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Application of Chitosan powder to enhance the properties of distillery spent wash

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ABSTRACT- Sugarcane molasses-based distillery effluent dumping into the environment is risky and has high pollution potential. Very high COD, BOD, total nitrogen and total phosphate content of the wastewater may consequence in eutrophication of natural water bodies. The highly colored components of the molasses wastewater reduce sunlight penetration in rivers, lakes or lagoons which in turn decrease equally photosynthetic activity and dissolved oxygen (D. O) concentration affecting aquatic life. Onsite anaerobic treatment technology has been implemented but still 100% chemical oxygen demand (COD), and biochemical oxygen demand (BOD) are not removed, so further post treatment is must to safely dispose the effluent. Application of chitosan powder as an adsorbent plays active role to remove the impurities and ingredient present in distillery effluent. Different parameters are enhanced by the application of chitosan powder. 93.33% COD degradation has been achieved by application of 10 gm of chitosan powder.

Keywords: - Chitosan Powder, distillery spent wash, chemical oxygen demand, Melanoidin.

1. INTRODUCTION

Sugarcane molasses is the consequence of sugar industry which generated throughout sugar manufacturing sugarcane molasses comprises 50 % fermentable sugar and about 4 to 10 kg of molasses which is required for 1 l of alcohol production [1, 2]. Sugar molasses is the dark brown, rotten, viscous liquid. Sugar molasses is the most common feed stock for industrial fermentation processes, molasses are diluted 1- 3 fold for successful fermentation process and manufacturing of spirit, alcohol and ethanol [3, 4]. Distillery Spent wash is highly acidic, having strong odour, variety of recalcitrant colouring pigment as melanoidins, metal sulfides and phenolics are responsible for dark brown colour of spent wash [2, 4, 5]. During manufacturing the ethanol, rectified spirit and alcohol spent wash is generated with huge quantity, during the ethanol production around 8 – 15 l of spent wash generated [2, 6]. Melanoidin is the color pigment formed during the Maillard reaction between the amino acid and sugar, which having high molecular weight [2, 6, 7]. Intense dark brown colour present in melanoidin is interfering the photosynthesis process by blocking sunlight rays, aquatic plant and animals are highly affected. To disposal the cumbersome, toxic distillery effluent anaerobic method has been implemented since 1980 and proved to be primary treatment to handle the distillery effluent. As effluent is complex cumbersome single primary treatment is not sufficient to dispose the effluent safely on ground. As day by day rules and legislation are mandatory for disposal of distillery effluent secondary treatment is must to dispose the effluent safely. In this paper chitosan powder is used as adsorbent to dispose the effluent effectively. Chitosan is a semi crystalline polymer in the solid state. Chitosan has been shown to be biologically renewable, biodegradable, biocompatible, non-antigenic, non-toxic and biofunctional. Chitin, the second-most abundant biopolymer, and its deacetylated product, chitosan, are high molecular-weight biopolymers and are recognized as versatile, environmentally friendly raw materials [8]. This paper illustrates application of chitosan powder to distillery industry.

2. MATERIAL

Chitosan powder has been procured from commercial seed supplier Meck Pharmaceuticals and Chemical limited Ahmedabad, having properties such as low density, off white to brown colour, sparingly soluble to 1% acetic acid. Distillery spent wash has been collected from Pravara Loni distillery plant and has been stored in refrigerator to maintain the temperature of the sample. Effluent were analysed for different test such as pH, chemical oxygen demand, total dissolved solids, as per the standard method of analysis [9]. The COD was measured by closed reflux method using potassium dichromate. H_2SO_4 and NaOH are use to adjust the pH of sample, distilled water were used to prepare the entire solution.

