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Studies on Sorption of Nickel Metal Using Immobilized Biomass of *Skeletonemacostatum* Microalgae

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Abstract: Ecosystem is deteriorating day by day due to Industrial effluents. The effluents are containing toxic chemicals which are in turn polluting ground drinking water and creating new diseases. Treatment methods for these Industrial effluents are becoming more costly. The Present study is aimed and focused at decreasing the toxicity of Industrial waters and the target is Reduction, Recycle and Reuse (RRR) using sorption. The objective in this study is to obtain maximum sorption capacity of nickel ions by using immobilized *Skeletonemacostatum* microalgae as sorbent. The influence of various parameters, such as pH (2-8), Contact time (1-180 min), sorbent dosage (10-60 g/L), Initial nickel concentration (20-200 mg/L), Temperature (283-323 ^{0}C) were investigated. Under this study the maximum sorption capacity of nickel (%) is observed at the optimum conditions of Contact time 50 min, pH 7.0, Biosorbent dosage 40 g/L, Initial nickel concentration 20 mg/L, Temperature 303^{0}C.

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Introduction

The presence of heavy metals in the environment is of major concern because of their extreme toxicity and tendency for bioaccumulation in the food chain even in relatively low concentrations [1]. Research and development, therefore focuses on sector-specific methods and technologies to remove colour and heavy metals from different kinds of waste streams [2, 3]. In view of the above toxicological effects of dyes and heavy metals on environment [4], animals and human beings, it becomes imperative to treat these toxic compounds in wastewater effluents before they are discharged into freshwater bodies [5,6]. Direct azo dyes, in particular, have great environmental concern due to their low removal rate during aerobic waste treatment and their degradation products, such as toxic aromatic amines [7]. However, significant reduction of expenses and/or enhancement of dye removal can be achieved e.g., by the combination of different methods in hybrid treatments [8]. Adsorption is one of the processes, which besides being widely used for dye removal also has wide applicability in wastewater treatment [9]. Moreover, the process is ecofriendly, rapid, easy to operate and independent of the physiological constraints of living cells [10].

The valorization of agricultural wastes into valuable materials without generating pollutants is a big challenge and recommended for an industrial sustainable development in order to preserve the environment [11]. Among several chemical and physical methods, adsorption process is one of the effective techniques that have been successfully employed for color removal from waste water [12]. Biosorption processes offer the advantages of low operating costs, high selectivity and efficiency, good removal performance and regeneration ability [13–17].

Experimental Procedure

Preparation of biosorbent (Figure 1 & 2): *Skeletonemacostatum* 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 NaEDTA 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 for15min. The mixture was filled in burette and dropped into the beaker which contains 0.05 M CaCl2.2H2O.

Immobilization Sodium alginate (SA) (LobaChemie) 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 *Skeletonemacostatum* 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 $CaCl_2.2H_2O$ (LobaChemie) 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 nickel 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 nickel metal utilizing *Skeletonemacostatum* has many influencing factors which incorporate characterization (FTIR, XRD, SEM), equilibrium studies (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). Finally, Optimization using Central Composite Design. The present study will emphasis on equilibrium studies.

Effect of contact time

During sorption time required for nickel metal with *Skeletonemacostatum* focus to arrive at a steady worth is characterized as length of harmony. By plotting the % sorption of nickel against tumult time is dictated by the balance of disturbance time is appeared in the figure 3 for the cooperation time spans between 1 to 180 min. In the initial 5 min 14 % (3.5 mg/g) of nickel is sorbed for 4mm beads of 10 g/L sorbent measurement. Up to 50 min arriving at 51% (12.75mg/g) the sorption % is energetically expanded.

