A Study on Simultaneous Bioremoval of Heavy Metal & Dye for Identified Waste Stream

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***Abstract* - In this study, biosorption of heavy metal and dye by microbes will investigate. Optimum pH values of the maximum heavy metal biosorption will be finding. The bioremoval of the dye also investigate at different pH, Removal rates will measure respectively. The presence of heavy metal with dye analysis will be done for uptake by biosorbents .The results expected to indicate that the isolated biosorbents deserves attention as a promising biosorption of heavy metal ions and dyes for Identified wastewater stream.**

***Keywords* - Heavy Metal, Dye, Microbes, Bisorption**

I. INTRODUCTION

The use of synthetic dyes is increasing in many areas. More than 10,000 chemically different dyes are manufactured. These dyes are mainly consumed in the textile, tannery, pharmaceutical, pulp and paper, paint, plastics, electroplating, and cosmetics industries. Interest in the pollution potential of textile dyes has been primarily prompted by concern over their possible toxicity and carcinogenic chromium into the water supplies. Even though physico-chemical methods are effective in dye removal, problems such as the overall cost, regeneration, secondary pollutants, limited versatility, interactions with other wastewater constituents, and residual sludge generation limit their usage. Although heavy metals can be removed from industrial wastewater by a range of physico- chemical treatment technologies such as precipitation, ion exchange, adsorption, electrochemical processes, and membrane processes; however, regulatory standards are not always sufficient.

As an alternative, biological treatments are a relatively inexpensive way to remove dyes from wastewater. Several microorganisms, such as bacteria, fungi, and microalgae, have been tested for their ability to accumulate heavy metals or dyes. The use of biological methods such as bioaccumulation and biosorption is suitable for the removal of pollutants from wastewaters. Biosorption is the removal of substances from solution by inactive, dead Biological materials, while bioaccumulation describes intracellular pollutant accumulation. These methods have the advantage over such as low operating cost, minimization of the concentration of pollutant and high efficiency in detoxifying very dilute effluents. Although these removal processes can be executed at ambient conditions rapidly, there are only few examples using bioaccumulation/bio-sorption based processes in practice. Mention the comparatively slower rates and longer completion times of these processes than physico-chemical treatments.

It is well known that live and dead cells of microbes are able to remove heavy metals ions and dyes from aqueous. There are many studies in the literature about the removal of a single dye or single heavy metal ions by growing cells. Even though some kinds of metal-based complex dyes are being used in the textile industry, very little attention has been paid to the binary bioremoval of binary reactive dye and metal ion systems. Depending on these findings and lack of attempts on binary bioremoval in the literature, it was aim to show that microbial biomass could be a better biosorbents, due to its higher availability. This review is critical approach to biosorption .Discussing many things like the decolonization of dye and the biosorption of chromium(VI),copper(II), and nickel(II) both singly and in binary combinations by a Nonliving microbes at batch scale level.

II. REVIEW OF BIOLOGICAL REMOVAL OF HEAVY METAL & COLOR

A. Bioremediation of heavy metal

Adam and Holmes (1935) described the removal of Ca and Mg ions by tannin resin, black wattle bark (Acacia mollissima), which were treated directly so that the condensation product was fixed on the woody fibres. Strong biosorbent behaviour of certain types of microbial cells towards metallic ions is a function of the chemical makeup of the microbial cells of which it consists this aspects is particularly important when it comes to the process application, whereby new biosorbents respective "Chemicals" are capable of sequestering a relatively large amount of the metals (Volesky 1987). Some types of biosorbents could have broad range binding of the majority of heavy metals with no specific priority, while others can even be specific for certain types of metals (Volesky and Kuyvcak, 1988). Microbial biomass was used as an adsorbing agent for the removal and recovery of uranium present in industrial effluents and mine wastewater (Nakajima and Sukaguchi, 1986). Biosorption by fungi as an alternative treatment option for wastewater containing heavy metal has been reviewed by Kapoor and Viraghavan (1995) and Modak and Natarajan (1996). Any fungi can tolerate high concentration of potentially toxic metals and with other microbes; this may be correlated with decreased intracellular uptake or impermeability. A close relation between toxicity and intracellular uptake has been shown for Cu^{2+}, Cd^{2+}, Co^{2+} and Zn^{2+} in yeast Saccharomyces cerevisiae (Gadd, 1986; white and Gadd; 1986). Biosorption by fungi as an alternative treatment option for wastewater containing heavy metal has been reviewed by Kapoor and Viraghavan (1995) and Modak and Natarajan (1996). Any fungi can tolerate high concentration of potentially toxic metals and with other microbes; this may be correlated with decreased intracellular uptake or impermeability. A close relation between toxicity and intracellular uptake has been shown for Cu^{2+}, Cd^{2+}, Co^{2+} and Zn^{2+} in yeast Saccharomyces cerevisiae (Gadd, 1986; white and Gadd; 1986).