3. METHODS

Experimental work has been carried out which consist of application of chitosan dosages and contact time with the three different dilutions of sample as shown in Table 1 Chitosan dosage of 2g, 5g, and 10g with the corresponding contact time of 6hr, 12hr and 24hr for every sample was used with every dilution. Each diluted sample of 600ml quantity is separated into three parts of 200ml quantity all. There are overall nine samples three from each diluted sample of 200ml quantity each. All concentration sample is taken in a volumetric flask of 250ml and added with a desired chitosan dose. Each flask was shaken for one hour and the samples was filtered and collected for analysis after desired contact time. Whole adsorption test was performed at room temperature. The chemical oxygen demand (COD) determines the amount of oxygen required for chemical oxidation of organic matter using a strong chemical oxidant, such as potassium dichromate under reflux conditions. Most of the organic matters are destroyed when boiled with a mixture of potassium dichromate and sulphuric acid producing carbon dioxide and water. A sample is refluxed with a known amount of potassium dichromate in sulphuric acid medium and the excess of dichromate titrated against ferrous ammonium sulphate. The amount of dichromate consumed is proportional to the oxygen required to oxidize the oxidizable organic matter.

Table 1 Showing varying chitosan dose with contact time at different dilutions

Sample no.	25% dilution		Sample no.	50% dilution		Sample no.	100 % dilution	
	Chitosan (gm)	Duration (Hr)		Chitosan (gm)	Duration (Hr)		Chitosan (gm)	Duration (Hr)
1	2	6	1	2	6	1	2	6
2	5	12	2	5	12	2	5	12
3	10	24	3	10	24	3	10	24

Formula for COD Calculations

$$\text{COD} = \frac{(a - b) \times N \times 8 \times 1000}{\text{ml of sample}} \times \text{D.F}$$

Where,

a = ml of titrant used for black correction

b = ml of titrant used for sample

N = normality of FAS = $\frac{2.5}{\text{Blank reading}}$

$$\text{COD Removal (\%)} = \frac{\text{COD Of Blank Sample} - \text{COD Of Next Sample}}{\text{COD Of Blank Sample}} \text{X } 100$$

Following are the parameters which were analyzed initially, before adsorption for the three dilutions of 25%, 50% and 100% pure sample and with different chitosan dose and contact time. Table 2 Shows parameter analyzed before adsorption

Table 2 Parameter to be tested for different dilution

Parameters	For 25% sample dilution	For 50% sample dilution	For 100% pure sample
pH	5.4	5.99	4.29
COD(mg/l)	1200	2560	3200
TDS(mg/l)	361	491	675
DO(mg/l)	3.0	1.7	1.2

Graphs after Adsorption

The following graphs illustrate the results obtained during the analysis of spent wash. In Figure 1 COD decreases with increase in chitosan dose up to 10gm and contact time of 24hr and then attains a constant value with increase in chitosan dose and contact time. The optimum percent removal 93.33% has been observed at an chitosan dose of 10gm, contact time of 24hr with 25% diluted sample.

