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Nanotechnology advancements in emerging contaminants removal from wastewater

Higher living standards and the thriving pharmaceuticals industry, personal care products, micro and nano-plastics, and other human-made chemicals introduced a significant problem in the water system. Humanity struggles with the wastes generated from these activities. They find their way to natural water bodies causing water pollution. Conventional water treatment processes are inadequate to remove this waste. Therefore, they are called emerging or persistent contaminants. Additionally, unconventional wastewater sources are a cause of concern, such as the water produced from oil and gas fields, also known as produced water. Nanotechnology involves the manipulation of atoms and molecules of matter, which has contributed to significant advances across several different fields, including the treatment of wastewater. Several advanced studies have demonstrated the potential for nanotechnology, either directly or indirectly, or in combination with other technologies for persistent contaminants treatment.

Many nanotechnology-based water treatment processes have been developed to target persistent and emerging pollutants, ensuring complete removal with no secondary by-products. These processes include nano-adsorption, photocatalysis, and functionalized membranes. They target organic, inorganic, and biological contaminants offering high efficiency, modularity, low energy requirement, and low-cost solutions to wastewater treatment. Advanced wastewater treatment processes utilize nanomaterials due to their unique features. Nanotechnology introduces new properties, characteristics, and specialized functions highly desirable for wastewater treatment. It offers the modularity to synthesize different nanomaterials forms to treat different contaminant types. Highly functional nanomaterials provide innovative treatment processes capable of handling unconventional wastewater sources for water reuse.

Recently, nanomaterials synthesis has become increasingly environmentally friendly and more cost-effective. Nanomaterials possess desired properties for large-scale development and demonstrate high wastewater treatment potential. Organic, inorganic, and polymer-based nanomaterials are the main nanomaterials used in water remediation. The non-poisonous nature, small size, and high surface area of nanomaterials make them ideal for wastewater treatment. Nanotechnology has sought to overcome the drawback of conventional membranes by designing and fabricating hybrid or functionalized membranes. The recent development of advanced electrospun nanofiber polymeric membranes (ENMs) and nano-functionalized membranes has provided a new opportunity to improve membrane performance for non-conventional wastewater treatment dramatically.

The ENMs outclass other membrane types because of their large surface area, high porosity, and productivity. Due to the complexity of large-scale system design, translating nanotechnology-based water treatment strategies into industrial practice has been relatively slow. Moreover, in light of the maturity of basic science, it is long overdue, and it is critical to narrow the gap between research and industrial needs.

Recent Publications

1. Mohammed Al-Abri, et al (2021), Structural, Mössbauer, and Optical studies of mechano-synthesized Ru3+-doped LaFeO3 nanoparticles, RT Al-Mamari, HM Widatallah, ME Elzain, AM Gismelseed, AD Al-Rawas, et.al, Hyperfine Interactions 243 (1), 1-12
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3. Mohammed Al-Abri, et al(2022), Copper nanoparticles decorated N-doped mesoporous carbon with bimodal pores for selective gas

separation and energy storage applications, Ajay Karakoti, Ajayan Vinu, Mohammed Al-Abri, et.al, Chemical Engineering Journal 431, 134056

4. Mohammed Al-Abri, et al (2022) Degradation of Sulfamethoxazole by Double Cylindrical Dielectric Barrier Discharge System combined with Ti/CN-TiO2 supported Nanocatalyst, Mohammed Al-Abri, Andrei Sarbu, Mariana Braic, Viorel Braic, Sergey Dobretsov, Journal of Hazardous Materials Advances 5, 100051

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Biography

Mohammed Zahir Al-Abri is an Associate Professor in Petroleum & Chemical Engineering, Department, College of Engineering at Sultan Qaboos University (SQU), Oman. In addition to his academic position, he is the Founder and Director of the Nanotechnology Research Center, SQU. He completed all his tertiary education at the University of Nottingham (UK) from 2003-to 2007. His major interest lies in cutting-edge research in water treatment, membrane technology, and environmental engineering including applications of nanotechnology in the water and petroleum industries. He has done more than 30 major research projects in different areas of water treatment and desalination, nanotechnology for environmental and renewable energy applications, and membrane technology. He has done more than 70 international journal papers, 27 international conferences, 25 technical reports, and three book chapters. He is a member of a number of international editorial boards including being a Topic Editor in “Membranes: MDPI Journal. He organized and co-organized several international conferences in nanotechnology and water treatment.

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