TREATMENT OF GELATIN BASED INDUSTRIAL EFFLUENT WITH DE-OILED GROUNDNUT CAKE AS NATURAL COAGULANT AND OZONATION

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Abstract*:* The hard gelatin capsule production pharmaceutical companies produce a high strength colored wastewater with a high protein content, a high COD and TSS concentrations. Effluents are highly complex in nature and applying conventional methods to treat would be difficult. Hence the techniques like Electrocoagulation (EC), Chemical coagulation, chemical oxidations are being investigated by the researchers.

In this study, gelatin based industrial effluent was treated by coagulation using natural coagulant, ozonation and integrated treatment with coagulation and ozonation. The natural coagulant used in the present investigation was De-oiled Groundnut Cake. Natural coagulant added to gelatin based industrial effluent in powdered form didn't prove to be effective in removal of either turbidity or TDS. Therefore, natural coagulant extract was used to treat gelatin based industrial effluent. Optimum coagulant concentration and dosage were obtained as 60mg/L and 70mL respectively based on removal efficiency of turbidity and TDS. The reduction in BOD and COD was also achieved to a marginal extent.The ozonation of gelatin based industrial effluent was carried out for 4 hours. COD and BOD reduction after 4- hour ozonation was 60% and 82% respectively due to oxidative nature of ozone. pH and TDS remained constant throughout ozonation. However, reduction in TSS was observed to be around 40%.

In the end, integrated treatment was carried out which involved treatment with natural coagulant in the first step and treatment with ozonation in the second and final step. The parameters COD, BOD and turbidity reduction of 97%, 94.6% and 92.7% respectively was observed. TDS removal was 70% due to effect of natural coagulant solution while ozonation didn't have any effect on TDS removal. pH remained constant throughout treatment.

Keywords *- Natural coagulant, De-oiled Ground Nut Cake, ozonation, integrated treatment method*

I. INTRODUCTION

Pharmaceutical industry wastewater requires complex treatment due to its variable flow and effluent characteristics over time. Gelatin capsules are widely used by pharma companies in the form of medicine. Gelatin capsule manufacturing industries produce high strength coloured wastewater with high COD and TSS concentrations, and high protein content. Washing of the equipments at the end of process and other minor polluting source contribute to wastewater generated by gelatin based industrial plant. Suitable treatment technologies are needed to be employed in order to meet industrial effluent standards.Different treatment methods are employed by industries to meet effluent standards from the treatment plant. In this study, Coagulation using natural coagulant and ozonation were considered for treatment of gelatin based industrial effluent.

II. MATERIALS AND METHODOLOGY

2.1 Materials

2.1.1 Gelatin based industrial effluent

It was collected from effluent collection tank at ***Natural capsules limited*** (NCL) plant located at Attibele Industrial Area, Krishnasagara Karnataka, 562107. Sampling and preservation were done as prescribed in IS 3025(Part 1).

2.1.2 De-oiled groundnut cake:

De-oiled groundnut cake was obtained from local market and cleaned manually to remove dirt and dust particles. It was procured at cost of Rs 50/Kg.

2.2 Methodology

1 Characterisation of Gelatin based industrial effluent

The analysis carried out for gelatin based NCL industrial effluent for the basic quality parameters by drawing the sample at collection tank(S-1) and second point of sample collection(S-2) i.e. treated effluent at the plant gave values as shown in Table 2.1 and Table 2.2.

Table 2.1Characteristics of effluent(S-1)

Parameter	Range of values
pH	6.8-7.1
TDS	462-896 mg/L
Turbidity	740-790 NTU
BOD	310-520 mg/L
COD	2880-3440 mg/L

Table 2.2 Characteristics of effluent(S-2)

Parameter	Range of values
pH	7.2
TDS	668 mg/L
Turbidity	513 NTU
BOD	110 mg/L
COD	242 mg/L

2.2.2Preparation of natural coagulant solution

De-oiled groundnut cake was obtained from local market and cleaned manually to remove dirt and dust particles.It was oven dried to get rid of moisture content and then ground to obtain powdered form. This powder was sieved through 200 micron sieve and the portion passing through sieve was taken for preparation of solution.40,60,80,100,110 mg of this powder was added to 1 litre of distilled water each to obtain concentration of 40mg/L, 60mg/L, 80mg/L, 100mg/L,110mg/L respectively.

2.2.3Treatment with natural coagulant solution

100ml sample of effluent was taken in conical flask and 10ml of prepared natural coagulant (40mg/l) solution was added to it.