For 25% Effluent Dilution

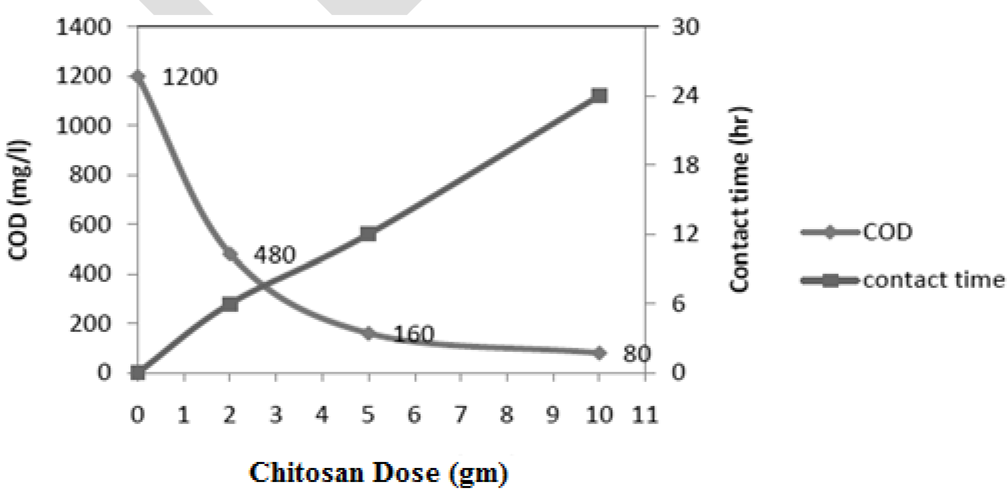

Fig 1 variation of COD with chitosan dose and contact time

In Figure 2 TDS decreases with increase in chitosan dose up to 10gm and contact time of 24hr. The maximum percent removal 70.6% has been observed at chitosan dose of 10gm, contact time of 24hr with 25% diluted sample

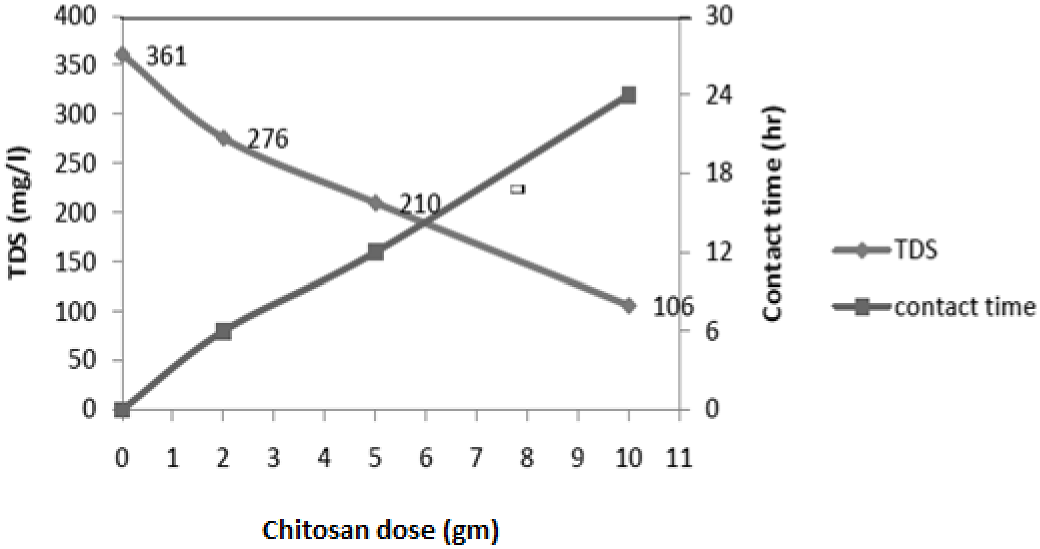

Fig 2 Variation of TDS with chitosan dose and contact time

In Figure 3 pH increases with increase in adsorbent dose up to 2gm and contact time of 6hr and then decreases with increase in chitosan dose and contact time. The maximum percent removal 25.31% has been observed at an chitosan dose of 2gm and contact time of 6hr with 25% diluted sample

