energies

MDPI

Editorial

Advances in Wastewater Treatment, 2024

Marin Ugrina [1,*] and Jelena Milojković [2]

[1] Department of Environmental Engineering, Faculty of Chemistry and Technology, University of Split, Ruđera Boškovića 35, 21000 Split, Croatia
[2] Institute for Technology of Nuclear and Other Mineral Raw Materials, 86 Franchet d'Esperey St., 11000 Belgrade, Serbia; j.milojkovic@itnms.ac.rs
* Correspondence: mugrin@ktf-split.hr; Tel.: +385-21-329-451

Water is undoubtedly the most important and invaluable natural resource that humans utilize. The main source of water for human consumption and various industrial uses on a global scale is groundwater. Different types of organic and inorganic contaminants from natural and, more often, anthropogenic sources, leach into all water systems, especially groundwater. A lack of water for human consumption is also a result of inadequate wastewater treatment, rising freshwater usage, and climate change. Therefore, it is necessary to adequately and conscientiously manage wastewater to ensure safe drinking water and sanitation for all, which is in line with Sustainable Development Goal 6 on water and sanitation (SDG 6) [1].

The systematic treatment of wastewater is carried out through three successive stages: primary (physical–chemical), secondary (biological), and tertiary (advanced physical–chemical) treatment. The primary goal of any wastewater treatment plant is to meet the legal regulations for the discharge of treated wastewater into water bodies. Currently, it is very challenging to achieve the required quality of purified wastewater, especially due to the appearance of emerging environmental pollutants. For this reason, advanced knowledge is necessary and desirable in developing new advanced technologies or improving existing technologies at all levels of wastewater treatment. However, even in the 21st century, almost all existing treatment methods for managing wastewater occur linearly (water is used, treated, and then discharged). This approach has several disadvantages that might affect sustainability and the environment. Some of the deficiencies include a loss of nutrients, pollutant discharge, non-renewable energy use, unsustainable use of finite water resources, waste generation, valuable resources not being fully recovered, limited climate resilience, high operational costs, public health concerns, difficulties in meeting increasingly stringent environmental regulations and standards, etc. Hence, the goal of any sustainable management, including wastewater management, should be circular sustainability. In this context, wastewater should not be viewed exclusively as a waste stream, but as a valuable resource since it contains a significant amount of stored chemical and heat energy, as well as nutrients [2]. Therefore, it is substantial to manage wastewater holistically, i.e., wastewater treatment, obtaining energy and resources at the same time. The reuse of purified wastewater with energy recovery is imperative for sustainable development, which is in agreement with two of the seventeen Sustainable Development Goals: SDG 6 (clean water and sanitation) and SDG 7 (affordable and clean energy) [1]. Thus, purified wastewater can be used for agricultural purposes, industry, etc., as well as for the supply of hydroelectric power plants to obtain electricity [3]. Recent findings indicate that chemical energy contained in wastewater is destroyed by aerobic biological oxidation [4]. Accordingly, the chemical energy contained in wastewater can be recovered in the form of biogas by anaerobic digestion; hydrogen can be obtained by electrohydrolysis, as can nitrogen and phosphorus. The heat contained in wastewater can be recovered using heat pumps and heat exchangers; alternatively, it can be obtained through sludge incineration [2–4]. The mentioned benefits as a result of wastewater treatment point to the water–energy nexus.

Citation: Ugrina, M.; Milojković, J. Advances in Wastewater Treatment, 2024. *Energies* **2024**, *17*, 1400. https://doi.org/10.3390/en17061400

Received: 24 February 2024
Accepted: 5 March 2024
Published: 14 March 2024

Therefore, the future perspective of wastewater treatment plants is ecological sustainability, i.e., the adaptation and redesign of existing plants and the design of new integrated plants for the simultaneous treatment and recovery of energy and resources.

Finally, it should be pointed out that water is the most essential resource contained in wastewater because it cannot be obtained from alternative sources, unlike energy. Ultimately, the production of cleaner water and energy through wastewater recycling is an important pathway to achieving the circular economy and sustainable development. Therefore, in dealing with environmental, economic, and social concerns, it demonstrates a comprehensive and responsible approach to water resource management.

"Advances in Wastewater Treatment, 2023" describes the progress, innovations, and improvements in the technology and processes utilized in wastewater treatment. All knowledge about the inter-relationship and synergy between wastewater and energy is welcome in this Special Issue, exploring the development of solutions for exploiting the hidden potential of wastewater.

Funding: This study received no external funding.

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

References

1. United Nations. *The UN Sustainable Development Goals*; United Nations: New York, NY, USA, 2015; Available online: http://www.un.org/sustainabledevelopment/summit/ (accessed on 18 January 2024).
2. Kehrein, P.; van Loosdrecht, M.C.; Osseweijer, P.; Garfi, M.; Dewulf, J.; Posada, J. A critical review of resource recovery from municipal wastewater treatment plants—Market supply potentials, technologies and bottlenecks. *Environ. Sci. Water Res. Technol.* **2020**, *6*, 877. [CrossRef]
3. Zarei, M. Wastewater resources management for energy recovery from circular economy perspective. *Water-Energy Nexus* **2020**, *3*, 170–185. [CrossRef]
4. Hao, X.; Li, J.; van Loosdrecht, M.C.M.; Jiang, H.; Liu, R. Energy recovery from wastewater: Heat over organics. *Water Res.* **2019**, *161*, 74–77. [CrossRef] [PubMed]