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Studies on Removal of Lead Using *Skeletonema costatum* Microalgae

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Abstract: Heavy metal pollution represents a serious environmental problem due to toxic effects of metals, their recalcitrance and consequent persistence. Among the heavy metals, lead is a common pollutant in effluents from industries such as electroplating, metal processing and mining. The search for newer methods of removal of toxic metals from wastewaters has directed attention to sorption. The main objective of this study was to study the sorption of lead metal ions by using *Skeletonema costatum* microalgae. The influence of various parameters, such as pH (2-8), Contact time (1-180 min), sorbent dosage (10-60 g/L), Initial Lead concentration (20-200 mg/L), Temperature (283-323 ^{0}C) were investigated. Under this study the maximum sorption capacity of Lead (%) is observed at the optimum conditions of pH 6.0, Contact time 60 min, Biosorbent dosage 30 g/L, Initial lead concentration 20 mg/L, Temperature 303^{0}C.

Keywords: Metal Pollution, *Skeletonema costatum,* pH, lead.

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Introduction

Water has the focal job in intervening worldwide scale biological system forms, connecting climate, lithosphere and biosphere by moving substances among them and empowering concoction responses to happen. Characteristic waters are never unadulterated H2O yet a complex and ever-changing blend of broke down inorganic and natural atoms and suspended particles. Substantial metals of concern incorporate cobalt, lead, chromium, mercury, uranium, selenium, arsenic, cadmium, silver, gold, nickel and so on. Because of their versatility in common water biological systems and their harmfulness to higher living things, overwhelming metal particles in surface and ground water supplies have been organized as major inorganic contaminants in nature. Substantial metal contamination in the oceanic framework has become a genuine danger today and of extraordinary ecological worry as they are non-biodegradable and accordingly tenacious. Upgraded modern action after the mechanical insurgency has prompted the release of synthetic substances, which causes ecological and general medical issues. The nearness of substantial metals in the earth is of significant concern on account of their outrageous poisonousness and inclination for bioaccumulation in the natural way of life even in generally low focuses [1, 2]. A multitude of biomass types comprising fungal biomass, bacterial biomass, algae, peat etc., have been studied for their biosorption of metals [3, 4, 5, 6].

To understand the equilibrium studies on the sorption process, kinetic and thermodynamics of sorption, the experiments were carried out is batch wise operation using *Skeletonema costatum* microalgae.

Experimental Procedure

Preparation of biosorbent (Figure 1 & 2) *Skeletonema costatum* microalgae was selected for the present study and procured from NIO Visakhapatnam. The biomass was washed several times with double distilled water.

Fog's Medium (for Algae)

$MgSO_4.7H_2O$	0.2g
K_2HPO_4	0.2g
*Micronutrient Solution	1.0ml
$CaCl_2.H_2O$	1.0ml
*Fe-EDTA solution	5.0ml
Distilled water	1.0L
Agar (Difco)	12.0g
Adjust pH to 7.5	

*Micronutrient solution

H_3BO_3	286.0mg
$MnCl_2.4H_20$	181.0mg
$ZnSO_4.7H_20$	22.0mg
$Na_2MoO_4.2H_20$	39.0mg
$CuSO4.5H_20$	8.0mg
Distilled Water	100.0ml

*Fe-EDTA solution

In hot water dissolve 745.0mg of Na EDTA and then add 557.0 Mg of $FeSO_4.7H_20$. Boil the solution for few minutes and make the volume to 100 ml.

Immobilization

4gms of Na-alginate was dissolved in 10ml of hot water and stirred vigorously with magnetic stirrer for 10min then 50ml of the solution is mixed with 50ml of algal solution for 15min. The mixture was filled in burette and dropped into the beaker which contains 0.05 M CaCl2.2H2O.

Immobilization Sodium alginate (SA) (Loba Chemie) 2% w/v and 4% w/v of Poly vinyl alcohol (PVA) (Sisco Research Laboratories-SRL) dissolved separately in hot Milli-Q water and the blend of polymer solution was made by SA solution added drop wise to PVA solution under magnetic stirring for 30 min at 50^0C. Pretreated *Skeletonema costatum* biomass 4% w/v was added to the blended mixture under stirring with magnetic stirrer.

The blended uniform solution was suspended drop wise using peristaltic pump into 0.05 M $CaCl_2$ $2H_2O$ (Loba Chemie) and 10 w/v of H_3BO_3 mixture present in beaker on gentle rotations on magnetic stirrer.