Table No. 1 Metal removal by different conventional & non conventional biosorbents

Sr. No.	Biosorbents	Metals	References
1	Lemna minor	Pb	Rahimani, et al.,1999
2	Amaranthus spinosus, Solanun nigrum	Cu	Chen, et al., 1996
3	Chicken feathers	Au, Pt	Suyama, et al., 1996
4	Canola meal	Cr	Al-asheh, et al., 1996
5	Hyacinth roots	Cr	Low, et al., 1997
6	Fly ash	Cr, Pb, Cd	Bhargava, et al., 1989
7	Fly ash	Cr, Pb, Mn, Fe	Sharma, et al., 1990
8	Agriculture residue	Cr, Cd	Orhan and Byakungar,
9	Saw dust	Cr, Pb, Cd	Campanella, et al., 1986
10	Coconut fibre	Cr	Tan, et al., 1993
11	Sargassum natans	Cr, Pb, Co, Cd	Volesky, 1995

Biosorbents, used in batch or dynamic conditions, can be naturally occurring materials (wood, peat, coal, chitin and chitosan, biomass, clays, etc.), as well as industrial/agricultural wastes or byproducts for dye removal(fly ash, red mud, blast furnace slag, metal hydroxide sludge, sawdust, bark, lignin, sunflower stalks, maize cob, rice husk, hazelnut shells, olive stones, seashell, etc.) (Zaharia and Suteu 2012a,b; Crini 2006; Bozlur et al. 2012; Suteu et al. 2009; Ayan et al. 2011; ; Zhang et al. 2011a ; Sulak and Yatmaz, 2012). Some of the various bio-adsorbents investigated for removal of dyes from aqueous solutions are listed in Table No.2.

Table No.2 Brief Review of Applications of Bio-adsorbents in Removal of Dyes

Bio-adsorbent	Dye	References
peel of Cucumis sativa fruit	malachite green	Santhi and Manonmani 2011
Almond shell(Prunus dulcis)	rhodamine 6G methylene blue methylene blue	Senturk et al. 2010
Wheat shells	methylene blue congo red	Bulut and Aidin 2006
Silkworm exuviates	malachite green	Chen et al. 2011
Rice husk ash	orange - G methyl violet	Chowdhury et al. 2009
Rattan sawdust bagasse fly ash seashells waste	Brilliant Red HE-3B	Hameed et al. 2008
Sunflower seed shells	Orange 16	Mall et al. 2006
rice husk	methylene blue	Suteu et al. 2012
Straw	methylene blue	Zhang et al. 2011b
waste newspaper fiber	malachite green	Vadivelan and Kumar 2005
sugar extracted spent rice biomass	methylene blue	Rehman et al. 2012

III. METHODS

A. Dye and heavy metal

It will be obtain from textile Industry, Ahmedabad, in pure form. The dye stock solution will be prepare by dissolving the powdered dyestuff in distilled water to a final concentration of 2% w/v. Stock solutions of copper(II), chromium(VI), and nickel(II) will prepare by dilution of anhydrous copper sulfate(Merck), potassium dichromate (Merck), and nickel sulphate hepta- hydrate (Merck)to a final concentration of 10 gL-1 of copper(II),chromium(VI),and nickel(II) ,respectively. Appropriate volumes of the stock solutions will add to the media.

