STUDY OF NANOMATERIALS AND NANOCOMPOSITES FOR THE REMOVAL OF HEAVY METALS AND DYES IN WASTEWATER TREATMENT

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ABSTRACT

Water contamination with toxic metal ions and organic dyes represent a serious worldwide problem in the 21st century. A wide range of conventional approaches have been used to remove these contaminants from wastewater. Recently, nanotechnology has been given great scope for the fabrication of desirable nanomaterials with large surface-to-volume ratios and unique surface functionalities to treat these pollutants. Amongst these, oxide-based nanomaterials are promising new materials for Wastewater treatment. We study a broad-spectrum overview of recent developments in the area of oxide-based nanomaterials, such as Fe_3O_4, ZnO and TiO_2, as well as their binary and ternary nanocomposites, for the removal of various toxic metal ions and organic dyes.

Keywords : Nanomaterials , Metal Oxides, Nanocomposite , Wastewater, Toxic Metal Ions

Introduction

Today's world faces alarming challenges in the rising demand for clean drinking water, and conditions are particularly bad in developing countries. The scarcity of water in terms of both quantity and quality has become a significant threat to the well-being of humanity. In particular, the quality of drinking water has become a serious concern, with the rapid escalation of industrialization towards a developed society. The waste products generated from the textiles, chemicals, mining and metallurgical industries are mainly responsible for contaminating the water. This contaminated water contains non-biodegradable effluents, such as heavy metal ions (arsenic, zinc, copper, nickel, mercury, cadmium, lead and chromium, etc.) and organic materials that are carcinogenic to human beings and harmful to the environment. Water contaminated with arsenic (As) causes cancer of the skin, the lungs, the urinary bladder and the kidney, as well as other skin problems such as pigmentation changes and thickening (hyperkeratosis). Another toxic metal pollutant is lead which, if present with a concentration of >70 µg/dL in blood levels (WHO), can damage various bodily systems, including the nervous and reproductive systems and the kidneys, and it can also cause high blood pressure and anaemia. Large amounts of lead (>100 µg/dL) in the body can lead to convulsions, coma and death . However, the presence of nickel at higher levels in the human body can cause serious lung and kidney problems as well as gastrointestinal distress, pulmonary fibrosis and skin dermatitis. A further neurotoxin is mercury, which can cause damage to the central nervous system, and its concentration within the range of 0.12–4.83 mgL−1 may cause the impairment of pulmonary and kidney function, chest pain and dyspnoea. High levels of cadmium exposure (1 mgm−3) may result in several complications leading to death . In addition to heavy metal contaminants, other hazardous contaminants found in the environment are organic dyes, discharged from textile manufacture and other industrial processes into the water. The dyes presently used in industries include methylene blue (MB), Rhodamine B (RhB), methyl orange (MO), Rhodamine 6G (Rh6G) as well as organic chemicals (phenol and toluene), and the release of these into lakes or other water sources has become a serious health concern. Various treatment techniques and processes have been developed for the removal of toxic contaminants from wastewater, such as adsorption, ion exchange, chemical precipitation, membrane-based filtration, photodegradation, evaporation, solvent extraction, reverse osmosis, and so on . Among these, adsorption and photodegradation are conventional but efficient techniques for removing toxic contaminants from water. For