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REMOVAL OF HEAVY METAL (Zn) FROM AQUEOUS SOLUTION USING EICHHORNIA CRASSIPES

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ABSTRACT

Heavy metals like Cr, Pb, Cu, Cd, Ni and Zn etc present in water and wastewater could be toxic to aquatic life and cause natural water to be unsuitable as portable water sources. These heavy metals are normally released into natural water bodies from domestic and industrial wastewater discharge. In order to remove these heavy metals pollutants from water and wastewater, the activated carbons are used commonly used as the adsorbent. It is not economical due to its high production and regeneration cost. Therefore the natural waste product is being used as adsorbents. Eichhornia crassipes (EC) was used as an adsorbent for the removal of Zinc (Zn) from aqueous solution and the sorption studies were performed in the laboratory by conducting batch experiments. The vital parameters affecting the adsorption process such as pH, contact time and different adsorbent dose in aqueous solution were studied. From the studies, it was observed that the uptake of zinc was 82.75%.

KEYWORDS: Heavy Metals, Eichhornia Crassipes, Bio-Sorption, Adsorbent

INTRODUCTION

Heavy metals are considered as the most toxic environmental pollutants. Its contamination of water bodies presents a severe hazard to public health and environment owing to their accumulation in the food chain as non- biodegradable pollutants and persistence in nature. The treatment and removal of these heavy metals from water or wastewater are really challengeable [1]. Various methods (e.g. ion exchange, chemical precipitation, membrane technologies, electrochemical treatment, and evaporation) have been developed for removing heavy metals from contaminated water. However, most of these methods suffer from some drawbacks, such as energy consumption, high reagent or the disposal of the residual floc residues that cause secondary pollution, and especially are not suitable for low concentrations of dissolved metal(s) ranging between 1 and 50 mg/l [2].

In recent decades, a number of research studies demonstrated that biosorption can be used to remove metals from aqueous solutions. Biosorption is an emerging technology that uses biological materials, such as biosorbents, for metal removal from water. In addition, biosorption is a cost-effective and eco-friendly alternative for metal adsorption [3]. Biosorption capacity is highly influenced by some operational conditions, for instance temperature, pH solution, metal and biomass concentration, stirring speed, and particle size, among others. In addition, the physical-chemical properties of biosorbents and pollutants play a major role in biosorption processes. But several researchers have reported the effects of those operational conditions individually [4].

Zinc is used in the process of galvanization, pigment formation, stabilizers, thermoplastics, alloys, and batteries. During the metallurgical processes, some amounts of metals are also released into the water bodies. The release of large quantities of heavy metals into the natural environment e.g. irrigation of agricultural fields by using sewage has resulted in a number of environmental problems and due to their non-biodegradability and persistence, can accumulate in the food chain, and thus may pose a significant danger to human health [9].

Most of the metal biosorption studies have been conducted taking very high concentration (1000 ppm) of heavy metals and sorbents, which seldom exist. Therefore, it is appropriate to carry out metal sorption studies at low and/or natural concentration of the metals in the industrial effluent as well [6]. Most leaf powder can serve as potent metal sequestering biosorbent. Because of this economical and efficient techniques, based on leaf powder, can be developed for adsorption of heavy metals [7].

The present investigation examines the feasibility of using Eichhornia Crassipes (EC) leafs as a sorbent, it is a floating aquatic macrophytic plant abundantly floated in meso and eutrophic water bodies such as ponds, lakes, rivers and reservoirs etc,. The objectives of the study which reveals the adsorbent capacity of Zinc (Zn), analyzing the effect of pH of the aqueous solution in the removal of Zn, effect of different doses of biomass in absorption and contact time.

MATERIALS AND METHODS

Preparation of Biomass

After collecting the required quantity of EC leaves in a jute bag, it was dried in sunlight for three days. The leaves were washed first with tap water, de-ionized water and oven-dried at 80 °C for 24 h, grounding in a ball mill and sieved to particle size range of 300 μm for use. The powder is washed twice with distilled water to remove unwanted materials, followed by washing with 0.1 HCl solutions, which is diluted with distilled water and heated it for 10 minutes. Finally, the biomass is washed with distilled water until all the color of the biomass is removed.

