Textile Wastewater Treatment Using Crab and Shrimp Chitosan

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***Abstract*-Discharging of textile effluent in to the nearby water bodies becomes a significant threat to environment mostly to the aquatic life. Textile effluent has so many offensive properties like strong odor, strong colour, Turbidity, alkalinity, Toxicity etc. The increase in the content of these objectionable properties results in to adversative effects which influences the marine organisms. Adsorption is simple and rapid technique. This is most often used pretreatment technique to treat the effluent. However, in this project work, the main concern is the preparation of chitin and chitosan from the raw materials of shrimp and crab shells. Then the prepared material has to be characterized by different characterization methods.**

Keywords: Textile wastewater, batch adsorption, Column adsorption. COD, Turbidity, Colour.

I. INTRODUCTION

The textile industry is confronted with serious environmental problems associated with its immense wastewater discharge, Substantial pollution load, extremely high salinity, heavily coloured effluent. Particular sources of recalcitrance and toxicity in dye-house effluent are two frequently used textile auxiliaries; i.e. dye carriers and biological finishing agents. Disposal of dyeing industry wastewater pose one of the major problems, because such effluents contain a number of contaminants including acid or base, dissolved solids toxic compounds and colour . Out of these, colour is the first contaminant to be recognized because it is visible to the human eye. Removal of many dyes by conventional waste treatment methods is difficult since these are stable to light and oxidizing agents and are resistant to aerobic digestion.

Adsorption is an efficient and economically feasible process for separation and purification. It plays an important role in a number of natural and industrial systems. The performance of any adsorption-based process greatly depends on the effectiveness of its design and operating conditions. There are a number of configurations dedicated to undertaking adsorption separation and purification process such as batch, fixed-bed and fluidized bed. In a batch operation, the adsorbent and adsorbate are in contact for a period of time until equilibrium is reached. In a column operation, adsorbate continuously enters and leaves the column; therefore equilibrium is never achieved at any stage.

II. MATERIALS AND METHODS

A. Preparation of chitin from raw samples

Chitin can be prepared from the raw samples of shrimp and crab shells. Depending upon the concentration of reagent taken, the different types of chitin are obtained. As a whole this process involves various major steps:-

1) Preconditioning:

Fresh samples of shrimp and crab shells were used here. Both the samples were washed thoroughly with water and dried in sunlight for 24 hrs. The samples were dried and weight of samples was recorded.

2) Deproteinization

In this stage a magnetic bead has put inside the solution and process is carried out on the electro-magnetic stirrer for time period of 30 minutes. The resulting solution then washed with distilled water several times up to when the neutrality of the solution is not obtained.

3) Demineralization

In this stage, a magnetic bead has been put inside the solution and the process is carried out on the magnetic stirrer for time period for 30 minutes. The solutions were continuously stirred. The resulting solution then washed with distilled water several times up to when the neutrality of the solution is not obtained. Then the demineralized sample is then filtered with the help of the vacuum pump and dried in an oven for a period of 2 hours at 60^0C. Then it is weighed which is none other than purified chitin.

B. Preparation of chitosan from chitin

1) Deacetylation

The weighed sample of chitin is taken in a round bottom flask and 40% NaOH is added to it. Then the flask put inside a water bath. The beaker is placed on the magnetic stirrer cum heater. The temperature is maintained throughout the process is 100^0C. The heating process is carried out for a period of 3 hours.

2) Purification

After the deacetylation process, the prepared samples from the flask is taken and washed several times with the help of vaccum pump up to the time when the solution became neutral. When the neutrality of the solution is obtained, the sample is filtered properly with the filter paper.

3) Drying

The filtrate is then dried at 60^0C in an oven for a time period of 3 hours. Then the dried samples can be collected with the help of a scrapper and weighed. The weighed sample is then grinded with help of grinder. The sample prepared is chitosan.