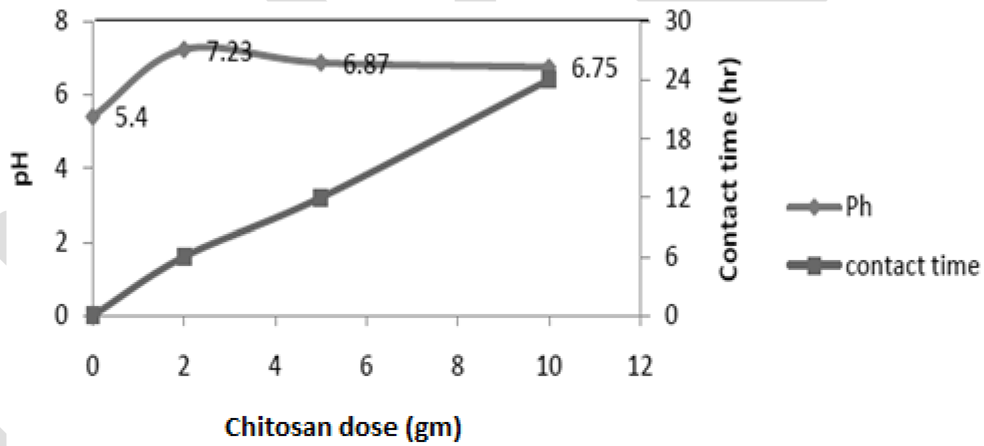

Fig 3 Variation of pH with chitosan dose and contact time

In Figure 4 DO increases up to a maximum value of 9.2 with increase in chitosan dose up to 10gm and contact time of 24hr. The maximum percent removal 67.39% has been observed at chitosan dose of 10gm, contact time of 24hr with 25% diluted sample.

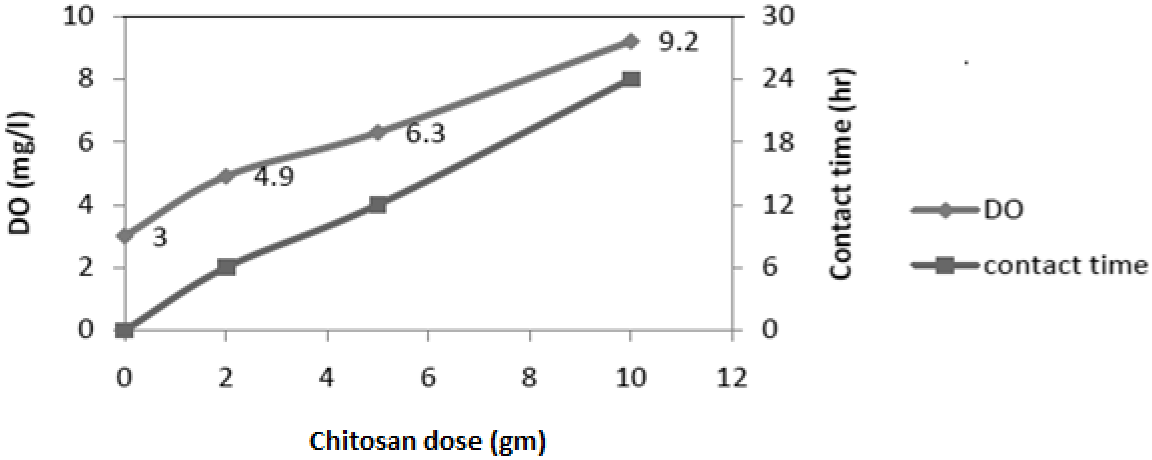

Fig 4 Variation of DO with chitosan dose and contact time

For 50% Effluent Dilution

In Figure 5 DO increases up to a maximum value of 8.5 with increase in chitosan dose up to 10gm and contact time of 24hr. The maximum percent removal 80% has been observed at chitosan dose of 10gm, contact time of 24hr with 50% diluted sample.