The % sorption is steady showing the accomplishment of harmony conditions past 50 min. In 50 ml of watery arrangement (Co=20 mg/L) the most extreme sorption of 51% is achieved for 50 min of disturbance time with 10g/L of 4mm beads sorbent blended. In the underlying stages the pace of sorption is quick on the grounds that sufficient surface region of the sorbent is accessible for the sorption of nickel metal with *Skeletonemacostatum*. It is brought about abatement of accessible surface region as time expands more measure of nickel metal with *Skeletonemacostatum* gets sorbed on to the surfaces of the sorbent due to Van der Waal powers of attractions. Over the surface the sorbate regularly frames a dainty one particle thick layer. The sorption limit is depleted when this monomolecular layer covers the surface. At 50 min the most extreme level of sorption is accomplished. After 50 min the % sorption of nickel metal with *Skeletonemacostatum* gets steady. In this way, all different analyses are directed at this unsettling time [18-20].

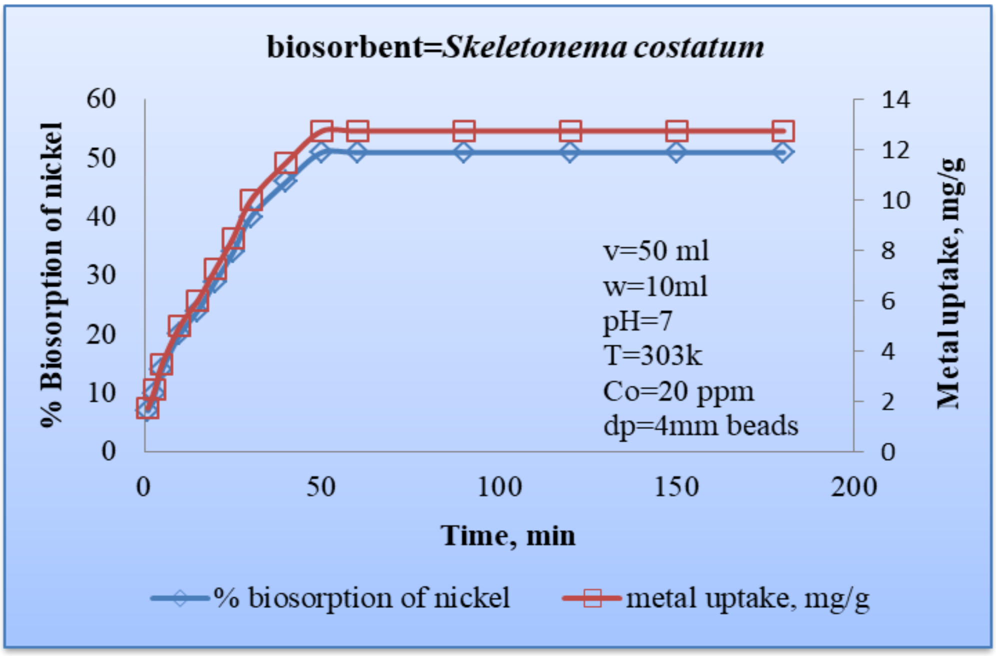

Figure 3. Effect of agitation time on % sorption of nickel metal

Effect of pH

The level of ionization pH controls sorption by impacting the surface difference in the sorbent and the types of sorbate. The scope of pH scope of 2 to 8 of the fluid arrangement (Co=20 mg/L) utilizing 10g/L of 4 mm beads sorbent in the current examination nickel metal with *Skeletonemacostatum* sorption information are gotten. In figure 4 the impact of pH of fluid arrangement on % sorption of nickel metal with *Skeletonemacostatum.* As the pH is expanded from 2 to 7, rate expanded from 33 to 51%. From pH 7 to 8 arriving at 51 to 46 % sorption is diminished.

For proper destinations on the sorbent surface low pH discourages sorption because of rivalry with H+ particles. This opposition debilitates with expanding pH and nickel metal with *Skeletonemacostatum* particles supplant H+ particles bound to the sorbent [21-23].

