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A review on Decontamination Techniques of Nickel(II) from Aqueous Environment

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ABSTRACT

Water Pollution is a major environmental issue in achieving sustainability. Removal of toxic inorganic and organic ions from wastewater is of utmost importance in water treatment. Heavy metal ions such as Nickel(II) can be removed from wastewater by various methods like
Adsorption, Electrocoagulation, Nanofiltration etc. This paper reviews removal techniques of Nickel(II) ions from wastewater.

Key words: Wastewater, Nickel(II) , Adsorption, Electrocoagulation, Nanofiltration

INTRODUCTION

Present era is facing problems of pollution, global warming, ozone layer depletion, acid rain, depletion of natural resources, unsustainability. Pollution is of many types like water, air, soil, noise, radiation, etc. Water pollution is due to release of toxic organic and inorganic pollutants into the water. Inorganic pollutants include heavy metals.

Heavy metals have atomic weights ranging from 63 to 200 g/mol. Sources of heavy metals include natural sources, such as geological weathering, and anthropogenic activities, such as those produced by various industries [1,2]. Many industries are considered sources of heavy metals, such as metal plating industries, mining processes, tanneries, and paper factories. Wastewater from these industrial practices contains toxic heavy metals, such as nickel (Ni), chromium (Cr), mercury (Hg), cadmium (Cd), arsenic (As), and lead (Pb)[3,4]. The acceptable limit of Ni in drinking water is 0.01 mg/L and the industrial discharge limit in wastewater is 2 mg/L [5]. The higher concentration of Ni causes poisoning effects like headache, dizziness, nausea, tightness of the chest, dry cough, vomiting, chest pain, shortness of breath, rapid respiration, cyanosis and extreme weakness [6]. Therefore, complete Nickel removal from water and wastewater is essential. In order to remove undesired heavy metals, many methods such as chemical separation, membrane processes, electrochemical treatment, electro-deposition and adsorption have been used[7]. This work critically assessed existing knowledge and research on the uptake of nickel by Adsorption, Electorcoagulation and Nanofiltration.

LITERATURE REVIEW

ADSORPTION

Adsorption is a process in which specific adsorptives are transferred from the fluid phase to the surface of suspended particles. Adsorption has advantages over other technologies due to its simple design, sludge-free environment, and potential for inexpensive initial investment [8]. Activated carbon is the most widely used adsorbent due to its effectiveness and versatility[9], but it is relatively expensive[10]. Hence focus was shifted to agricultural wastes as adsorbents.

PEANUT HULL

Periasamy and Namasivayam prepared activated carbon from peanut hulls an agricultural waste by-product, for the adsorption of Ni(II) from aqueous solution. Quantitative removal of Ni(II) from 100 mL aqueous solution containing 20 mg/L Ni(II) by 85 mg Peanut Hull Carbon was observed over a pH range of 4.0 to 10.0. A comparative study with a commercial granular activated carbon showed that Peanut hull carbon was 36 times more efficient compared to granular activated carbon based on Langmuir adsorption capacity (Q_O)[11]

CALOTROPIS PROCERA

Piyush kant pandey et al investigated the removal of Ni(II) by the fresh biomass and chemically treated leached biomass of Calotropis procera. The Calotropis biomass was successful in removing Ni(II) with 85% sorption efficiency from aqueous solution containing 250 mg/L Ni(II). Chemically treated biomass showed better Ni(II) removal capabilities compared to fresh biomass. It was found that the maximum Ni(II) uptake capacity was 15.75 mg/g for batch adsorption and 20.75 mg/g in column adsorption mode from the 250 mg/L of Ni(II) solution.[12]

PACHIRA AQUATICA AUBL.