Preparation of Stock Solution and Biosorption Studies

The Preparation of adsorbate solution was carried out by preparing the stock solution containing 1000 mg/L of Zn. 2.908g of $Zn(NO_3)_2$ in 1000 ml of de-ionized water. The pH of the solution adjusted to 6 to prevent hydrolysis. 1g of biomass powder was contacted with 100ml metal ion solution in a conical flask by placing it in a mechanical shaker. Sample was taken out at the specific duration of time and centrifuged at 1000rpm for 15min. The supernatant liquid was separated for low residual Zn ions and analyzed by AASP. The Atomic Absorption spectrophotometer 210 CHEMTO (AASP) is a spectro analytical procedure for the quantity determination of chemical elements using the absorption of optical radiation (light) by free atoms in the gaseous state.

RESULTS AND DISCUSSIONS

Effect of Contact Time on Removal of Zinc from EC

Figure 3.1 indicates the uptake of metal ions vs. contact time at pH 6.35 and the initial dosage of biomass as 1 g. The removal Zn ranges between 76.87% and 82.75% at 30-150 min at the concentration of 100 ppm. The rate of Zn binding with EC leaf powder is more at initial stages and further gradually increases and remains constant during the period. Equilibrium contact time was found to be 120 min. These results are important, as equilibrium time is one of the important parameters for selecting a wastewater treatment system. Where the time consumed for wastewater disposal should be considered.

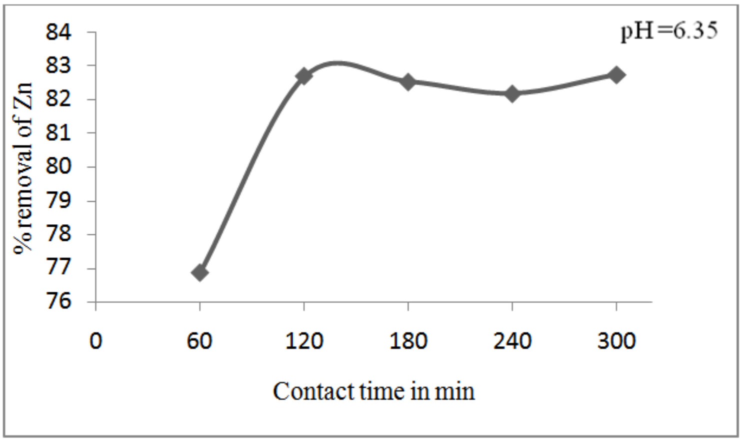

Figure 1: Effect of Contact Time on Removal of Zn

Effect of Biomass Dose on Adsorption

The figure 2 illustrated the relationship between percentage removal and dose variation ranges from 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0g at pH 6.35 for contact time of two hours. It reveals the removal of Zn range between 65% to 79.5% percent at 120 minutes for the concentration of 100ppm. The rate of Zn ion concentration binding with leaf powder is increases gradually and varies in minimum percentage when the dosage of biomass increases with concentration and pH remains constant at 120 minutes.