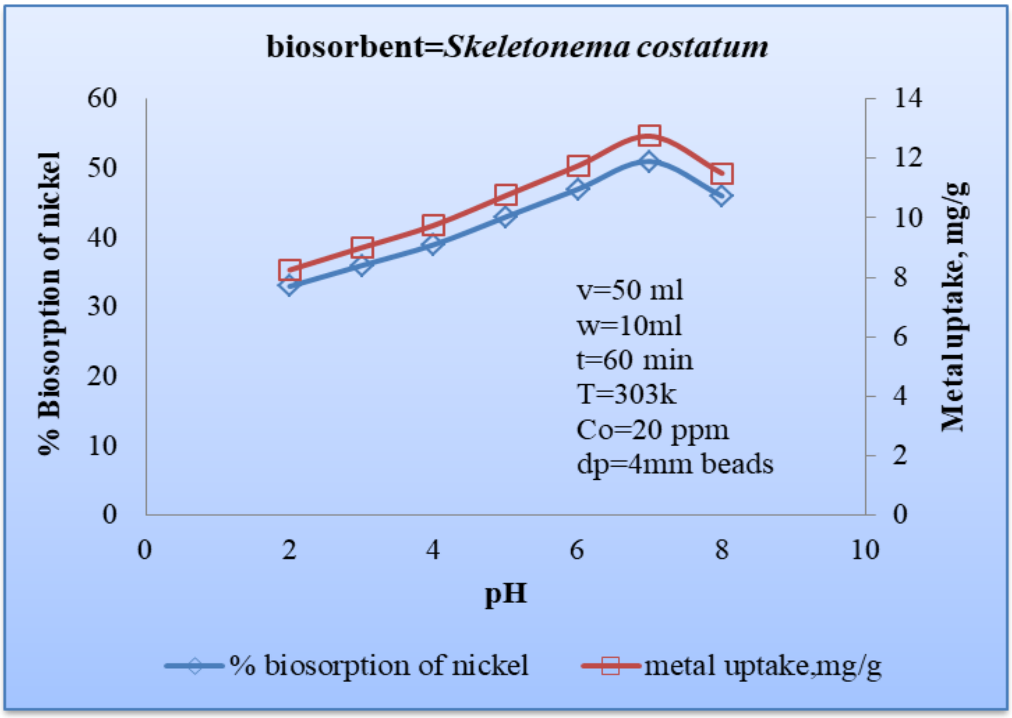

Figure 4. Effect of pH on % sorption

Effect of nickel metal concentration with *Skeletonemacostatum*

The figure 5 shows the impact of introductory grouping of nickel metal with *Skeletonemacostatum* in the fluid arrangement on the % sorption of nickel metal with *Skeletonemacostatum*. With an expansion in Co from 20 to 100 mg/L the % sorption of nickel metal with *Skeletonemacostatum* is diminished from 51 to 37%. To the expansion in the measure of sorbate to the perpetual number of accessible dynamic locales on the sorbent, this conduct can be attributed [24-26].

