

Functionalized Materials for Water Purification

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ABSTRACT

The new decade has witnessed severity in water-related problems around the globe. According to a report by UNICEF, nearly 1.2 billion people lacks access to clean drinking water, even in the modern era of science and technology. Amongst this, most of the population thrives in an area which have menace to groundwater pollutants. Some of the organic pollutants are biodegradable and hence can be removed by specific classes of bacteria, which consumes such pollutants and run its metabolic cycle. However, different class of inorganic pollutants form soluble complexes in water and continue their hazardous persistence. Some of these pollutants causes severe health implications upon consumption. Typical examples are fluoride, arsenic and heavy metals, such as, cadmium, copper, zinc and nickel. Different methodologies such as adsorption, coagulation, ion exchange and membrane separation have been involved in the treatment of infected water streams. Some of these processes requires costly and complex materials in addition to frequent regeneration. Thus, in order to devise a frugal and relatively simple method, naturally abundant materials such as laterite (rocky soil and a rich source of iron and aluminium, especially found in the “Rarh” region of Eastern India and Plateau of Southern and Western India) and bone meal (mixture of bones of different domestic animals used in the preparation of phosphate fertilizer) was chemically treated to uptake lead and fluoride from drinking water, respectively. Intensive characterizations, followed by batch and column run was performed using these adsorbents, followed by scale up studies. Finally, a gravity-based purification filter, comprising of different layers of adsorbents, was designed and installed in an actual fluoride affected area for pilot scale monitoring.

In a different research arena, functionalized membranes, named as mixed matrix membranes, were prepared by impregnating specific inorganic in a polymer solution. The polymer-inorganic solutions were later casted to form a flat sheet membrane or extruded through an indigenous spinneret for making hollow fibers. These membranes can exploit both filtration capability of a membrane and adsorptive property of the impregnated inorganic to remove contaminants and microorganism from polluted water stream. Natural materials and waste products, such as laterite and iron ore slime were treated and used as an inorganic dope in polyacrylonitrile and polysulfone based membrane, respectively and they showed significant results for arsenic removal. Similar results were obtained when activated alumina and treated carbonized bone meal were impregnated in cellulose acetate phthalate and polysulfone based membranes, respectively. Such membranes have high potential for scalability and treatment of real-life feed solution.

Keywords: Adsorption, Laterite, Bone meal, mixed matrix membrane, Iron ore slime, fluoride, arsenic, heavy metals, microorganisms