Similarly, 20ml, 30ml, 40ml up to 80ml was added to 100ml effluent taken in different conical flasks.Conical flasks were placed onto rotary flask shaker. RPM was maintained between 150-160RPM. Contact time was taken as 20minutes. [2]

The above procedure was repeated for different concentrations i.e. 60mg/l, 80mg/l, 100mg/l and 110mg/l in order to find out optimum concentration.

2.2.4 Ozonation

1 Liter of effluent was taken in 1800 mL capacity glass beaker and placed in plastic container to collect spillage. Few drops of DPAF i.e. antifoaming agent was added before ozonation. The extension/diffuser was placed such that Ozone is homogeneously bubbled into the sample.

2.2.5 Treatment with Natural coagulant solution followed up by Ozonation.

Optimum dosage of natural coagulant solution of optimum concentration was added to one-liter effluent. It was placed on flask shaker with optimum rotational speed and contact time of 20 minutes. After coagulation, 1000 ml of this mixed sample was taken for ozonation. Small portion say about 60mL was taken for analysis at intervals of every 30minutes.Sample was allowed to settle for 1 hour before being analyzed.

III. Results and Discussion

3.1 Treatment with natural coagulant solution

Figures 3.1 and 3.2 show the variation of TDS and turbidity for different dosage of natural coagulant extracts of earlier mentioned concentrations.

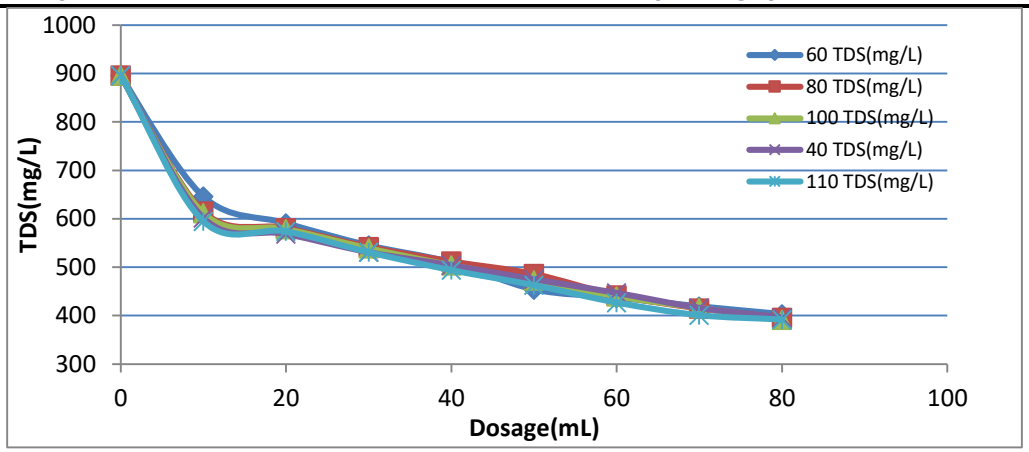

Figure 3.1 TDS vs Dosage of Natural coagulant extract

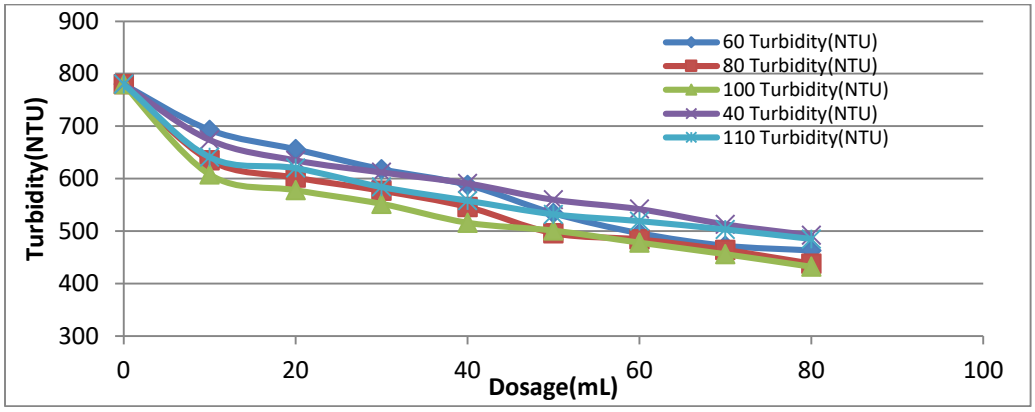

Figure 3.2 Turbidity vs Dosage of Natural coagulant extract

The variations of TDS and turbidity are observed to be decreasing with respect to dosage. The behavior of the different concentrations in reducing the parameters is seen to be following the same trend. Especially, a single line can be fitted to address the behavior of reduction of TDS. The rate of decrease is observed to be decreasing with the dosage. The optimum coagulant concentration and dosage, hence, are fixed as 60mg/L and 70mL respectively for further experimentation. At optimum condition, the reduction in TDS and turbidity was observed to be 53% and 40% respectively. The cake powder contains proteins, different electrical charges and particles. The seeds of this tropical plant have a high amount of proteins that act like cationic polyelectrolytes once they are added to raw water. The analysis carried out revealed the band on approximate 9kDa in 12% gel. [2]