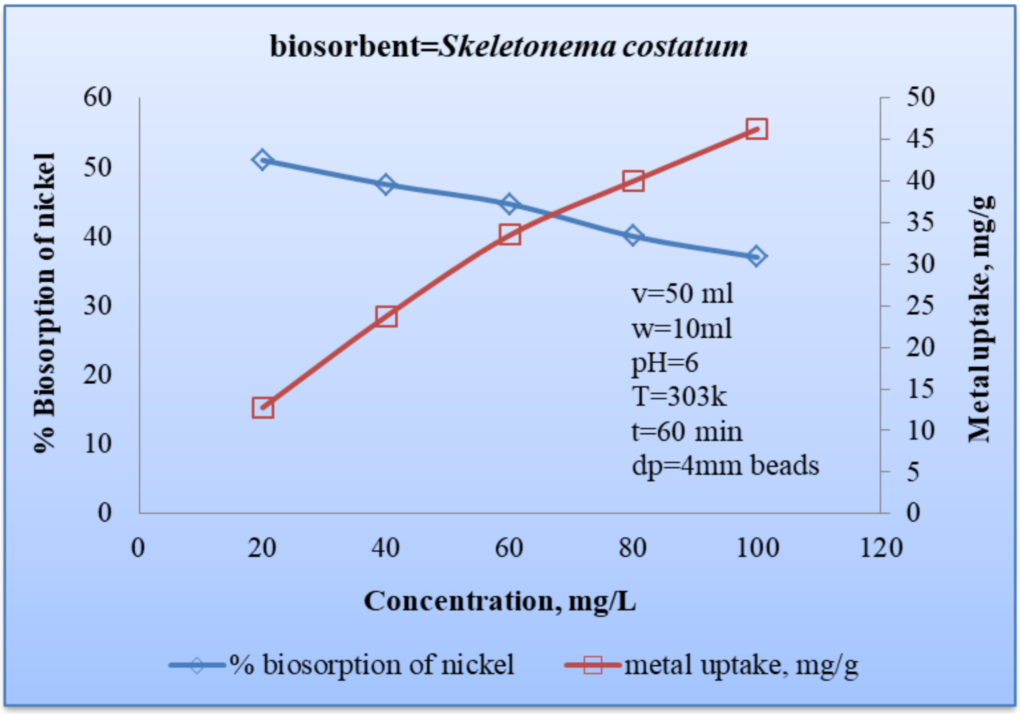

Figure 5. Effect of initial concentration for the sorption

Effect of sorbent weight

The figure 6 is drawn against the % sorption of nickel metal with *Skeletonemacostatum* and sorbent measurement for 4 mm beads sorbent. From 10 to 40 g/L the sorption of nickel metal with *Skeletonemacostatum* expanded from 51 to 71% with an expansion in sorbent measurement.

With an expansion in sorbent dose this conduct is evident in light of the fact that the quantity of dynamic locales accessible for nickel metal with *Skeletonemacostatum* sorption would be more. At the point when 'w' is expanded from 30 to 40 g/L the adjustment in rate sorption of nickel metal with *Skeletonemacostatum* is minimal from 65 to 71%. At 40 g/L measurement subsequently all different examinations are conducted [27-29].

