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REMOVAL OF TOXICITY FROM THE WASTEWATER BY USING MICROALGAE

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Abstract — *Rigorous research works are going on in the field of wastewater treatment. The recent research of wastewater treatment by using microalgae is also proving more effective in removal of toxicity from wastewater. Microalgae have developed an extensive spectrum of mechanisms (extracellular and intracellular) to cope with heavy metal toxicity. Their wide-spread occurrence along with their ability to grow and concentrate heavy metals, ascertains their suitability in practical applications of waste-water bioremediation. Heavy metal uptake by microalgae is affirmed to be superior to the prevalent physicochemical processes employed in the removal of toxic heavy metals. This review summarizes several areas of heavy metal remediation from a microalgal perspective and provides an overview of various practical avenues of this technology. It particularly details heavy metals and microalgae which have been extensively studied, and provides a schematic representation of the mechanisms of heavy metal remediation in microalgae.*

Keywords – *heavy metals(HM) , microalgae*

INTRODUCTION

Heavy metals occur as natural constituents of the earth crust and soil. Although there is no clear definition of a heavy metals, in most cases density is the defining factor; conventionally, heavy metals are defined as elements with metallic properties having an atomic number >20. In general, the term HM refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. It is essential to realize that the metal is only "removed" from solution when it is appropriately immobilized. The procedure of metal removal from aqueous solutions often leads to effective metal concentration. Apart from the rather slow natural process of metal mineralization, the ultimate removal is attained only when the metal becomes concentrated to the point that it can be either returned to the process or resold. This aspect of the operation deals with the potential recovery of the metal. The term microalgae refer to all algae too small to be seen properly without microscope, and often include both eukaryotic microalgae and the prokaryotic cyanobacteria. Micro algal biomass can be used for hydrogen gas production, bioenergy conversion and production of pharmaceutical substances or food just to give some examples. This paper is a compilation of reported experiences from wastewater treatment with microalgae. The aim is mainly to explain the most important factors that affect micro algal growth and to give some advice on design and operation of algal treatment steps. Bio-treatment with microalgae is particularly attractive because of their photosynthetic capabilities, converting solar energy into useful biomasses and incorporating nutrients such as nitrogen and phosphorus causing eutrophication.

I. MATERIALS AND METHOD

A. Procedure

The synthetic wastewater of about 5 liters was fed into the feed tank and by gravity it was fed into the rectangular reactor of 35 x 25 x 18 cm size [4]. The reactor was operated at room temperature. Each algae of initial dosage 60 g was fed to the reactor. Then the operating parameters were varied to find the optimum condition.

B. Optimization of number of days

The synthetic wastewater was fed to the reactor containing 60 g of each algae. No pH adjustment was made. Then at each day samples were collected and analyzed for the various parameters like pH, TDS, Turbidity, BOD, COD, Ammonia Nitrogen and Phosphate.

C. Optimization of pH

After optimizing number of days, the pH of synthetic wastewater was varied. The Synthetic wastewater with different pH was fed to the reactor with 60 g of each algae. The selected pH were 4, 5, 6, 7and 8. The samples collected after the optimized days were analyzed for the various Parameters.

D. Varying algal species

Oscillatoria and Chlorella algae of 60 g each were taken separately for treating with synthetic wastewater. Combinations of algal species of 60 g were also taken for the study simultaneously.

E. With aeration

After fixing optimum days and pH the synthetic wastewater was treated with Oscillatoria and
Chlorella algae separately of 60 g. Aeration of 9 l/min has been provided. The samples were analyzed after treatment. The same has been repeated with the combination of algal species.

F. Without Aeration

After fixing optimum number of days and pH treatment of algae with synthetic wastewater has been carried out without aeration. Here also combination of algal species has been taken for the
Treatment. Similarly individual algal species also has been taken for the treatment. Samples after
Treatment has been taken for the analysis of the parameters [4].

G. Varying algal dosage

The synthetic wastewater was treated with algal species of varying dosage after optimizing number of days and pH. Aeration has been provided.20, 40, 60, 80, 120 and 140g of each algal species were taken for the study. The samples collected after treatments were analyzed for the various parameters [4].

II. CONVENTIONAL TREATMENTS FOR REMOVAL OF HEAVY METAL

There are specific methods on removal of dissolved inorganic compound in wastewater through use of different unit operations:-

1. Carbon – Activated Sludge Adsorption.
2. Chemical Oxidation and Coagulation
3. Reverse Osmosis and Ultra filtration
4. Physico-chemical methods
5. Chemical Precipitation
6. Electrochemical Treatments
7. Biological Methods

A. Carbon- activated sludge adsorption:

Activated carbon is one of the most effective media for removing a wide range of contaminants from industrial and municipal waste water, landfill leachate and contaminated groundwater as the world's most powerful adsorbent; it can cope with a wide range of contaminants. Different contaminants may be present in the same discharge and carbon may be used to treat the total flow, or it may be better utilized to remove specific contaminants as part of a multistage approach[3].