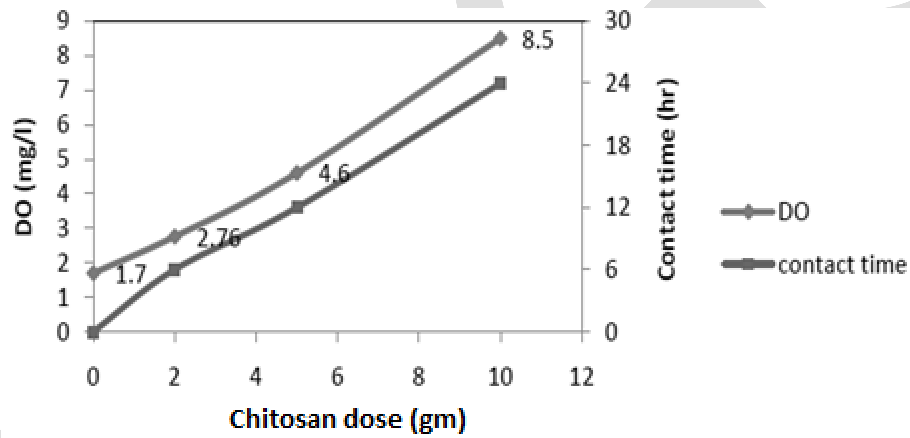

Fig 5 Variation of DO with chitosan dose and contact time

In figure 6 pH increases with increase in chitosan dose up to 5gm and contact time of 12hr and then decreases with increase in chitosan dose and contact time. The maximum percent removal 20.13% has been observed at an chitosan dose of 5gm, contact time of 12hr with 50% diluted sample

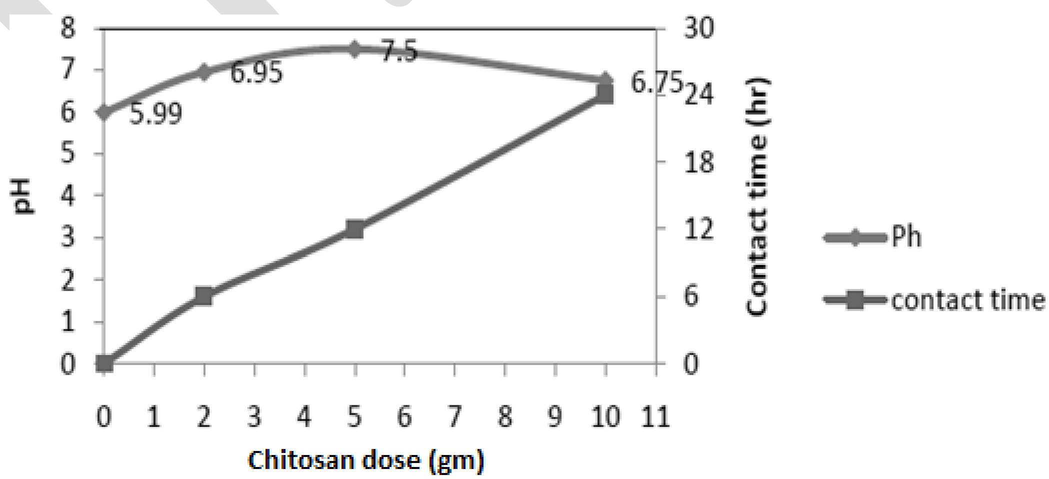

Fig 6 Variation of pH with chitosan dose and contact time

In Figure 7 COD decreases with increase in chitosan dose up to 10gm and contact time of 24hr and then attains a constant value with increase in chitosan dose and contact time. The maximum percent removal 75% has been observed at chitosan dose of 10gm, contact time of 24hr with 50% diluted sample.

