Chapter 1
Advanced Water Treatment Systems and Their Applications

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ABSTRACT

The chapter gives an idea about water as a life-sustaining medium and the sources of its pollution along with the deteriorating effects of over burdening of natural resources and the effect of various heavy metal ions discharged into the water bodies on human health and wellbeing. Several human diseases and disorders that are caused due to intake of water polluted by toxic heavy metal ions are also listed. The need and urgency in determination and removal of heavy metal ions from the water sources in order to release load on aquifers by making water safe for reuse is emphasized. The procedure and advantages of composite cation-exchangers along with the work carried out in the field to develop various lead, cadmium, chromium, and mercury selective cation-exchangers are also included. The utility of organic-inorganic composite material for the detection of heavy metals, which render portable water unsafe for use and pose a threat to the wellbeing of man, is also discussed.

1. INTRODUCTION

The rapid, unplanned and ambitious industrial development has lead to environmental problems throughout the world. The natural sources are being exploited in the name of the industrial growth and development. The natural resources are currently being over-burdened, so the ecological balance is disturbed, which threatens the very survival of life on the planet (Deblonde, Leguille, & Hartemann, 2011). The industrial processes (mining, extraction, processing) and domestic discharges pollute air, water and soil. The environmentalists are facing a serious task to provide safe, clean and favorable environment for life. Pollution is defined as any adverse changes in the physical, chemical or biological properties of air, land and water that may adversely affect human life or other desired species or industrial production processes, living conditions and cultural assets (Obasi, 1999). These pollutants are a threat not only to humans but other life forms also. Pollutants can be solid, liquid or gaseous substances and may have chemical or energy form. Pollutants are even natural, but in this context these don't lead to serious environmental problems.

A collective problem now-a-days is the water pollution, more importantly, means and measures that should be adapted to control and monitor this threat. The new trends in research should focus not only on the effective handling of pollution, but to prevent and minimize the production of toxic and hazardous substances in the first place.

2. WATER EMINENCE

It is not possible to even think about life in absence of water. About 70% of the earth's surface is covered with water. About 97% of the water is present in the ocean, 2% as ice and only 1% of the water as present in lakes and rivers maintains the life on the earth (Dessouky & Ettouney, 2002).

Water is essential for food, health, economy, energy (Moore, Gould, & Keary, 2003) and plays a leading role in photosynthesis and breathing, which are the processes of life. It is used as solvent in a number of metabolic processes for plants and animals. Water constitutes about 69% of the body weight, 70% of the brain and 80% of the blood by volume. The Royal Society of Chemistry has placed water at first place in the list of green solvents. Annual utilization of fresh water is about 3240 cubic kilometres, agriculture (69%), industry (23%), only 8% of the water is available for domestic use (Sethi, 2001).

3. POLLUTION OF WATER

Any toxic chemical (organic and inorganic), biological or radioactive substance that enters water and changes the physical, chemical and biological properties of water is known as water pollutant. The industrial revolution and uncontrolled use of natural water resources, population growth, urbanization and changing ways of life are a major cause of serious water pollution (Shannon et al., 2008). Water quality deterioration is mainly due to industrial wastes and human activities. Water quality deterioration affects aquatic ecosystems, groundwater and human life. Annually about 10-20 billion deaths are reported due to water borne diseases, (Leonard, 2003) alone diarrhoea causes about 6,000 children to die every day (Ashbolt, 2004). It is estimated that about 0.78 million people throughout the world have no access to safe drinking water (WHO, UNICEF, 2013).

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