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REMOVAL OF HEAVY METAL BY USING HATCHERY RESIDUAL BIO SORBENT: A REVIEW

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ABSTRACT: *Water is essential to all forms of life and makes up 50-96 % of the weight of all plants and animals. In recent years pollution of aquatic environment by heavy metals has increased. The continuous mixing of industrial effluents containing heavy metals to the natural resources deposits the toxicity in natural water resources. Due to their potential toxic effect and ability to bioaccumilate it is very difficult to remove from wastewater stream. The potential sources of the heavy metals are industries, mining, and agriculture. The most commonly witnessed heavy metals in industrial wastewater are Arsenic, Lead, Mercury, Cadmium Chromium, Copper, Nickel, and Zinc. Despite of use of suitable conventional chemical treatment processes for the removal of heavy metals, the effluent after treatment contain too high concentration of heavy metals. In order to trouble shoot the problems of conventional chemical treatment various bio sorbents such as eggshells, microalgae and banana peels can be adopted as supplement to conventional treatment.*

KEYWORDS: *hatchery residual biosorbent, heavy metal*

I. Introduction

Due to rapid increase in the concentration of heavy metals there is a necessity of efficient methods for the removal of heavy metals from industrial wastewater stream before discharge so as to eliminate the risk on the human life as well as on the aquatic environment. If this heavy metals are exposed to natural ecosystem, accumulation of heavy metals takes place in the human body through food chain and direct intake. In order to reduce environmental pollution due to heavy metals a number of studies are being conducted to minimize the problem. Though conventional method such as membrane process, chemical precipitation, electrochemical process, ion exchange etc. are adopted still number of studies are being carried on the development of other process such as biological treatment, treatment based on the bio sorption process etc. to supplement the conventional process so as to increase removal efficiency. Eggshell waste has been widely used as biosorbent for the removal of heavy metals from industrial wastewater. Physical and chemical properties of treated eggshell are studied and were found to have the applicability in removal of heavy metal.

II. Sources of heavy metal

The various potential sources include

Milling and smelting

Energy and fuel production

Fertilizer and pesticide industry

Electroplating ,Electrolysis

Table1. Source distribution of heavy metals [1]

Industries	Ag	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Ti	Zn
General industry and mining			X	X	X		X		X		X
Plating		X	X	X				X	X		X
Paint products			X						X	X	
Fertilizers		X	X	X	X	X	X	X	X		X
Insecticides and Pesticides				X		X					
Tanning			X								
Paper products			X	X		X		X	X	X	X
Photographic	X		X								
Fibres				X							X
Printing and Dyeing			X						X		
Electronics	X										
Cooling water			X								
Pipe corrosion				X					X		

III. Conventional treatment for removal of heavy metal

The commonly used procedures for removing metals ions from aqueous streams include chemical precipitation, lime coagulation, ion exchange, reverse osmosis and solvent extraction. The process description of each method is presented below.

A.Reverse Osmosis:

It is a process the heavy metals are separated by a semi-permeable membrane at a pressure higher than the osmotic pressure. Though it the most efficient process the major disadvantage of this method is that it is very expensive.

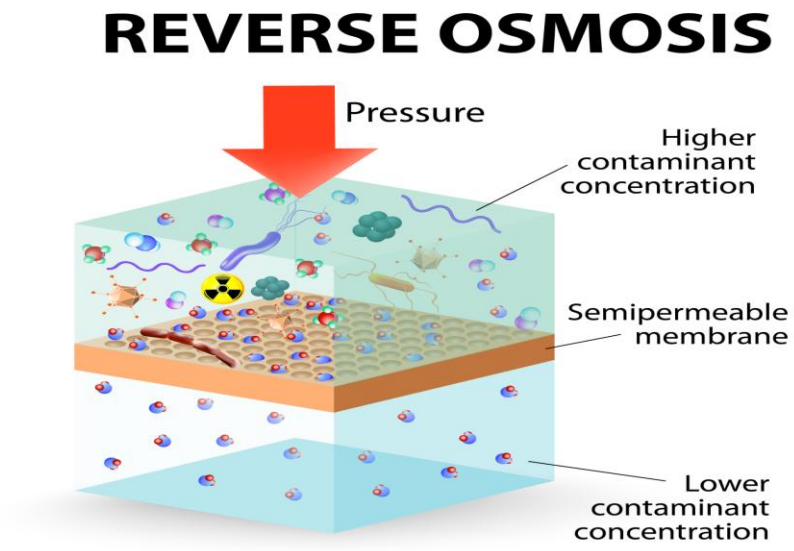

Figure 1: Reverse osmosis

B. Electrodialysis:

This process is employed for separation of the ionic components (heavy metals) using of semi-permeable ion selective membranes. Electrical potential is applied between the two electrodes which causes the migration of cations and anions towards respective electrodes. The cation and anion permeable membranes are placed alternately and hence results into

the formation of concentrated cell and dilute salts. The major disadvantage witnessed is the formation of metals hydroxides, which clog the membrane.