The formed Algal beads were cured at half strength of $CaCl_2.2H_2O$ and H_3BO_3 mixture solution for 24 h. The blended beads were used as sorbent for further experimentation of the removal of lead ions.

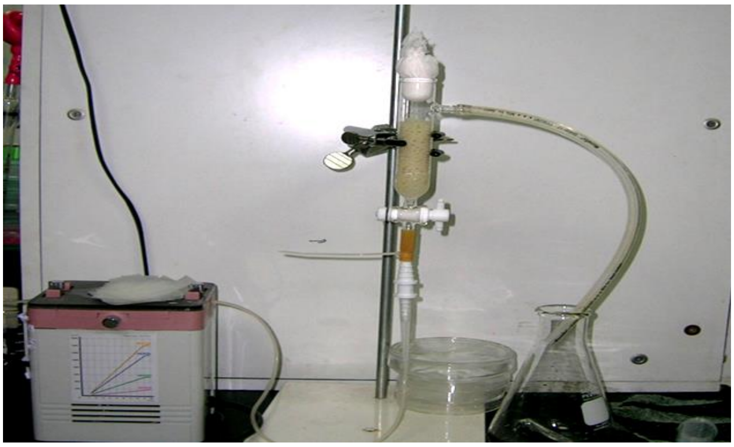

Figure 1. Peristaltic Pump

Figure 2. Ca-alginate beads

- ✓ Sodium alginate is prepared from marine alga, so it self-having the capacity to complex with heavy metal ions due to may be presence of –COOH groups at the sugar molecules but the capacity is very less.
- ✓ To determine the amount of metal ions complexed with the blank alginate beads. The above experiments were carried out in this tenure of research.

Results and Discussion

Removal of Lead Metal utilizing *Skeletonema costatum* has many influencing factors which incorporate portrayal (FTIR, SEM), harmony examines (contact time, pH, concentration, biosorbent dose, temperature), Isotherms (Langmuir, Freundlich, Temkin), Kinetics (Lagergren First Order, Pseudo Second Order), Thermodynamics (Entropy, Enthalpy and Gibb's Free Energy).

Effect of contact time

Time required for the term of harmony sorption for metal fixation to each a consistent incentive during sorption. In figure 3 the balance fermentation time is controlled by plotting the % removal of lead metal with *Skeletonema costatum* against contact time in the timespans from 1 to 180 min and is shown in Figure 3. In the initial 15 min, for 4 mm beads of 10 g/L sorbent, 24% (6 mg/g) of lead metal with *Skeletonema costatum* is sorbed. By arriving at 57.5% the % sorption is expanded energetically up to 60 min (14.375 mg/g) the % sorption is consistent past 60 min which demonstrates the achievement of balance conditions.

In 50 ml of fluid arrangement (Co = 20 mg/L) the most extreme sorption of 57.5% is achieved for 60 min of tumult time with 10g/L of 4mm beads sorbent blended. In the underlying stages the pace of sorption is quick on the grounds that satisfactory surface territory of the sorbent is accessible for the sorption. Due to Van der Waals powers of fascination as the time builds more measure of lead metal with *Skeletonema costatum* is ingested onto the outside of the sorbent. The outcome accessible in surface region is diminished. Over the surface the adsorbent, regularly shapes a meager one particle thick layer. The limit of the adsorbent is depleted when this monomolecular layer covers the Surface [07-11].

