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Editorial: Advances in removal of toxic substances from wastewater

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Editorial on the Research Topic
Advances in removal of toxic substances from wastewater

Industrialization has caused significant environmental harm through pollution by various toxic substances, both inorganic and organic. Heavy metals and toxic and recalcitrant compounds are some of the pollutants that have attracted the interest of wastewater engineers and researchers. These pollutants are found in a variety of industrial effluents, such as dyestuff, petrochemical, petroleum refining, steel, tanning, coal gasification, polymeric resin production, paint, and battery, as well as pesticides and fungicides production. If not adequately treated, the effluents can easily contaminate surface and groundwater sources and eventually impact human health. Many of these compounds are reported to have mutagenic and carcinogenic properties that affect different organs of the body. Being recalcitrant, they largely escape removal in conventional wastewater treatment plants and can remain in the aquatic environment for long periods of time.

This Research Topic aims to discuss the environmental impacts of these compounds and address the application of treatment technologies for the removal of toxic substances from wastewater. Adsorption, chemical precipitation, ion exchange, liquid-liquid extraction, filtration, and flotation are some of the heavy metal removal technologies that have been developed. Activated carbons and biochars have been frequently used and novel low-cost adsorbents are being sought. Advanced materials such as graphene and MXenes have shown promise in the removal of heavy metals and are still actively investigated. Advanced oxidation processes (AOPs), catalytic and photocatalytic oxidation, and electrochemical oxidation are particularly suitable for the treatment of wastewater with organic contaminants because their removal is *via* actual degradation rather than mere separation from the wastewater stream. Other modern wastewater treatment techniques include membrane processes, magnetic nanocomposite materials, nano zero-valent iron (nZVI), ultrasound, and a combination of various methods. This is notably a vast field and several volumes are needed to provide adequate coverage of all existing topics. This Research Topic covers some of them.

Population growth and industrialization have led to increased utilization of resources and environmental pollution by organic and inorganic contaminants. Water pollution by metal(loids) is generally caused by the discharge of effluents from various industries. The review article by Kumar et al. covered the environmental and human health impacts of metal(loids), namely, Cu, Cr, Cd, Zn, Ni, Pb, Hg, Sb, Sn, and As. The paper discussed the

environmental problems caused by hazardous metal(loids), their sources, and the associated health and environmental concerns. It highlighted the significance of developing low-cost and environmentally friendly methods of wastewater treatment for these metal(loids). Treatment applications such as ion exchange, membrane filtration, photocatalysis, bioremediation, phytoremediation, biosorbents, and nanomaterials were also reviewed.

Dye wastewater is produced worldwide by various industries, such as textile, printing, leather, and cosmetics. This colored wastewater can find its way to water bodies and adversely impact the flora and fauna in terrestrial and aquatic ecosystems. Some dyes are carcinogenic and can impact human health. Thus, dye wastewater must be adequately treated before discharge into the environment. Adsorption is an effective method for the removal of dye from wastewater but is associated with the high cost of activated carbon (AC). A review of the recent methods in the production of activated carbon from date palm residues (DPR) for textile dye adsorption was presented by Alharbi et al. They discussed different physical and physiochemical methods including the conventional heating method, microwave heating method, and hydrothermal carbonization method. The paper discusses the technological advances in the production of DPR-based adsorbents and their performance in the adsorption of textile dyes. Characteristics of DPR, adsorption isotherms, and kinetic models were reviewed in this study.

Nitrocellulose is widely distributed in nature. It is rich in hydroxyl groups. When exposed to light, nitrocellulose membrane (NCM) can produce hydroxyl radicals, which lead to the degradation of organic pollutants by oxidation. Wu et al. studied the influence of factors, viz., light intensity, solution pH, temperature, membrane area, initial dye concentration, anions, and cations on the photodegradation of acid orange 8 by NCM. The acid orange 8 degradation rate constant in the NCM system was found to be 1.94×10^{-3} min^{-1}, which was 27.3 times that in pure water. For acid orange 8, the photodegradation rate increased with a decrease in dye concentration in the studied range of 20–120 μmol/L and increased with an increase in the NCM area. The technology showed potential for industrial application in the future.

Phenol and phenolic compounds are typically regarded as toxic and recalcitrant. A combination of phenol and chlorine produces chlorophenols that are more stable and resistant than phenol. The toxicity and biodegradability of chlorophenols depend on the chemical structure of the compound; a higher number of substituted chlorines in the aromatic ring implies higher toxicity and lower biodegradability. A widely used chlorophenol, 2-4-6 Trichlorophenol (TCP) finds its application in industries such as wood, pharmaceutical, military, petrochemical, textile, bleach, pesticides, herbicides, fungicides, insecticides, and disinfection. Microorganisms can acclimatize to different levels of toxic compounds. The study by Ghochlavi and Aghapour investigated the effect of operating factors and showed the conditions under which TCP can be degraded biologically. The researchers employed a sequential anaerobic-aerobic treatment system that uses a sequential batch reactor followed by a rotating biological bed reactor (SBR-RBB).

This Research Topic provides readers with a comprehensive understanding of the fundamentals, mechanisms, kinetics, and application of different wastewater treatment techniques for the removal of toxic substances from aqueous mediums. The manuscripts included here provide both theoretical and practical coverage of the topic and will serve as reference material for researchers and industry personnel working in the field.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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