RECENT ADVANCES IN NANOTECHNOLOGY-BASED WATER PURIFICATION METHODS

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ABSTRACT

Water and wastewater treatment is undoubtedly the most important topic in the field of environmental technologies. Membrane-based processes are the most widely applied technologies for drinking and ultrapure water production, desalination, wastewater treatment and water reuse. Intrinsic advantages of membrane-based processes include continuous, chemical-free operation, low-energy consumption, easy scale-up and hybridization with other processes, high process intensity (i.e., small land area per unit volume of water processed), and highly automated process control. However, the main disadvantages of the conventional membrane-based processes are related to short membrane lifetime, limited selectivity, concentration polarization, and membrane fouling. In particular, polarization and fouling of membranes require extensive physical and chemical pretreatment of feed water (e.g., chlorination, in-line coagulation, flocculent aid addition, membrane filtration), recovery operation, extensive chemical cleaning, and frequent operator intervention. Recent advances in nanotechnology-based water purification methods (e.g., functional nanostructured materials, nanosorbents, nanocatalysts, bioactive nanoparticles, etc.) can largely contribute to the improvement of conventional membrane-based water and wastewater treatment.

The nanostructured membranes most frequently applied in water and wastewater treatment processes include zeolite-coated ceramic membranes, self-assembled block copolymer membranes, inorganic/organic thin film nanocomposite (TFN) membranes, hybrid protein/polymer biomimetic membranes, aligned carbon nanotube (CNT) and graphene-based membranes. The aforementioned membranes exhibit improved separation performance, chemical, thermal and mechanical stability, interfacial properties and advanced functionality depending on the selected nanostructured material. Current issues related to nanotechnology-based methods for water and wastewater treatment, including nanostructured membranes and nanocatalysts, molecularly imprinted materials, nanosorbents, biomimetic membranes and membrane bioreactors (MBR), among others, are critically reviewed [1,2].

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