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Editorial

Wastewater Treatment: Current and Future Techniques

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Citation: Mojiri, A.; Bashir, M.J.K. Wastewater Treatment: Current and Future Techniques. *Water* **2022**, *14*, 448. https://doi.org/10.3390/w14030448

Received: 27 January 2022
Accepted: 31 January 2022
Published: 1 February 2022

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1. Introduction

With the rapid growth in urbanization and industrialization, environmental contamination has worsened due to the incessant discharge of toxic substances into water bodies, which has become a worldwide problem [1]. Furthermore, the demand for water in domestic and industrial activities has significantly increased, which has accordingly increased the amount of wastewater that is released into sewage systems. Thus, the reuse and treatment of wastewater have become important concepts in the attempt to increase water availability [2]. The wastewater industry is in a state of transition [3] due to the recent wastewater effluent standards and emerging contaminants such as pharmaceutical and personal care products, and dyes in water bodies [4]. At present, several physicochemical methods (e.g., advanced oxidation process, adsorption, and membrane technologies), biological methods (e.g., activated sludge process, phytoremediation, bioremediation, and anammox), and hybrid methods have been developed to treat polluted water [1]. However, a treatment method with maximum efficiency in the removal of all kinds of contaminants is still far being realized. Moreover, the United Nations' sustainable development goal (https://www.un.org/sustainabledevelopment/water-and-sanitation/ (accessed on 25 January 2022)) emphasizes access to water and sanitation for all. All these issues led to the proposal of a Special Issue (SI) entitled, "Wastewater Treatment: Current and Future Techniques". This SI discusses state-of-the-art wastewater and water treatment technologies that could be used to develop a sustainable treatment method in the future. On this topic, studies have focused on measurements, modeling, and experiments under laboratory and field conditions.

2. Summary of the SI

Original research and review papers (12 papers in total) on advanced technologies applied to the treatment of industrial wastewater, domestic wastewater, and sludge were published after the peer-review process. The studies presented in this SI include the following themes.

One of the current main concerns is the emerging contaminants in water bodies. For instance, widespread water contamination with perfluoroalkyl and polyfluoroalkyl substances (PFASs) has become a great concern [5]. In this SI, Abunada et al. [5] monitored the concentrations of PFASs worldwide. Moreover, previous studies [6,7] have reported that conventional wastewater treatments have failed to remove emerging contaminants from water bodies. Therefore, researchers have tried to propose new systems with maximum performance in removing emerging pollutants. In a study published in this SI, 89.73% of the amount of polycyclic aromatic hydrocarbons was removed from water at optimal conditions using the ferrate (VI) oxidation process [8]. In another study, UV light and oxidizing disinfectants removed from 0% to 99.9% of the amounts of cetirizine, furosemide, diclofenac, losartan, venlafaxine, benzotriazole, and lamotrigine [9]. In addition, Alazaiza et al. [10]

discussed the performance of several natural coagulants in eliminating pharmaceuticals and personal care products from water bodies. The use of these natural coagulants has been described as an efficient method of removing emerging micropollutants.

Furthermore, in recent years, water contamination with dyes, which are harmful organic pollutants, has become a serious issue. Consequently, the elimination of these contaminants from water is a global demand to ensure human and environmental safety. In one study, more than 80% of anionic dye reactive black 5 (RB5) was removed with hybrid hexadecylamine-impregnated chitosan powder-activated carbon beads [11]. In this study, adsorption data were fitted to the Freundlich and pseudo-second-order models.

Another toxic compound found in water bodies is ammonia, and ammonia contamination in wastewater and water bodies has become a major environmental problem [12]. Several techniques have been established for the treatment of nitrogen. Among these techniques, anaerobic ammonium oxidation (anammox) has received researchers' attention for nitrogen removal purposes. Anammox is a microbial procedure in which ammonia is oxidized to nitrogen gas, with nitrite as the electron acceptor [13]. Hosokawa et al. [13] studied the cometabolism of *Patescibacteria* with anammox in an anammox reactor. On the basis of their study, *Patescibacteria* might play an ecological role in supplying lactate and formate to other coexisting bacteria, supporting growth in the anammox reactor.

The discharge of heavy metals into the environment has significantly increased. The main source of heavy metal ions is the industrial effluents of various processing industries [14]. The toxicity of heavy metals has already been proven to be a major threat to humans and the environment [15]. Almost 75% of hexavalent chromium (Cr VI) was removed using rice husk. In the study by Bhattacharjee et al. [15], the adsorption data were more fitted to the Dubinin–Radushkevich and Langmuir models.

Wastewater and landfill leachate contain different organic and inorganic contaminants. Among the several techniques for removing a wide range of pollutants, membrane filtration could provide a suitable purification process [16]. By using a new polyvinylidene fluoride membrane synthesized by integrating powdered activated carbon, 35.3% of chemical oxygen demand, 48.7% of color, and 22% of ammonia were removed from landfill leachate [16]. In addition, different types of membrane techniques were discussed in terms of their performance in the treatment of poultry slaughterhouse wastewater [17]. Moreover, several treatment methods, such as membrane and biological methods, were discussed and compared by Gutu et al. in terms of their performance in the removal of organics and nutrients [18].

Finally, green and sustainable wastewater technologies (GSWTs) have recently attracted researchers' attention. GSWT represents a term that denotes sustainable and environmentally friendly approaches to wastewater treatment [19]. Nanoremediation and microalgae-based systems can be considered important GSWTs. Alazaiza et al. [20] mentioned the advantages of using nanoremediation technologies for remediation. In another study, microalgae harvesting with biopolymers was described by Ang et al. [21] as a sustainable algae-based system.

Author Contributions: Writing—original draft preparation, A.M.; writing—review and editing, M.J.K.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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