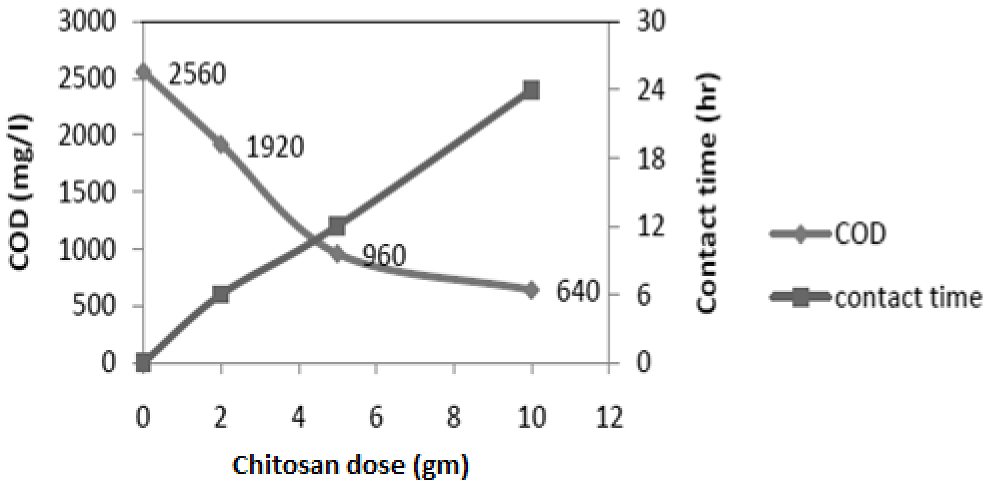

Fig 7 Variation of COD with chitosan dose and contact time

In Figure 8 TDS increases with increase in chitosan dose up to 2gm and contact time of 6hr and then decreases with increase in chitosan dose and contact time. The maximum percent removal 45.21% has been observed at an chitosan dose of 10gm, contact time of 24hr with 50% diluted sample.

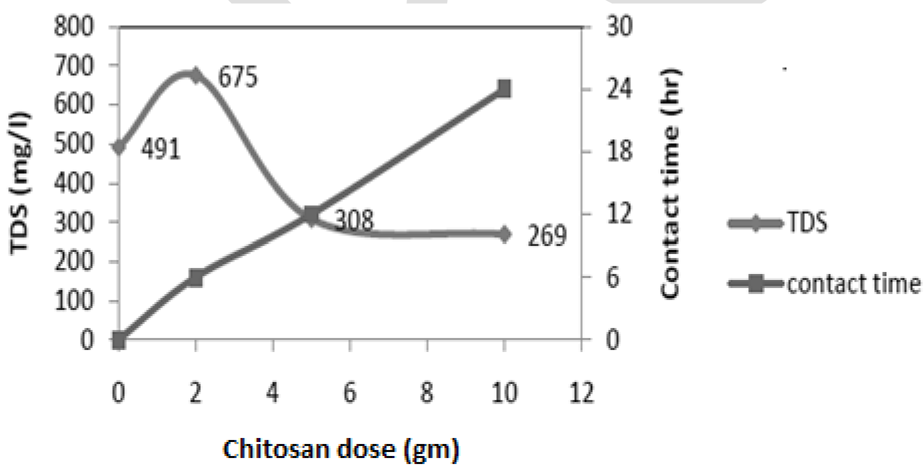

Fig 8 Variation of TDS with chitosan dose and contact time

For 100% Effluent Dilution

In Figure 9 pH increases with increase in adsorbent dose up to 5gm and contact time of 12hr and then there is not much effect with increase in chitosan dose and contact time. The maximum percent removal 42.95% has been observed at chitosan dose of 10gm, contact time of 24hr with 100% pure sample.