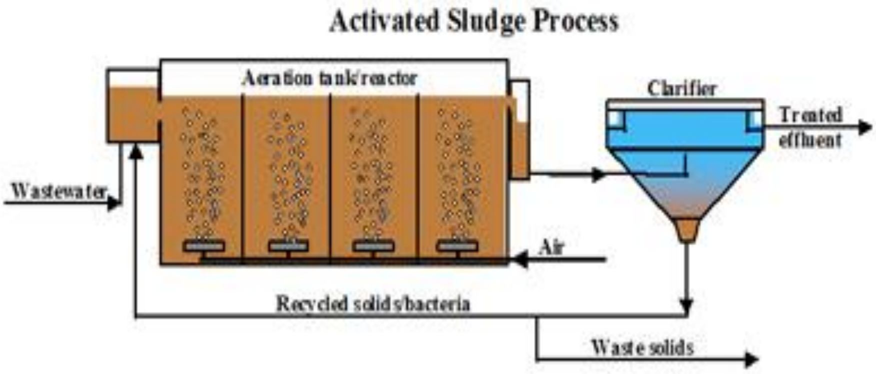


Fig.1- Activated sludge process

B. Chemical oxidation and coagulation:

This process involving oxidation and coagulation, for removal of color and chemical oxygen demand from synthetic textile waste water containing polyvinyl alcohol and a reactive dyestuff. The experimental variables studied include dosages of iron salts and hydrogen peroxide, oxidation time, mixing speed and organic content. The result show the color was removed mainly by Fenton oxidation

C. Reverse Osmosis:

It is a process in which heavy metals are separated by a semi-permeable membrane at a pressure greater than osmotic pressure caused by the dissolved solids in wastewater [3]. The disadvantage of this method is that it is expensive.

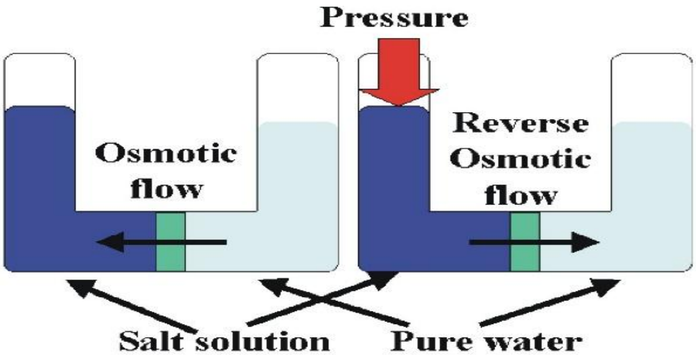


Fig.3- Reverse osmosis

Comparison of conventional process and algal process for removal of Toxicity

Algal processes **ADVANTAGES**	**Conventional process** **DISADVANTAGES**
Cost effective	High cost of construction
Low energy requirement	High energy requirement
Production of useful biomass	Required high area of land
Reduction in sludge formation	Requires mechanical device
Remove heavy metals	Complex technology
Algae contain more than 50% of oil in its biomass	Required technically skill
They provide much higher yields of biomass and fuels, 10-100 times higher than comparable energy Crops.	Low treatment efficiency
They can be grown under conditions which are unsuitable for conventional crop production.	Required man power for operation and maintenance

III. REMOVAL BY USING MICROALGAE

A. SIGNIFICANCE OF MICROALGAE

Instead of using mainly bacteria, it is also possible to use mainly algae to clean waste water because many of the pollutant sources in waste water are also food sources for algae. Nitrates and phosphates are common components of plant fertilizers for plants. Like plants, algae need large quantities of nitrates and phosphates to support their fast cell cycles. Certain heavy metals are also important for the normal functioning of algae. These include iron (for photosynthesis), and chromium (for metabolism). Because marine environments are normally scarce in these metals, some marine algae especially have developed efficient mechanisms to gather these heavy metals from the environment and take them up. These natural processes can also be used to remove certain heavy metals from the environment. The use of algae has several advantages over normal bacteria-based bioremediation processes. One major advantage in the removal of pollutants is that this is a process that under light conditions does not need oxygen. Instead, as pollutants are taken up and digested, oxygen is added while carbon dioxide is removed.

B. METHOD USED

Physical adsorption is a reversible process, independent of metabolism, and has several advantages. It is demarcated as a process where the metal ion in solution binds to polyelectrolytes present in microbial cell walls through electrostatic interactions: Van der Waals forces, covalent bonding, redox interaction, and biomineralization, to achieve electro neutrality. However, the physical adsorption encompassing a process, wherein the metal ions are attracted by the negative potential of the cell wall, is a pH dependent process. With increasing pH, generally numerous sites are replaced by negative charges that increase the attraction of metallic cations and their adsorption to the cell surface. Kuyucak and Volesky (1988) report uranium, cadmium, zinc, copper and cobalt sorption by dead biomasses of algae occurring through electrostatic interactions between the metal ions in solutions, and, the cell walls of the cell. Similarly, in the alga C. vulgaris, electrostatic interactions occur during copper biosorption; here, the physical adsorption occurs with the aid of van der Waals forces.