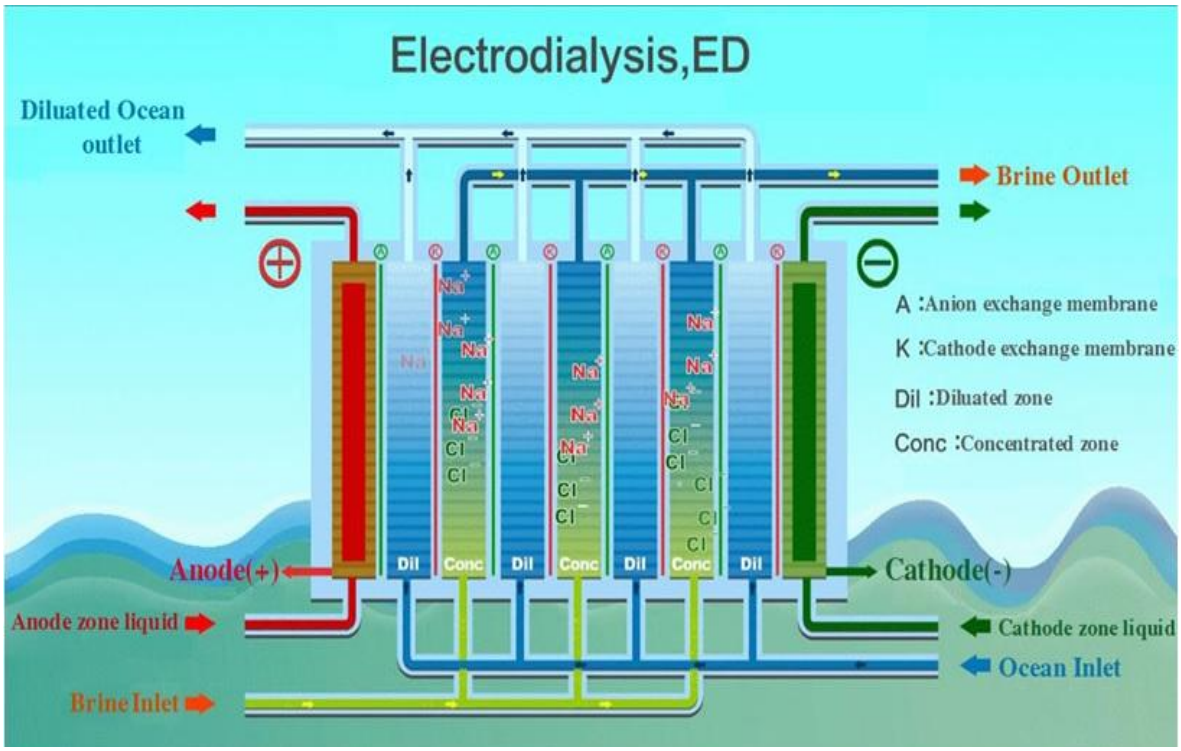

Figure 2: Electrodialysis

C. Ultra filtration:

They are pressure driven membrane operations that use porous membranes for the removal of heavy metals. The main disadvantage of this process is the generation of sludge.

Figure 3: Ultra filtration

D. Ion-exchange:

In this process, metals ions from dilute solutions are exchanged with ions held by electrostatic forces on the exchange resin. The disadvantages include: high cost and partial removal of certain ions. Chemical Precipitation: Precipitation of metals is achieved by the addition of coagulants such as alum, lime, iron salts and other organic polymers. The large amount of sludge containing toxic compounds produced during the process is the main disadvantage.

IV. Disadvantages of conventional treatments

Metals are a class of pollutants, often toxic and dangerous, widely present in industrial wastewaters. Electroplating and metals finishing operations, electronic circuit production, steel and aluminium processes are the few industries, producing large quantities of wastewater containing Heavy metals. Although many of the conventional process as discussed above are used for the removal of heavy metals due to various disadvantages encounteredsuch as costly processes, sludge production and its disposal there arises the need of the processes (such as Biosorption) supplement to conventional processes to achieve better removal efficiency.

