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Water and Wastewater Engineering: Advancements, Challenges, and Future Needs

Dr. Mehrab Mehrvar
Professor and Associate Chair, Graduate Studies, Department of Chemical Engineering,
Toronto Metropolitan University,
Toronto, Ontario, Canada M5B 2K3
mmehrvar@torontomu.ca

The decline of freshwater availability and resources has redirected the objectives in water and wastewater treatment from disposal to minimization, reuse, and recovery. On the other hand, the increasing trend of toxic, recalcitrant, and inhibitory compounds in industrial and municipal wastewaters has had adverse effects on the quality of the environment. Moreover, the progressively stricter standards for effluent discharge worldwide have made the developing of advanced water and wastewater treatment technologies necessary. As a result, a high level of treatment must be achieved by developing novel technologies to accomplish higher degradation rates with cost-effective performance. Therefore, advanced water and wastewater treatment has become crucial for the continuing development of societies.

Although biological processes are known as the most cost-effective treatment methods, several industrial effluents, such as those from petrochemical, winery, pharmaceutical, slaughterhouse, textile, and soluble polymeric wastewaters, contain considerable non-biodegradable, recalcitrant, and refractory organic compounds. The degradation of these non-biodegradable compounds by conventional treatment processes is a big challenge; therefore, standard regulations cannot be reached. Hence, advanced oxidation processes (AOPs) are used efficiently to degrade resistant materials and mineralize stable, inhibitory, and toxic contaminants. Even though AOPs are highly effective in treating organic compounds, some drawbacks prevent their commercial applications. A high requirement of oxidant/catalyst dosage, high electrical power consumption, and nutrients removal are common disadvantages of AOPs. Thus, these processes are recommended as complementary treatment options, either as pre-treatment or post-treatment, to biological processes. Advanced wastewater treatment is focused on the reduction in operation and maintenance costs, making the combined processes more attractive than conventional methods. The optimized integration of AOPs and biological processes contributes to a cleaner production and greener environment, providing high-quality treated effluents and allowing water recycle in industrial applications with overall pollutant removal efficiencies over 90%. This presentation will review the advancements, challenges, and future needs and directions in water and wastewater treatment. In addition, some recent results will be discussed.