C. FACTORS AFFECTING THE ALGAL GROWTH

Algal growth and nutrient uptake are not only affected by the availability of nutrients, they also depend on complex interactions among physical factors such as pH, light intensity, temperature, and biotic factors. The first biotic factor significantly influencing algal growth is the initial density, it is expected that the higher the algal density, the better the growth and the higher the nutrient removal efficiency.

1. Temperature: -Generally, temperatures around 15–25ºC seems to suit most algal species, even those which are adapted to growth at colder temperatures.

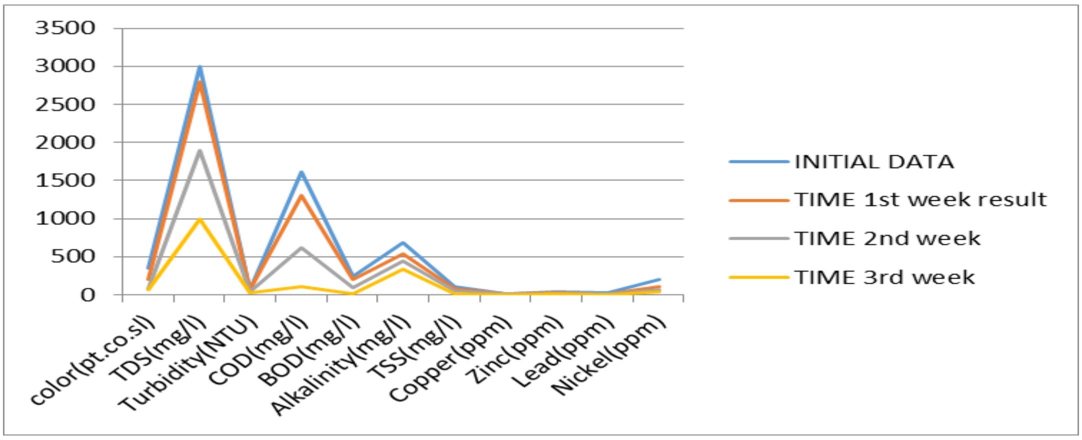
2. pH: -The pH regulates what species of inorganic carbon that is available.

3. Light: - There are several strategies used by microalgae to remain near the water surface in order to catch enough light. These strategies aim to decrease the specific gravity and thereby minimise the sinking rate. Examples of this are fat accumulation, selective accumulation of ions (monovalent ions have a lower specific gravity) and buoyancy among some cyanobacteria which float due to gas vacuoles.

4. 4. Biotic factor: - Not only physical and chemical factors affect algal growth. In nature, species have to compete with each other for space and nutrients, and this can be reflected in algal cultures as well. Some species inhibit the growth of others in mixed culture.

IV. RESULTS AND GRAPHICAL REPRESENTATION

SAMPLES	INITIAL DATA	TIME		
		1st week result	2nd week	3rd week
color(pt.co.sl)	350	200	80	60
TDS(mg/l)	3000	2800	1900	1000
Turbidity(NTU)	72	61	43	31
COD(mg/l)	1608	1304	616	100
BOD(mg/l)	246	197	90	14
Alkalinity(mg/l)	686	533	446	330
TSS(mg/l)	106	80	46	10
Copper(ppm)	18	9	6	4
Zinc(ppm)	40	26	17	8
Lead(ppm)	20	12	7	3
Nickel(ppm)	200	110	67	45



V. CONCLUSION

Biological treatments are eco-friendly, best removal and low cost methods. Lot of bio adsorbents can be found in nature. Physical and other most common chemical methods are produced toxic sludge which is unable to settle within industries. Although chemical cost is high chemical treatments is one of the most suitable treatments for toxic inorganic compounds produced from various industries which cannot removed from any biological and physical techniques. The current trends in this report point toward exploitation and suitable adaptation of existing mathematical models, as well as toward the synthesis of more advanced computer models reflecting the ligand metal interaction on a molecular level and the process mass transfer and hydrodynamics on a macroscopic scale relating to the process equipment design and scale-up. Work is currently in progress in several key academic laboratories that addresses the fundamental as well as applied aspects of the biosorption process, relating particularly to the better understanding of biosorption mechanisms, metal desorption and biosorbent regeneration, formulation of new biosorbent materials suitable for process application, and development of new methodologies to facilitate the quantitative process description, its performance prediction, and optimization. At the same time, commercial interest in the exploitation of new biosorption technology is on the rise.

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