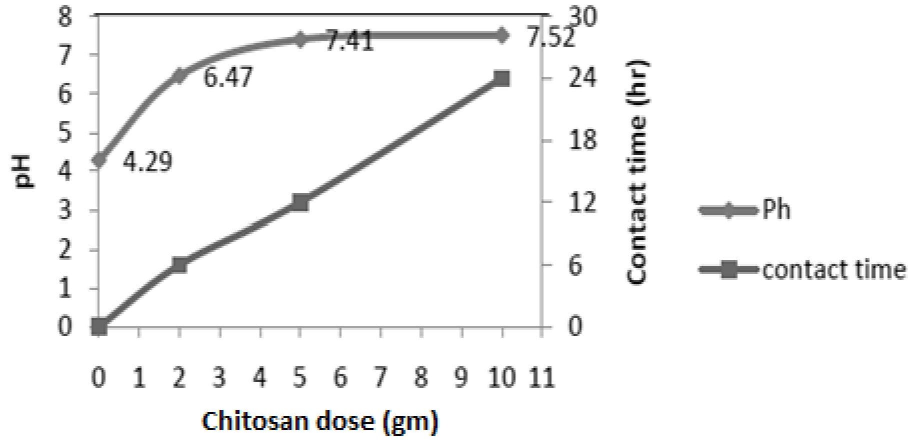

Fig 9 Variation of pH with chitosan dose and contact time

In Figure 10 COD decreases with increase in chitosan dose up to 10gm and contact time of 24hr and then attains a constant value with increase in chitosan dose and contact time. The maximum percent removal 40% has been observed at chitosan dose of 10gm, contact time of 24hr with 100% diluted sample.

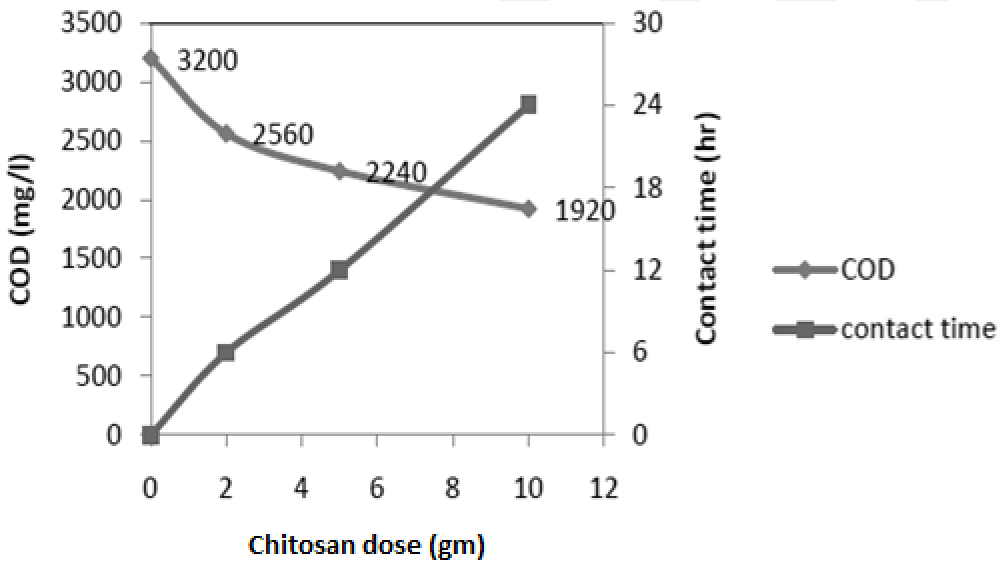

Fig 10 Variation of COD with chitosan dose and contact time

In Figure 11 TDS decreases with increase in chitosan dose up to 10gm and contact time of 24hr and then attains a constant value with increase in chitosan dose and contact time. The maximum percent removal 39.85% has been observed at chitosan dose of 10gm, contact time of 24hr with 100% diluted sample.