B. Isolation of dye and heavy metal biosorbenting microbes

The soil sample, which will be collect from Textile industrial area only, serially dilute to 10-fold. The dilute sample (0.1 mL) spread on Petri plates containing molasses media with50 mg/L dye, 50 mg/L heavy metal (copper, chromium, and nickel) . The composition of the growth medium will be molasses solution (nearly equivalent to 10g/L sucrose), 1.0 g/L NH4SO 4, and 0.5 g/L KH 2 PO4 .Agar (15 g/L)will be add to the plates. The pH of the growth medium will adjust to 6 with 0.01 M sulphuric acid or 1 M sodium hydroxide solutions. The Petri plates will incubate at 30 ±1° C for 7days. The Microbial colonies that appear on the molasses medium agar plates will be isolate and purify by streaking the cells repeatedly on the molasses medium agar plate with dye and heavy metals. The pure cultures will keep at 4 °C and will transfer to molasses media containing dye and a mixture of all three heavy metal .

C. Optimization of different parameters for dye degradation

The dye decolorization potential of bacterial isolate will perform in minimal nutrient medium containing dye (100 mg l−1) for optimization of parameters. The effect of oxic and static conditions on dye decolorization will monitor at shaking (100 rpm) and static conditions, respectively. The effect of pH and temperature will monitor under static condition in the range of pH, 5.0–9.0 and temperature, 20–500 C, respectively. In order to study the tolerance, the biosorbent will amend with varying concentration of Dye. To evaluate the decolorization efficiency of the strain will given repeatedly exposure of dye, (100 mg l−1) will be add repetitively (after every 24 hr). The decolorization will monitor at 480 nm .

D. Simultaneous biosorption of dye and Heavy metal

The efficiency of biosorption will test for heavy metal sorption in absence & Presence of dye & decolorization of dye in presence of heavy metal.

E. Monitoring of water quality

In water quality assessment total organic carbon (TOC), total dissolved solids (TDS), chemical and biological oxygen demand(COD and BOD) are important parameters for indirect measures of organic load.

F .Chromatographic and spectroscopic Analysis

The samples after complete decolorization will withdrawn, centrifuge at 10,000 × g for 15 min. The supernatant will extract using dichloromethane and dry over anhydrous sodium sulfate.The solvent will evaporate in rotary evaporator and samples will be subject to various spectral and chromatographic analysis. Preliminary degradation of dye will confirm by high performance liquid chromatography (Shimadzu UFLC, CTO 20A)on C-18 column using methanol: water (30:70) as mobile phase with flow rate of 1 ml min−1at 480 nm.. The concentrations of heavy metal will be determine by spectrophoto metrically analysis The biomass concentration will determine by measuring dry weight. Absorbance measurements and centrifugation will performe using a Shimadzu UV 2001 model spectrophotometer and Hettich EBA12 model centrifuge, respectively.

The dye and heavy metal bioaccumulation properties of biosorbents will investigate in a batch system as a function of initial pH, and dye and heavy metal concentrations. The percentage up- take of dye or heavy metal will calculate from Eq.(1):

$$\text{Uptake } \% = (C0\text{-}Cf/ C0) \text{ X } 100 \text{.......(1)}$$

The bioaccumulation capacity of dye or heavy metal is the concentration of dye or heavy metal in the biomass and can be calculate base on the mass balance principle from Eq. (2)

$$qm=(C0\text{-}Cf)/Xm \text{......................................(2)}$$

In these two equations ,qm(the maximum specific dye or heavy metal uptake) represents the maximum amount of dye or heavy metal per unit dry weight of microbes(mg/L),Xm the maximum dried cell mass(g/L),and C0 and Cf the initial and final concentrations(mg/L),respectively.

BOD5 and COD will analyze in the laboratory according to the methods previously recommend COD of samples will estimate by the open reflux method describe in the standard methods for examination of water and wastewater.

IV. CONCLUSION

An integrated approach has been attempted in order to explore the potential biosorbent for bioremediation and detoxification of environmental contaminants .This study will concluded by the biosorbents effective in simultaneous dye & Heavy metal reduction with exceptionally high rates.

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