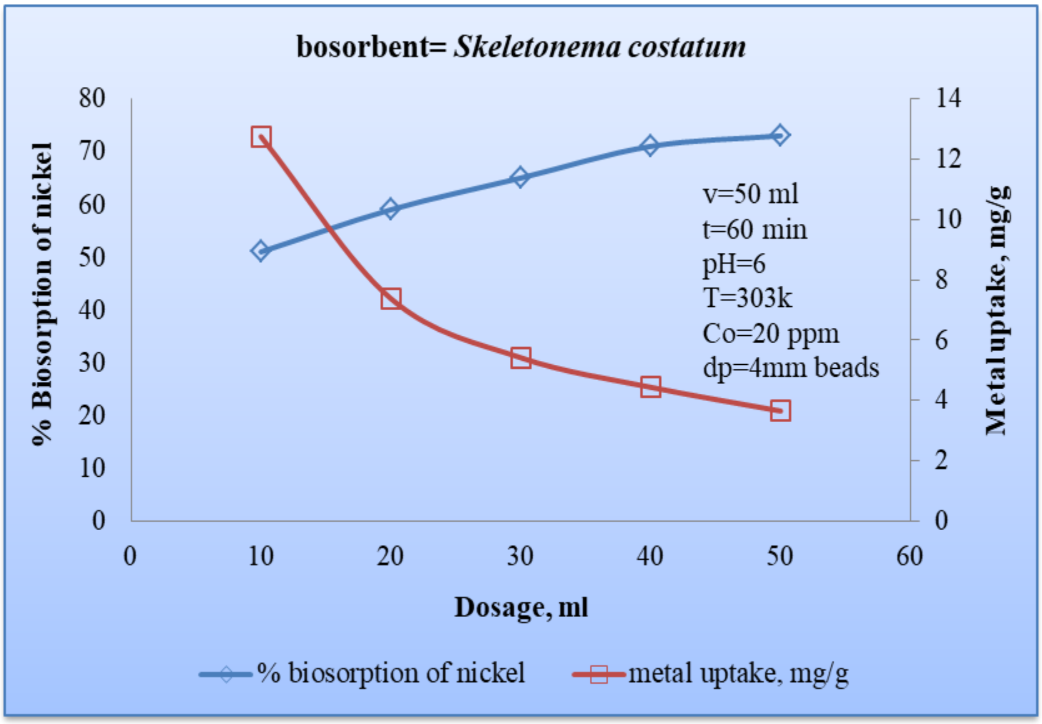

Figure 6. Effect of sorbent dosage on % sorption

Effect of Temperature

On the harmony nickel metal with *Skeletonemacostatum* take-up was huge on the impact of temperature. In figure 7 the impact of changes in the temperatures on the nickel metal with *Skeletonemacostatum* take-up. With expanding temperature when temperature was lower than 303 K nickel metal with *Skeletonemacostatum* take-up. The nickel metal with *Skeletonemacostatum* and this reaction proposed an alternate connection between the ligands on the cell divider.

Concoction sorption systems assumed a prevailing job in the entire sorption process under 303 K and was relied upon to increment by increment in the temperature. The rate adsorption expanded from 63.5 to 73%.

The biomass powder were in a non-living state while at higher temperature and physical sorption turned into the fundamental procedure. Over 303 K the sorption for the current examination has expanded as the procedure is endothermic. There is a slight increment in % sorption is found with further increment in temperature [30-32].

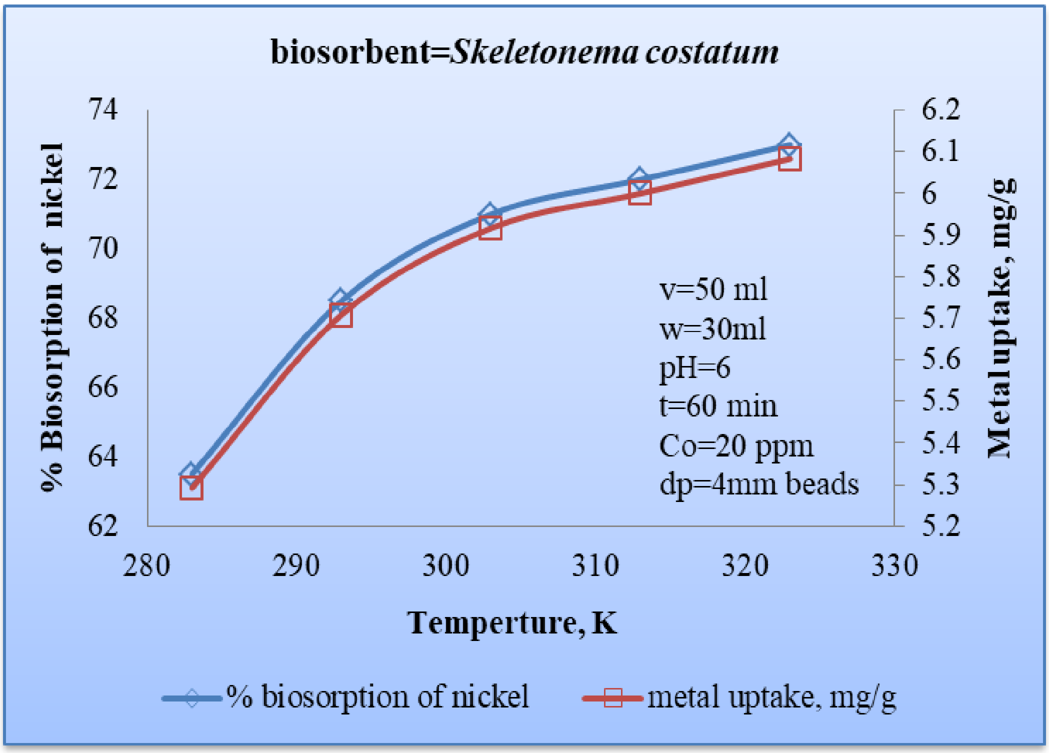

Figure 7. Effect of temperature for the sorption

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