V. Removal of heavy metal by using Hatchery residual biosorbent

A. Preparation of eggshell powder

The removal of heavy metal by using hatchery residual biosorbent is based on the principle of biosorption. The bio sorption process includes a solid phase (sorbent or biosorbent; biological material) and a liquid phase (solvent, here wastewater) containing a dissolved species to be sorbed. Biosorption process is very specific that is the different bio sorbents have different affinity for different species. Hence various mechanisms are adopted according to the species to be sorbed. Eggshell collected from different sources are washed with distilled water to remove dirt . The washed sample is then dried in an oven at 150℃ for 3 hours and then cooled and crushed to fine powder of 80- 120µm. This dried eggshell is used as bio sorbent. The chemical composition of eggshell powder is as follow:

$CaCO_3$: 92%
$MgCO_3$: 4%
Protein: 3%
Organic Matter: 1%

B. Adsorbate Solution

Analytical grades of $FeSO_4$, HCl and NaOH are required. Ferrous ions were prepared by dissolving its corresponding Sulphate salt in distilled water. Stock solution of Cu (II) was prepared by using $CuSO_4.5H_2O$. All chemicals used of analytical grade and distilled water was used to prepare solutions.

C. Removal of heavy metal [6]

Individual and mixed solutions of Fe and Cu with different concentrations of 5, 10, 20, 40, 100 mg/L were prepared , the experiment were performed using three different amount of adsorbent 0.5, 1, 1.5, in single solution. 0.5 gm adsorbent was placed in a conical flask in which 100 ml of solution with known concentration of Fe was added and the mixture was shaken in shaker. The mixture was than filtered after 24 hours contact time and final concentration of metals ion was determined in filtrate by atomic adsorption spectrophotometer (GBC 902). All the Experiments carried out in triplet and mean concentration calculated by averaging them. The procedure repeated by varying the adsorbent dose and concentration of Fe and Cu solution both individual and in mixed solution. Based on residual concentrations, the adsorption efficiency of eggshell powder is calculated and summarized in Table

Table 2: Eggshell powder Adsorption Efficiency for Copper at various Concentrations (24 hour contact time) [6]

Sr. no	Quantity of egg shell powder	Initial concentration of Cu (mg/l)				
		5	10	20	40	100
		Adsorption efficiency				
1	0.5	91	90	86	70	65
2	1	93	92	90	90	80
3	1.5	99	98	98	97.5	75

Table 4: Eggshell powder Adsorption Efficiency for Iron various Concentrations (24 hour contact time) [6]

Sr. no	Quantity of egg shell powder	Initial concentration of Pb(mg/l)				
		5	10	20	40	100
		Adsorption efficiency				
1	0.5	82	82	80	73	62
2	1	86	85	80	76.5	70.5
3	1.5	93	90	80	80	74

Table 5: Eggshell powder Adsorption Efficiency for Copper and Iron in Mixed Metals solution using 0.5g Eggshell powder (24 hour contact time)[6]

Sr. no	Metals solution	Initial concentration (mg/L)				
		5	10	20	40	100
		Adsorption efficiency %				
1	Cu	88.4	87	80	80	73
2	Fe	76.8	76	70	63	60.3

VI. Advantages of hatchery residual biosorbent

Cheap: the cost of the biosorbent is low since they often are made from abundant or waste material.
Metals selective: the metals sorbing performance of different types of biomass can be more or less selective on different metals. This depends on various factors such as type of biomass, mixture.
In the solution, type of biomass preparation and physico-chemical treatment.
Regenerative: biosorbents can be reused, after the metals is recycled.
No sludge generation: no secondary problems with sludge occur with biosorption, as is the case with many other techniques, for example, precipitation.
Metals recovery possible: In case of metals, it can be recovered after being sorbed from the solution.
Competitive performance: biosorption is capable of a performance comparable to the most similar technique, ion exchange treatment. Ion exchange is, as mentioned above, rather costly.

VIII. Conclusion

Hatchery residual is being an alternative to conventional methods for the removal of toxic heavy metals from industrial effluents. These Conventional methods are expensive, hence the use of low cost, abundant environmentally friendly biosorbents have to be used. The advanced development of the biosorption processes requires further improvement in the direction of modelling, regeneration of biosorbent material and of testing immobilized raw biomasses with basic industrial effluents.

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