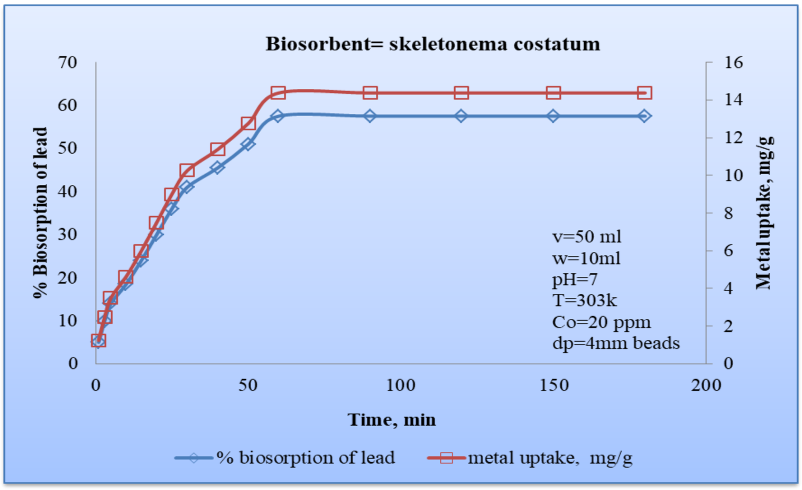

Figure 3. Effect of Agitation Time on % removal of lead Metal

Effect of pH

The surface charge of the adsorbent impacts the pH, the types of adsorbate in sorption and the level of ionization. In figure 4 the impact of pH of watery arrangement (Co=20mg/L) on% expulsion of lead metal with *Skeletonema costatum* by unsettling 10g/L of 4mm beads sorbent for 60 min is drawn. For pH estimation of 2 to 8 the % expulsion is expanded from 52.5 to 62% and it is expanded from 2 to 6 and afterward diminished past pH estimation of 6 arriving at 62%. On the adsorbent surface for fitting locales low pH discourages sorption of lead metal particles, which might be because of rivalry with H+ particles. Anyway framing piece of the surface practical gatherings, for example, OH, COOH, etc. [12-16].

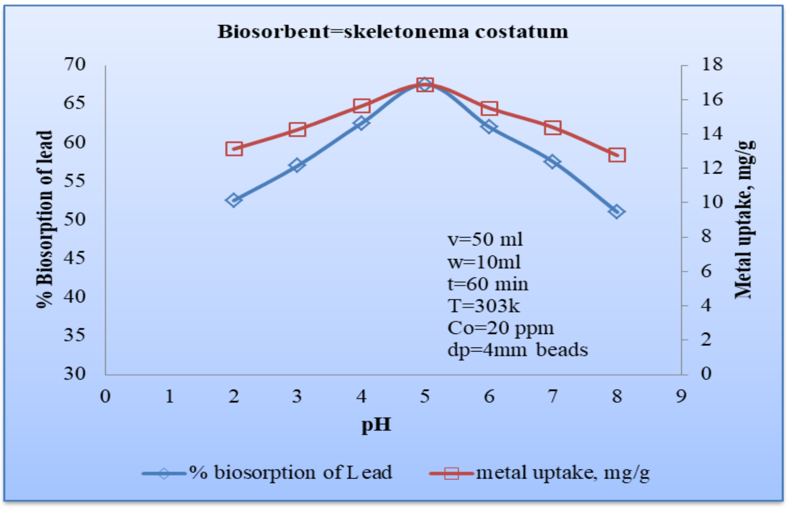

Figure 4. Effect of pH on % sorption

Effect of Initial Concentration of lead metal with *Skeletonema costatum*

In figure 5 it is demonstrated the impact of beginning centralization of lead metal with *Skeletonema costatum* in the fluid arrangement on the % removal of lead metal with *Skeletonema costatum*. While the take-up limit is expanded from 15.5 to 50 mg/g the % removal of lead metal with *Skeletonema costatum* is diminished from 62 to 40% by expanding in Concentration from 20 mg/L to 100 mg/L. To the constant number of accessible dynamic destinations on the adsorbent and expanded in the measure of adsorbent is the conduct on which it tends to be attributed [17-21].