III. EXPERIMENTAL PROCEDURE

A. Sample collection and materials

Sample of textile wastewater was collected from a textile company nearer to Kozhikode, Kerala, India. The sample had been stored in the refrigerator in order to minimize the changes in the characteristics of wastewater sample since it may vary from day to day. Chitosan obtained from crab and shrimp shells in powdered form is used as coagulant.

B. Batch adsorption

1) Coagulant preparation

Stock solution should be prepared before starting the experiment. Prepare a solution of chitosan such that 1 ml of solution represents 3mg of chitosan and then acetic acid was added inorder to dilute the chitosan powder. The purpose of addition of acetic acid was chitosan soluble in acidic solution, which makes it more available for application.

B. Column adsorption

For removal of COD, colour, Turbidity and Total solids continuous column experiments of textile wastewater were carried out in a glass column with internal diameter 2cm. The column was provided with bed height at 3cm intervals.

At the bottom of the column 2cm high layer of glass beads were used to ensure uniform inlet flow to the column. For each experiment column was packed with a chitosan adsorbent (both shrimp and crab separately) and over this glass beads to a height of 2.5cm. The wastewater was introduced in to the column in top to bottom mode using a peristaltic pump at constant flow rate of 10ml/min. Before wastewater was passed through the column, deionised water was pumped through the column in a down flow direction. Effect of bed height (3, 6, 9 and 12cm) and pH (4, 6, 8, and 10) were studied.

IV. RESULT AND DISCUSSION

A. Batch adsorption

1) Effect of chitosan dosage

The effect of dosage of chitosan was studied by varying the dosage from 0.3 to1.5g/L while making other parameters constant (pH=6, mixing time=60, mixing rate=50 rpm). It was found that as the dosage of chitosan was increased, the percentage removal of COD, Turbidity and Colour also increased as shown in fig 1. For optimum dosage of 0.9g/L Crab chitosan recorded the highest percentage reduction in Turbidity (78.3%), Total solids (80.15%), COD (64.1%), Colour (81.6%). Insufficient dosage or over dosing would result in the poor performance in flocculation.

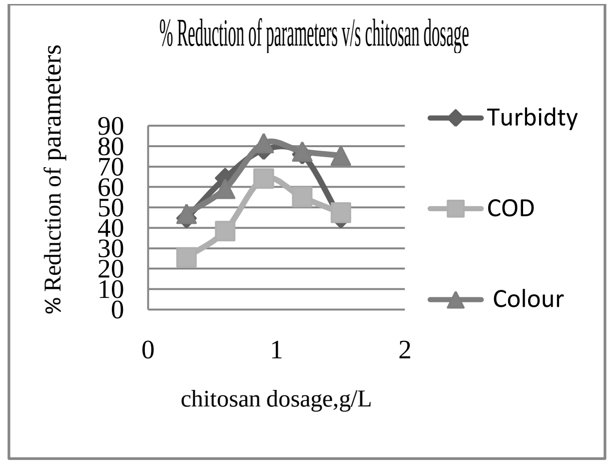

Fig 1. Effect of chitosan dosage for COD, Turbidity, Colour (pH=6).

2) Effect of mixing time

The variation of mixing time was studied in the range of 15-75min. to get possible result. Mixing time plays an important role on flocculation and coagulation process. Dispersion of flocculation and adsorption of particle takes place during mixing period. The suspension was stirred at different time intervals and optimum time was found to be 60min. The results are as shown in fig 2.

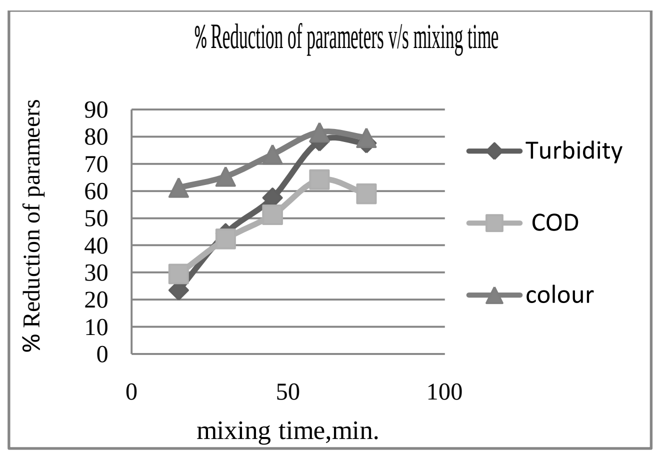

Fig 2. Effect of mixing time for COD, Turbidity Colour (pH=6).