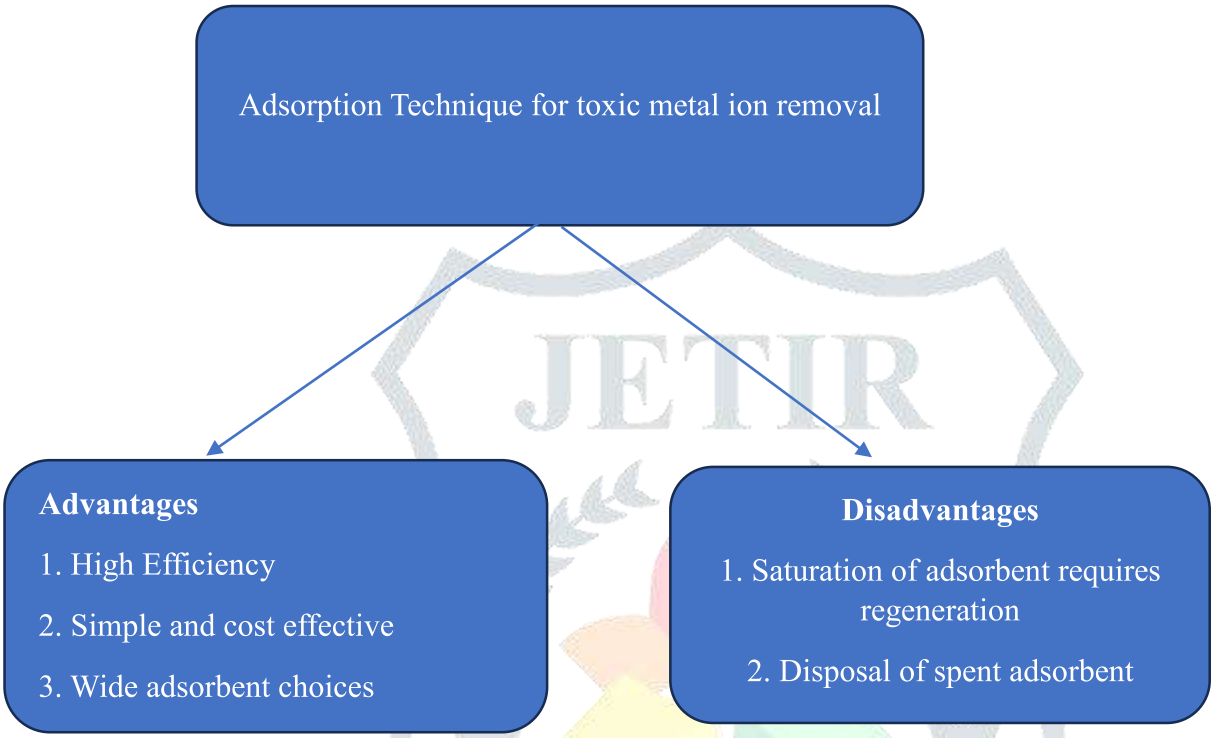
Nascimento et al assessed the value of Pachira aquatica Aubl. fruit peels by exploring their applicability in the biosorption process for the removal of Ni(II) and Cd(II) metal ions.. Biosorption equilibrium time was achieved at 300 min for both ions. The column removal was 98% and 99% for Ni(II) and Cd(II), respectively [13]

WALNUT SHELL

Tulun et al determined the removal of Ni (II) ions from aqueous solutions containing 100 mg L^{-1} of nickel using walnut shell. The effects of various parameters such as optimum adsorbent mass, contact time, pH of the medium were investigated. The maximum removal efficiency of 43.23% was obtained at a pH of 5.85 with a 5-min contact time for a 5 mg L^{-1} solid-to-liquid ratio and an initial heavy metal concentration of 100 mg L^{-1}[14]

RICE HUSK

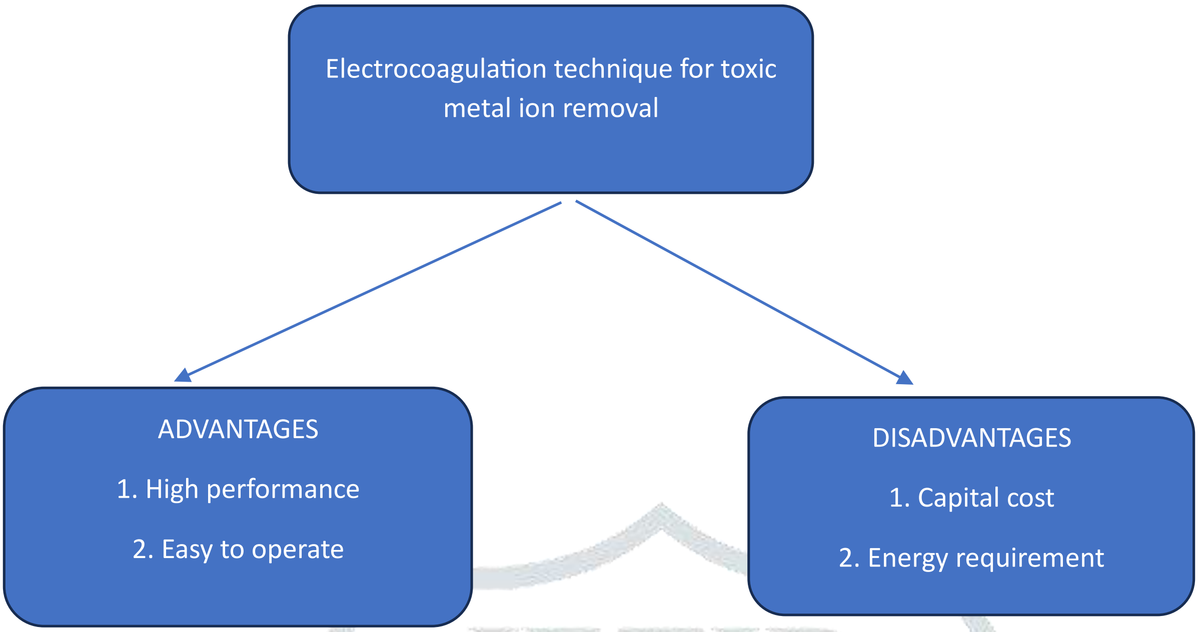
Manjeet Bansal et al examined the potential of rice husk for nickel adsorption from aqueous solutions. Maximum nickel removal was observed at pH 6.0. The efficiency of rice husk for nickel removal was 51.8% for dilute solutions at 20 g L^{-1} adsorbent dose. In desorption HCl eluted 78.93% nickel.[15]