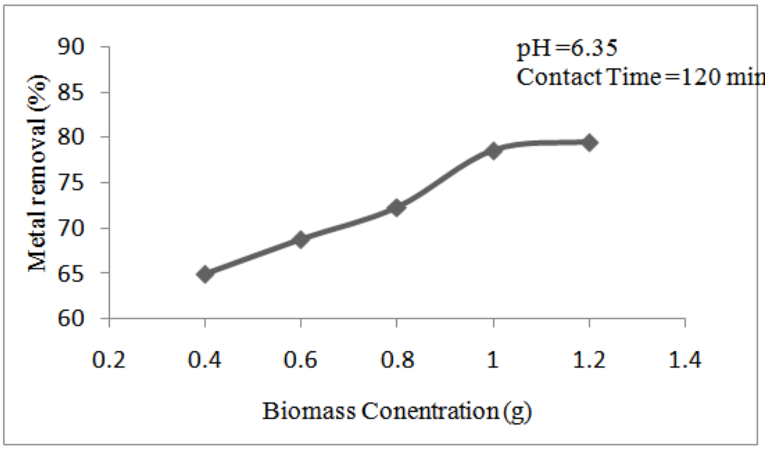

Figure 2: Effect of Biomass Concentration in Percentage Removal of Zn

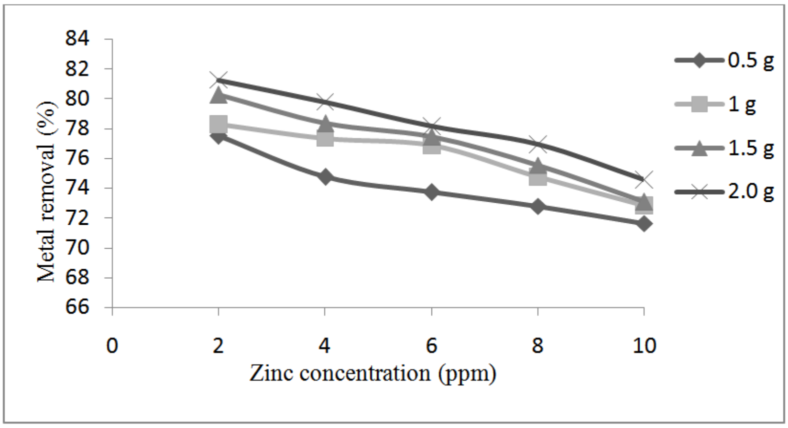

Figure 3: Effect of Initial Ion Concentration for the Removal of Zn for Different Dosage of Biomass

Effect of pH on Adsorption

The effect solution of pH on the Zn removal was studied by varying the initial pH and keeping the other process parameter as constant. The experiments were carried out at 1.0 g/100 mL EC leaves powder mass at room temperature at different initial pH of the aqueous solution (pH 2.0 ~ pH 11.0). The effect of solution pH on the uptake of Zn is presented in fig.34. The data indicate that Zn removal favorable with the addition of EC used as adsorbent as compared to the solution solely pH adjusted. The figure also shows that Zn removal increased drastically in pH from 6 to 11. The maximum sorption capacity of 81.16%.was attained at pH 7. At low pH, low metal adsorption has been caused by the competition of metal ions with hydrogen ions for the available adsorption sites as well as the positive charge density on the metal binding sites where the high concentration of protons in solution inhibiting metal removal. In contrast, the negative charge density on the adsorbent surface increases as pH increases due to deprotonation of metal binding sites and thus enhance the adsorption efficiency. Experiments were carried out at pH 6.35 due to Zn obtained the best removal at this pH value in the acidic range plus metal precipitation occurred at higher pH values. The result suggests that the absorption is mainly due to the ionic attraction between biomass and metal ions.

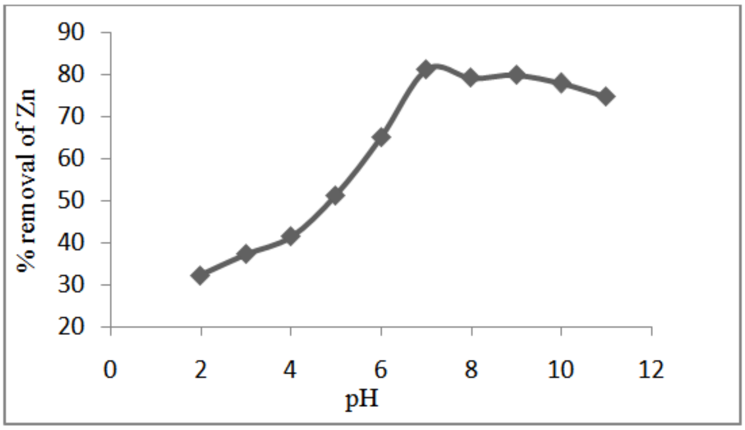

Figure 4: Effect of pH on Percent Removal of Zn

CONCLUSIONS

Eichhornia crassipes (EC) leaves powder has been studied as an adsorbent for Zn removal under various parameters. If the contact time between the solution containing the heavy metal and the biomass is more, then the efficiency of removal of heavy metals will also be high. This depends on the amount of biomass added to the solution and pH of the solution maintained during the experiment. This study revealed that the adsorption capacity of Zn was 82.75% by using the Eichhornia crassipes (EC).

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