



Review Article

Utilisation of polymer based nanocomposites in the removal of heavy metal ions using adsorption technology

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ABSTRACT

Water pollution due to heavy metal ions has become one of major critical issues in developing countries even in the world. Heavy metals are non-biodegradable, highly water soluble and some of them highly toxic to environment and living organisms at very low concentrations. The conventional methods used in the removal of heavy metal ions from water and waste water are chemical precipitation, electro-winning, pre concentrations, reverse osmosis, ultrafiltration and adsorption. Among these adsorption technique is highly efficient, low cost and applicable in the large scale operations of waste water treatments. Polymer based nanocomposites have attracted great attentions in the removal of heavy metal ions because of their advanced physical, chemical and mechanical characteristics. The optimised conditions like suitable contact time, pH, dosage, concentration and temperature can be used in the maximum removal of heavy metal ions from waste water.

Key words: Heavy metal ions, Waste water treatment, Adsorption, Polymer based nanocomposites

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INTRODUCTION

The waste water treatment has become a critical issue in the fields of environmental safety and now a day's fresh and saline water contaminated by the waste water streams of different industries. Water pollution due to heavy metals is one of the major challenging issues in modern human society. Heavy metals have high molecular weight, high atomic numbers and high toxicity to all organisms and environment[1-3]. The main toxic heavy metals ions are lead (Pb), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), zinc (Zn), mercury (Hg) and cobalt (Co). Many of them are beneficial in the living world but few are very toxic at very low concentrations[4]. They are exposed into natural environment through different anthropogenic activities such as industrialisations, urbanisations, agricultural activities and mining operations. They can be deposited

into human body through contaminated water and different food chains and definitely cause serious health hazards. Heavy metals are toxic, neurotoxic, carcinogenic and mutagenic [5-9]. Heavy metals are water soluble in nature and easily absorbed by tissues and organs of all living organisms and once they enter in food chain, a large amount of metals can be accumulated by human cells [9]. The common removal methods for heavy metals are chemical precipitation, ion exchange, reverse osmosis, electro-winning, pre-concentrations, adsorption and ion-exchange. Among these conventional methods, adsorption based removal of heavy metals is highly efficient, low cost and can apply in large scale operations of waste water treatment [10,11]. The highly used available adsorbents are [12,13], activated carbon [14,15], carbon nanotubes

[16,17], mesoporous silica [18], zeolite [19, 20], chitosan [21,22], red mud [18], biosorbents [23,24,25], metal oxide and polymer based adsorbents [26]. The polymer based adsorbents are also commonly used in waste water treatment techniques due to their highly specific properties [26].

POLYMER BASED NANOCOMPOSITES

Polymer nanocomposites are consisted of a polymer or co-polymer has nanoparticles or any types of nanoparticles are dispersed in the matrix of a polymer. The polymer based nanocomposites may be of different shape and sizes. Mainly fibrous, spheroidal and platelets polymer nanocomposites have been reported with particle sizes 10-500 nm. Such nanocomposites undergo a multiphase system require mixing, stabilisations and dispersions [27-30]. These are very active, sensitive and exhibited adhesion and adsorptive properties [31]. Polymer based nanocomposites are also characterised by variations in dimensions, energetic functionalities and film forming capabilities. These also have advance physical, chemical and mechanical properties and containing different binding groups for adsorption of heavy metal ions from water or waste water [27,28]. In future, the polymer based nanocomposites should be designed on the basis of following features [31]:

1. Low production cost and eco-friendly.
2. High adsorption capacity and efficiency at very low amount.
3. Highly recyclable.
4. Heavy metals should easily be removed from the surface of polymer based nanosorbent after the adsorption.

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5. Capable for large scale waste water treatments.

ADSORPTION OF HEAVY METAL IONS BASED ON POLYMER BASED NANOCOMPOSITES

The sorption study of heavy metals on the surface of polymer based nanosorbents in the laboratory scale is usually carried out under the batch system. The batch system includes contact time, pH, concentrations, dosage and temperatures. Take a requisite amount of sorbent and contaminated water with definite concentrations of heavy metal ions in a conical flask at constant shake, agitation time and pH [23-26]. After that, the sorbent is filtered out and the concentration of metal ions determined by a suitable spectroscopic methods like Atomic Absorption Spectroscopy. The optimized conditions have been found from the batch experiments. These can be applicable in the large scale removal processes of heavy metal ions from contaminated water. The metal recovery is possible from metal loaded sorbents. The overall process of adsorption is summarized below in figure.

CONCLUSIONS

The adsorption process using a suitable adsorbent is a good alternative over the other conventional methods used for waste water treatments in large scale operations. In this mini review, we have discussed some important characteristics of polymer based nanosorbents. They can make adsorption process more convenient due to their advance physical and chemical properties. They can be manufactured under very low cost and used for the large scale waste water treatment.

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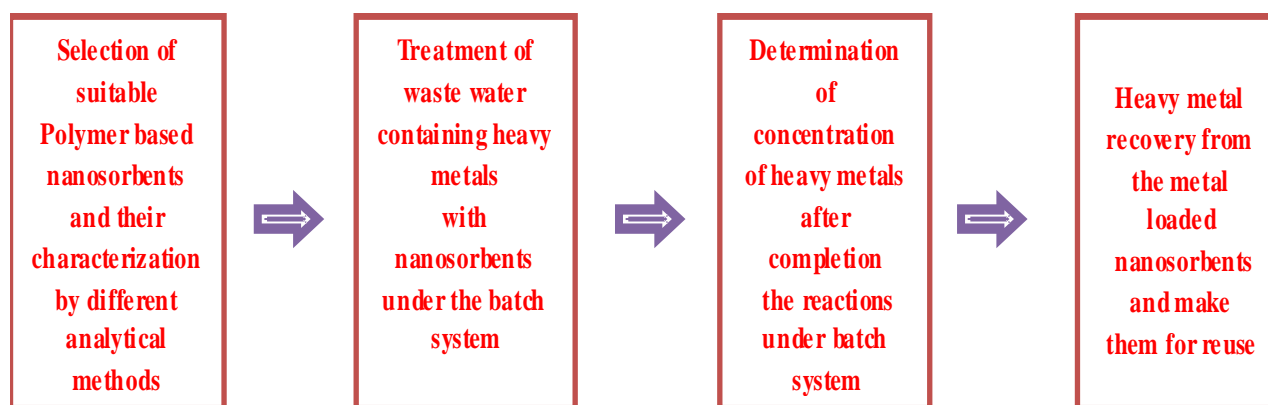


Fig. 1 Overall adsorption processes