3) Effect of pH

The pH will not only affects the surface charge of coagulants, but also affect the stabilization of suspension. Besides the solubility of chitosan in aqueous solution is influenced by pH value. Therefore, the study of pH was essential to determine the optimum pH condition of the treatment system. It is observed that the best performance was achieved at a pH=6 and the parameters reduction was poor when pH was less or greater than 6,which is shown in fig 3.

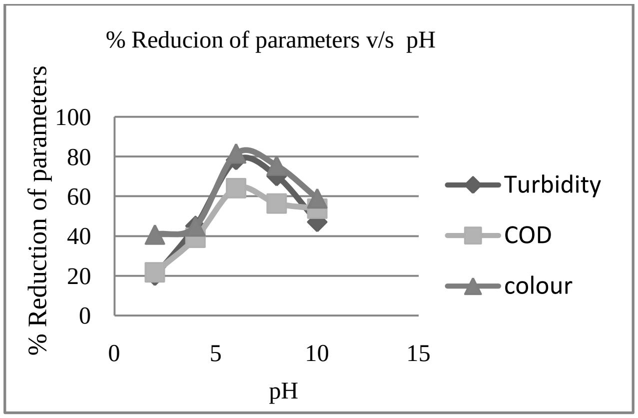

Fig 3. Effect of pH for COD, Turbidity Colour (pH=6).

B. Column adsorption

1) Effect of bed-height

The effect of bed height for removal of Turbidity, Total solids, COD, color from textile waste water using crab chitosan bed at height of 3, 6, 9,12cm at constant flow rate 10ml/min. Were mentioned fig. The breakthrough time increased with increasing the bed height of 3 to 12 cm was lies above 180min. for turbidity, colour, and COD

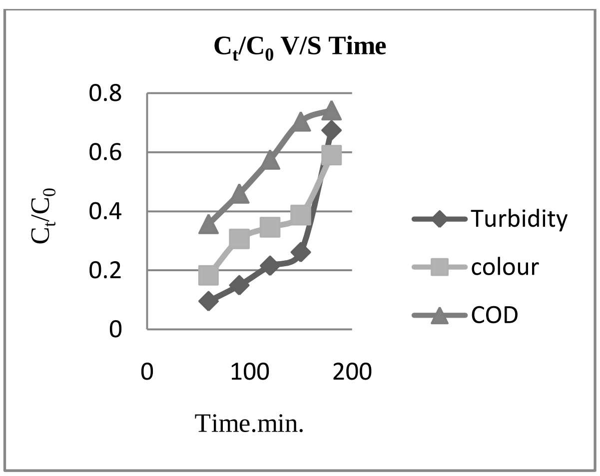

Fig 4. Break through curve for COD, Turbidity, Colour (Bed depth=3, 6, 9, 12cm, pH=4, Q=10mL/min)

2) Effect of pH

Fig.4.15 and Fig.4.16 represents the effect of pH for Turbidity, COD and color removal respectively on the breakthrough curves, in which textile wastewater were inserted at flow rate 10 ml/min, through the crab chitosan packing column controlling pH 4, 6, 8 and 10 and then after the sample was collected from at bed-height of 12 cm. The breakthrough time increased with increasing pH, in Further, column was difficult to be completely exhausted at basic pH i.e. the breakthrough was much higher, found to be lies above 180 min for Turbidity, colour and COD.