ELECTROCOAGULATION

Electrocoagulation is one of the promising electrochemical technologies for wastewater treatment . The pollutant removal mechanism in EC depends on electrochemical reactions, chemical reactions, and physical processes, occurring in series or parallel. A simple EC unit consists of two electrodes, submerged in a beaker with the aqueous solution to be treated, externally connected to a power source. The coagulants are generated in situ to neutralize charges and attract and form flocs that float or settle. The generation of metal ions occurs at the sacrificial anode and is accompanied by a hydrogen gas evolution at the cathode[16].

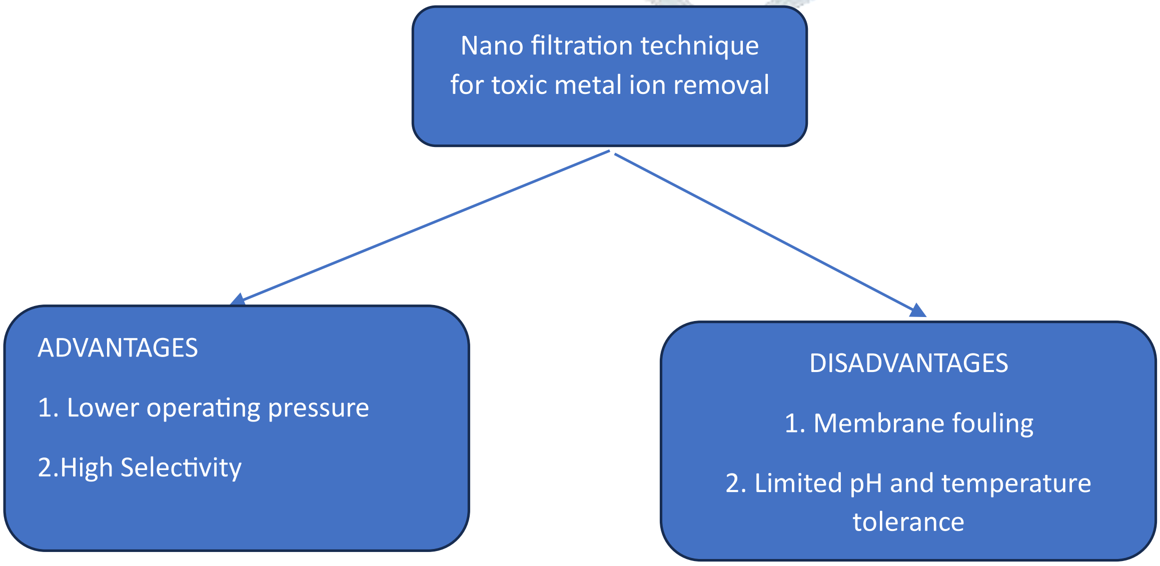
Omar A Shaker et al investigated Ni removal from synthetic and real wastewater using electrocoagulation. Zinc, as a novel electrode, was used as the sacrificial anode. Several operating conditions were assessed, including current density, initial pH, electrolysis time, and spacing between electrodes. The maximum Ni removal efficiency, after 90 min, reached 99.9% at a current density of 10 mA/cm2 when the pH was 9.2 and the gap distance was 4 cm. The Ni removal rate reached 94.4% and 94.9% at a 2- and 6-cm spacing, respectively, after 90 min[17]



NANOFILTRATION

Membrane processes have shown promise for the treatment of wastewater containing heavy metals. Nanofiltration is a pressure-driven membrane process. Other new technologies for membranes are reverse osmosis and ultrafiltration.

Gizem Basaran et al treated aviation industry metal plating wastewater containing Ni^{2+} and Cr^{6+} by nanofiltration by using two commercial membranes (NF90 and NF270) and two membrane filtration systems (dead end and cross flow). The optimum conditions were found to be at 30 bar with a pH of 10 for both the NF90 and NF270 membranes. Under optimum conditions for the NF90 membrane,the rejection values of Ni^{2+} and Cr^{6+} were found to be 99.2 and 96.5%, respectively. For the NF270 membrane, the rejection values of Ni^{2+} and Cr^{6+} were 98.7 and 95.7%, respectively[18]



CONCLUSION

The review has shown that different techniques like adsorption, electrocoagulation and nanofiltration has been applied for removal of Nickel from wastewater. Various agricultural wastes have substantial potential as biosorbents for effectively removing Nickel and can make valuable contribution to the the mitigation of water pollution. Also the various advantages and disadvantages of the various techniques has been shown. Disposal of the removed Nickel can be studied further.

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