007/978-981-95-6079-0_7

Table 1 (continued)

Contaminant	Removal method	Advantages	Disadvantages
	Chlorination	Effective disinfection, low cost, widely used	Forms harmful disinfection byproducts (DBPs), ineffective against some pathogens
	UV irradiation	No chemical addition, effective against a wide range of pathogens	High energy consumption, no residual disinfection, limited by water turbidity

References

1. Li X, Shen X, Jiang W, Xi Y, Li S (2024) Comprehensive review of emerging contaminants: detection technologies, environmental impact, and management strategies. Ecotoxicol Environ Saf 15(278):116420
2. Kumar V, Sharma N, Umesh M, Chakraborty P, Kaur K, Duhan L, Sarojini S, Thazeem B, Pasrija R, Vangnai AS, Maitra SS (2023) Micropollutants characteristics, fate, and sustainable removal technologies for landfill leachate: a technical perspective. J Water Process Eng. 1(53):103649
3. Teh CY, Budiman PM, Shak KP, Wu TY (2016) Recent advancement of coagulation–flocculation and its application in wastewater treatment. Ind Eng Chem Res 55(16):4363–4389
4. Ahmed MB, Zhou JL, Ngo HH, Guo W, Thomaidis NS, Xu J (2017) Progress in the biological and chemical treatment technologies for emerging contaminant removal from wastewater: a critical review. J Hazard Mater 5(323):274–298
5. Rashid R, Shafiq I, Akhter P, Iqbal MJ, Hussain M (2021) A state-of-the-art review on wastewater treatment techniques: the effectiveness of adsorption method. Environ Sci Pollut Res 28:9050–9066
6. Jawed A, Saxena V, Pandey LM (2020) Engineered nanomaterials and their surface functionalization for the removal of heavy metals: a review. J Water Process Eng 1(33):101009
7. Li H, Chen X, Shen D, Wu F, Pleixats R, Pan J (2021) Functionalized silica nanoparticles: classification, synthetic approaches and recent advances in adsorption applications. Nanoscale 13(38):15998–16016
8. Thomas N, Dionysiou DD, Pillai SC (2021) Heterogeneous Fenton catalysts: a review of recent advances. J Hazard Mater 15(404):124082
9. Ahmad N, Rahman QI, Iqbal A, Siddiqui MR, Wabaidur SM, Ahmad N, Coulon F (2024) Design of novel Sb_2S_3/polythiophene heterojunction for efficient adsorption and methanol sensing. Sep Purif Technol 18(350):127826
10. Ahmad I, Aftab MA, Fatima A, Mekkey SD, Melhi S, Ikram S (2024) A comprehensive review on the advancement of transition metals incorporated on functional magnetic nanocomposites for the catalytic reduction and photocatalytic degradation of organic pollutants. Coord Chem Rev 1(514):215904
11. Zhang J, Wu H, Shi L, Wu Z, Zhang S, Wang S, Sun H (2024) Photocatalysis coupling with membrane technology for sustainable and continuous purification of wastewater. Sep Purif Technol 15(329):125225
12. Liu Y, Tourbin M, Lachaize S, Guiraud P (2014) Nanoparticles in wastewaters: hazards, fate and remediation. Powder Technol 1(255):149–156
13. Bushra R, Ahmad M, Alam K, Seidi F, Shakeel S, Song J, Jin Y, Xiao H (2024) Recent advances in magnetic nanoparticles: key applications, environmental insights, and future strategies. Sustain Mater Technol 20:e00985