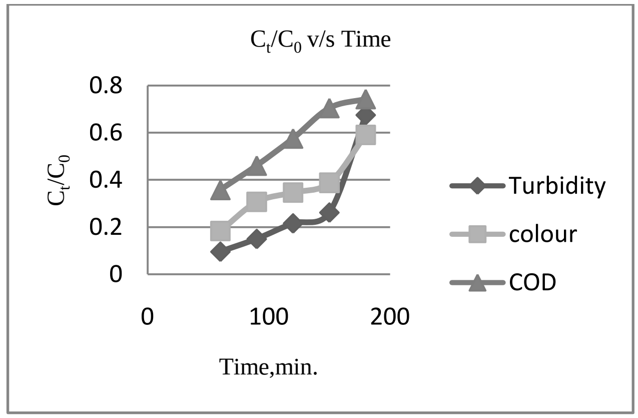

Fig 5. Break through curve for COD, Turbidity, Colour (Bed depth=12cm, pH=4, 6, 8, 10, Q=10mL/min)

V. CONCLUSION

Chitosan prepared from crab and shrimp shells were found to be good sources of adsorbent. From the batch experimental study, the percentage reduction of COD, Turbidity, Total solids and colour of textile wastewater by using crab chitosan were found to be 64.1%, 78.3%, 80.15% and 81.6% respectively. On the basis of column experimental study, percentage reduction of COD, Turbidity, Total solids and colour of textile wastewater by using crab chitosan were found to be 65.3%, 94.2%, 82.6% and 85.7% respectively. While comparing both batch and column adsorption process, Column adsorption provides efficient treatment for textile waste water than batch adsorption.

REFERENCES

[1] **Abbasi Z** and **Alikaami M** (2012), Kinetics and thermodynamics studies of acetic acid adsorption from aqueous solution by peels of banana, *j.Biochemistry and Bioinformatics*, vol.1, pp.1-7.

[2] **Alaton I.A. Insel G, Eemektar G, Babuna F.G** and **Orhon D** (2006), Effect of Textile Auxiliaries on the Biodegradation of Dye house Effluent in Activated Sludge, *j.chemosphere issue 6(2),pp.49-57.*

[3] **Albena S, Desislava K.T Saneva, Milena I.Nikolova,Tsyetko V.Pokopov, Stoyanova and panteley P.Denev** (2017), Evaluation of Adsorption Capacity of Chitosan-citral Schiff Base for Wastewater pre-Treatment in Dairy Industries, *Ecologia balkanica,* vol.9.issue 1.pp.91-102.

[4] **Dr. L. Nageswara Rao** (2015), Coagulation and Flocculation of industrial wastewater by chitosan, *International journal of engineering and applied science,* vol.2.issue-7.pp.50-52.

[5] **Hima karnika Alluri, Srinivasa Reddy Ronda, Vijaya saradhiSettalluri,Jayakumarsingh,Bondili,Suryanaayana.V** and **Venkateshwar** (2007),Biosorption: An eco-friendly alternatively for heavy metal removal, *African journal of Biotechnology*,25,pp.2924-293.

[6] **M.Geetha Devi, Joefel Jessica Dumaran** and **S.Feroz** (2003), Dairy waste water treatment using low molecular weight crab shell chitosan. *J.Inst Eng.India Scr.E,*Vol.93(4),pp.9-14.

[7] **Majeti N.V** and **Ravi kumar** (2000),A review of chitin and chitosan applications, *j.Reactive and Functional polymers*,vol.1,pp.27-36.

[8] **Mohamed Abu-Shoer (2010),** A Simple Colorimeric Method for the Evaluation of chitosan,*American journal of Analytical Chemistry*,vol.2,pp.91-94.

[9] **Mohammad taghi Vakil** and **Mohd Rafatullah** (2104),Application of chitosan and its derivatives as adsorbents for dye removal from wastewater, *j.Cabohydrate polymers*,1(13),pp.115-130.

[10] **Poots, V.J**. and **Healy** (1978), Removal of basic dye from effluent using wood as an adsorption,*Water pollut.control Fed.50,pp.926-935*.