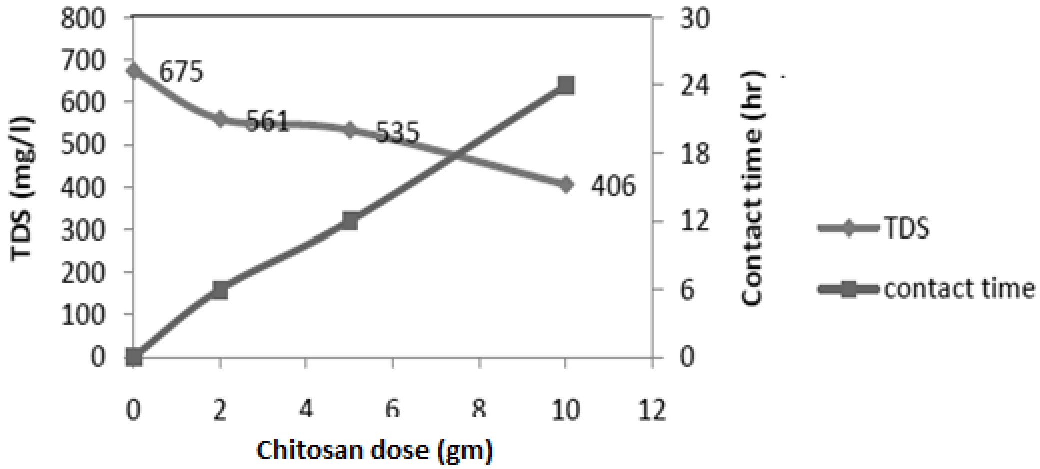

Fig 11 Variation of TDS with chitosan dose and contact time

In Figure 12 DO increases up to a maximum value of 7.9 with increase in chitosan dose up to 10gm and contact time of 24hr. The maximum percent removal 84.8% has been observed at chitosan dose of 10gm, contact time of 24hr with 100% diluted sample.

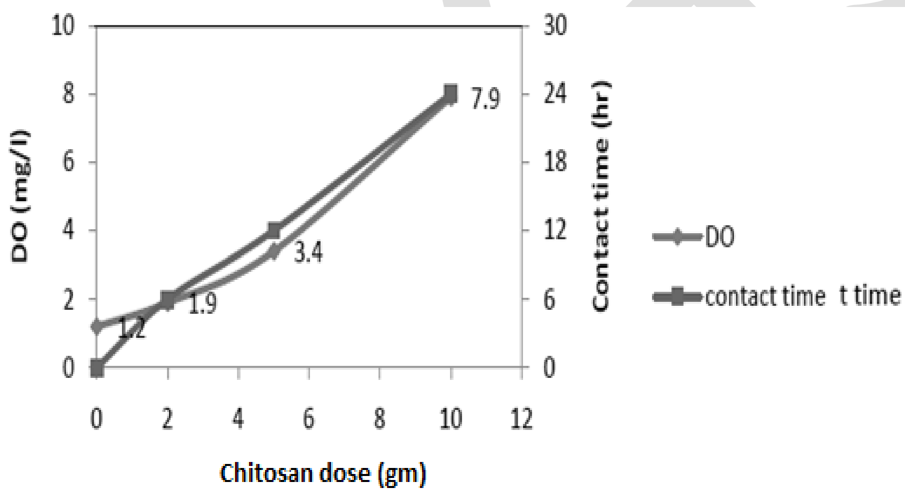

Fig 12 Variation of DO with chitosan dose and contact time

Table 3 Combine results of different dilution in a tabular form

Pollutants	Sample Dilution%	Chitosan dose (gram)	Contact time (hr)	% Removal
pH	100%	10	24	42.95
COD	25%	10	24	93.33
TDS	25%	10	24	70.6
DO	100%	10	24	84.8

4. CONCLUSIONS

- It revolved that chitosan dose of 10 gram and contact time of 24 hr for 200ml of sample is originate to be most successful for different dilutions for removal of most pollutants.
- For removal of heavy metals, chitosan dose of 5 gram and contact time of 12 hr create to be most helpful. Ever-increasing the chitosan dose and contact time after this limit there is not much consequence on the elimination of pollutants and heavy metals. This is may be due to the adsorptive capacity of the chitosan is reached to optimum.

- The chitosan dosage, pH, contact time and initial concentration of organic matter have significant effect on the COD removal and dissolved oxygen. The optimum removal 42.95% of pH has been observed at 10gm of chitosan dose and a contact time of 24hr for without dilution of sample.
- The optimum degradation of COD has been observed 93.33% at 10gm of chitosan dose and a contact time of 24hr for 25% diluted sample. The maximum removal 70.6% of TDS has been observed at 10gm of chitosan dose and a contact time of 24hr for 25% dilution. The optimum removal of 84.8% DO has been observed at dose of 10gm of chitosant and a contact time of 24hr for without dilution of sample.

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