


Chapter 13

Wastewater Treatment and Recycling Using Adsorption Enhanced by Artificial Neural Networks

Soukayna Maitouf


 <https://orcid.org/0009-0000-4619-7863>

Faculty of Sciences Agadir, Morocco

Ahmed Bachar


Ibn Zohr University, Morocco

Assia Mabrouk

 <https://orcid.org/0000-0001-6399-0644>

Ibn Zohr University, Morocco

Nadia Faska

 <https://orcid.org/0000-0001-6203-6904>

Faculty of Applied Sciences Ait Melloul, Morocco

ABSTRACT

The world is facing a lack of freshwater because of high population growth rates, and an increase in industrial activities. Therefore, new approaches to wastewater treatment and recycling are essential in sustainable water management. This chapter focuses on the integration of adsorption, which is an economically feasible method of pollutant removal, and Artificial Neural Networks (ANNs), known for their exceptional skills in complex system modeling and process optimization. ANN aids in increasing the efficiency and flexibility of adsorption systems to ensure appropriate

DOI: 10.4018/979-8-3373-2700-6.ch013

Copyright © 2026, IGI Global Scientific Publishing. Copying or distributing in print or electronic forms without written permission of IGI Global Scientific Publishing is prohibited. Use of this chapter to train generative artificial intelligence (AI) technologies is expressly prohibited. The publisher reserves all rights to license its use for generative AI training and machine learning model development.

water quality for reuse. This integration is feasible and beneficial not only from an environmental perspective, but also from an economic one, as shown through its practical implementation in municipal and industrial settings.

INTRODUCTION

Wastewater treatment and recycling are crucial components of sustainable water management, addressing the dual challenges of water scarcity and environmental pollution (Yadav & Kamsonlian, 2023). As global populations grow and industrial activities expand, the demand for freshwater intensifies, and the generation of contaminated wastewater has escalated. Effective treatment processes are essential for removing pollutants, protecting ecosystems, and enabling the safe reuse of water for agricultural, industrial, and municipal applications (Gupta et al., 2012). Among the various methods employed, chemical processes, such as adsorption, membrane filtration, and chemical oxidation, have emerged as prominent solutions because of their efficacy in targeting diverse contaminants, including heavy metals, organic compounds, and emerging micropollutants. (Almukhtar et al., 2018; Saravanan et al., 2021)

Adsorption, in particular, has gained widespread recognition for its versatility, cost-effectiveness, and ability to be integrated with other treatment technologies (Liu, 2023). This process leverages the surface properties of adsorbents to capture and remove pollutants, offering a sustainable alternative to conventional methods (Tony, 2021b). However, the efficiency of adsorption and other treatment techniques is influenced by complex factors such as the operating conditions, contaminant properties, and material regeneration. To optimize these processes, advanced tools, such as Artificial Neural Networks (ANNs), have been increasingly adopted (Nguyen et al., 2020). ANNs provide predictive modeling, real-time monitoring, and operational optimization, thereby enhancing the performance and scalability of wastewater treatment systems. (Yetilmezsoy & Demirel, 2008 ; Sadek et al., 2023)

This work explores the principles, applications, and challenges of wastewater treatment and recycling, with a focus on chemical methods and the role of ANNs in improving process efficiency. Case studies from industrial and municipal contexts highlight practical implementations and the potential for reuse of treated wastewater. By addressing technological limitations and emphasizing innovative solutions, this study contributes to the advancement of sustainable water management practices.

34 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/wastewater-treatment-and-recycling-using-adsorption-enhanced-by-artificial-neural-networks/392470

Related Content

Cooperation Protocol Design Method for Repository-Based Multi-Agent Applications

Wenpeng Wei, Hideyuki Takahashi, Takahiro Uchiyaand Tetsuo Kinoshita (2013). *International Journal of Software Science and Computational Intelligence* (pp. 1-14). www.irma-international.org/article/cooperation-protocol-design-method-for-repository-based-multi-agent-applications/101315

Designing a Car-Driver's Cognitive Process Model for considering Degree of Distraction

Taku Harada, Kazuaki Mori, Akira Yoshizawaand Hirotooshi Iwasaki (2015). *International Journal of Software Science and Computational Intelligence* (pp. 1-16). www.irma-international.org/article/designing-a-car-drivers-cognitive-process-model-for-considering-degree-of-distraction/155156

A New Approach for Suggesting Takeover Targets Based on Computational Intelligence and Information Retrieval Methods: A Case Study from the Indian Software Industry

Satyakama Paul, Andreas Janecek, Fernando Buarque de Lima Netoand Tshilidzi Marwala (2014). *Mathematics of Uncertainty Modeling in the Analysis of Engineering and Science Problems* (pp. 290-308). www.irma-international.org/chapter/a-new-approach-for-suggesting-takeover-targets-based-on-computational-intelligence-and-information-retrieval-methods/94517

Connectionist Systems and Signal Processing Techniques Applied to the Parameterization of Stellar Spectra

Diego Ordóñez, Carlos Dafonte, Bernardino Arcayand Minia Manteiga (2010). *Soft Computing Methods for Practical Environment Solutions: Techniques and Studies* (pp. 187-203). www.irma-international.org/chapter/connectionist-systems-signal-processing-techniques/43152

Nature Inspired Feature Selector for Effective Data Classification in Big Data Frameworks

Appavu Alias Balamurugan Subramanian (2019). *Nature-Inspired Algorithms for Big Data Frameworks* (pp. 75-92).

www.irma-international.org/chapter/nature-inspired-feature-selector-for-effective-data-classification-in-big-data-frameworks/213031