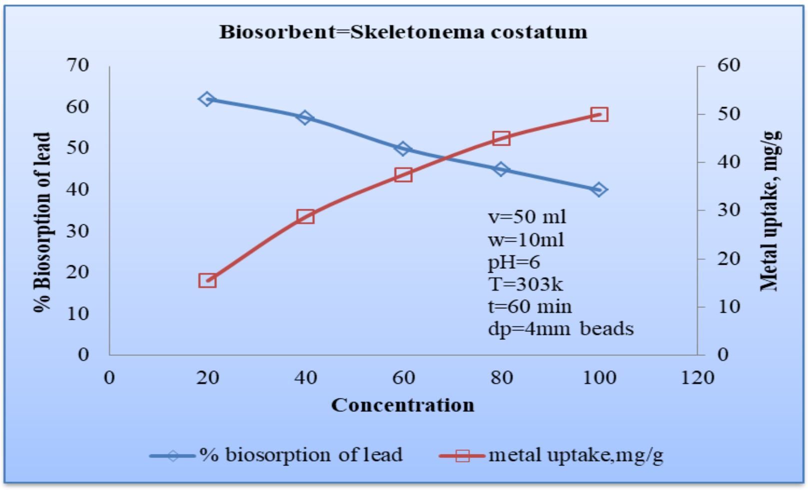

Figure 5. Effect of Initial Concentration of lead for the sorption

Effect of sorbent dosage

In figure 6 the sorbent measurement is drawn against the % removal of lead metal with *Skeletonema costatum* dosage. With an expansion in sorbent dose from 10 to 50 g/L, the removal of lead metal with *Skeletonema costatum* incremented from 62 to 77%. The quantity of dynamic locales accessible for lead metal with *Skeletonema costatum* expulsion would be more and this conduct is evident in light of the fact that the sorbent measurements are expanded. At the point when 'w' is expanded from 10 to 30 g/L the change in % removal of lead metal with *Skeletonema costatum* is minor. Along these lines, every single other investigation are directed at 30 g/L sorbent dosage [22-26].

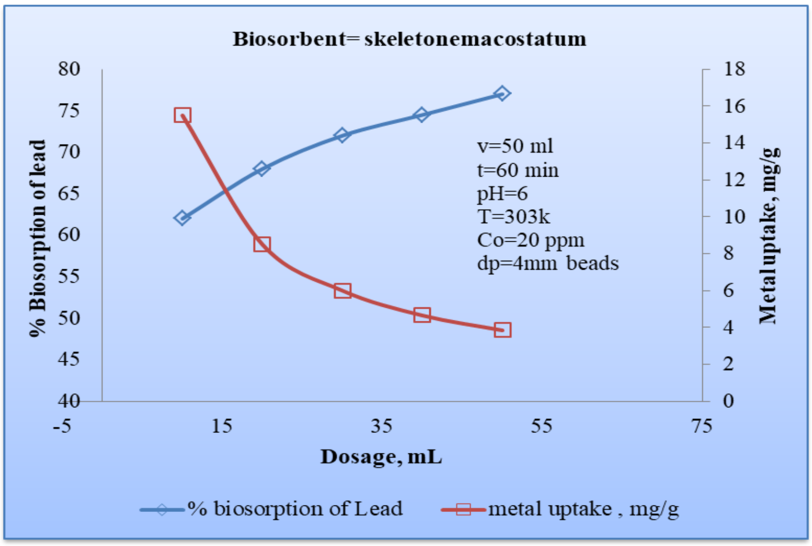

Figure 6. Effect of sorbent dosage on % sorption

Effect of temperature

On the harmony metal take-up the impact of temperature was noteworthy. In figure 7 the impact of changes in the temperature on the lead metal with *Skeletonema costatum* take-up is appeared, lead metal with *Skeletonema costatum* take-up in enhancing with expanding temperature when the temperature was lower than 303K just as it is in shift minute when the temperature was over 303K.

An alternate cooperation between the lead metal with *Skeletonema costatum* and the ligands on the cell is recommended by this reaction. Compound sorption mechanics assumed a significant job in the entire sorption process beneath 303K and it was relied upon temperature. The minimal is expanded at higher temperatures [27-31], hence neglected and 303K was considered as optimum.

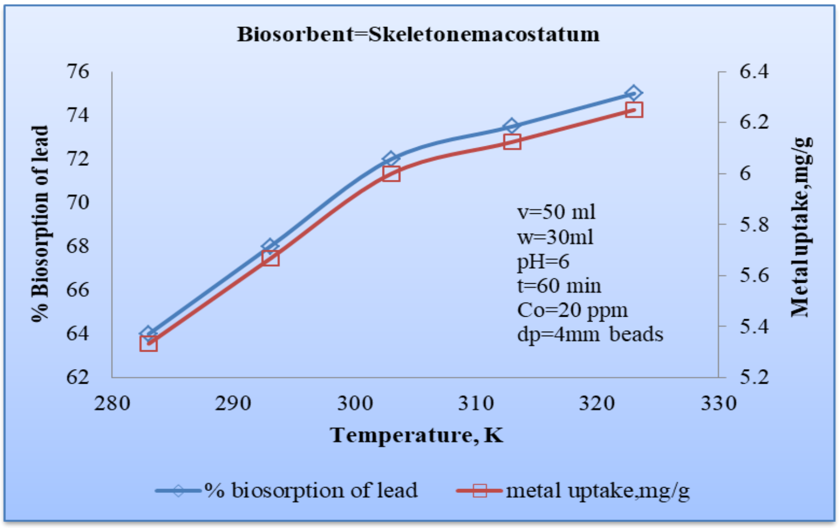

Figure 7. Effect of temperature for the sorption

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