BOD and COD analysis was carried out for different concentrations of natural coagulant solution by keeping optimum dosage of 70 mL as constant. There is considerable reduction of COD and BOD. At optimum condition (60 mg/l), the reduction of COD and BOD was observed to be 58.3% and 38% respectively. After obtaining optimum concentration and dosage, scale up experiments were carried out by increasing effluent and dosage volumes proportionally while keeping concentration of natural coagulant solution as constant at 60mg/l.The values obtained are as shown in Table 3.1.

Table 3.1 Scale up experiments

Effluent sample(mL)	Dosage(mL)	pH	Turbidity(NTU)	TDS(mg/L)	BOD (mg/L)	COD(mg/L)
100	70	6.8	472	419	298	1200
200	140	6.9	323	378	282	1180
300	210	6.9	298	332	270	1160
400	280	6.8	269	306	246	1110
500	350	6.9	252	304	218	1060
700	490	7	228	271	158	940
1000	700	7	122	236	110	880

3.2 Treatment with ozonation

One litre of well mixed effluent was taken and ozonation was carried out. The samples were drawn at uniform interval for the analysis.Following values were obtained at interval of 30minutes (Table 3.2):

Table 3.2 Ozonation of gelatin-based NCL effluent

TIME(minutes)	PARAMETERS				
	pH	TDS(mg/L)	TSS(mg/L)	BOD(mg/L)	COD(mg/L)
0	6.8	689	1115	520	3440
30	7	709	998	460	2840
60	7.1	715	910	368	2600
90	7	706	867	274	2320
120	6.9	692	810	195	2040
150	6.8	685	778	168	1920
180	6.8	692	727	120	1680
210	6.9	680	702	104	1520
240	6.8	662	686	93	1400

Throughout the ozonation process, pH and TDS values remained constant. Due to oxidative nature of ozone, there was reduction in BOD and COD values by 82.12% and 59.3% respectively at the end of 4hour treatment. Color was visibly reduced and odor was completely eliminated at the end of the treatment.

3.3 Treatment with natural coagulant solution followed by ozonation

First step of integrated method involved treatment with natural coagulant solution. Fresh sample obtained from gelatin capsules industry was analyzed and yielded following results **pH of 6.8, TDS of 846 mg/L, Turbidity of 740 NTU, BOD of 310mg/L, COD of 3440mg/L.** Treatment with 700 mL of 60mg/L natural coagulant solution was carried out for 1L gelatin based effluent sample at 160 RPM for 20 min contact time.After coagulation following values were obtained: **pH 6.8, TDS 236mg/L, Turbidity 142 NTU, COD 880 mg/L and BOD 90 mg/L.** However, color was still visibly present and odour was not eliminated.

In second step of this integrated treatment, 1 liter of well mixed sample treated with natural coagulant solution was taken for ozonation. 60mL of sample was extracted for analysis at the interval of every 30 mins. Table 3.3 represents various parameters analyzed during ozonation.

Table 3.3 Treatment by ozonation for sample treated with natural coagulant solution

Time (Hours)	pH	TDS (mg/L)	Turbidity (NTU)	COD (mg/L)	BOD (mg/L)
0	6.8	236	142	880	91
0.5	6.9	235	74	480	62
1	6.8	238	79	360	56
1.5	6.8	240	68	162	42
2	6.7	238	57	80	28

Ozonation didn't have any effect on TDS removal and also pH remained constant throughout the treatment.
At the end of combined treatment, COD and BOD reduction of 97% and 94.6% was achieved respectively which is higher than treatment plant effluent. Turbidity removal was observed to be 92.7% whereas TDS removal was 70% in combined treatment method compared to 30% turbidity removal and 25.4% TDS removal in treatment plant effluent. Color of effluent at the end of treatment was transformed to almost transparent and odor was completely eliminated whereas small amount of odor and color was still present in treatment plant effluent.

IV. CONCLUSION

For de-oiled groundnut cake based natural coagulant extract, optimum coagulant concentration and dosage were obtained as 60mg/L and 70mL respectively based on removal of turbidity and TSS. The efficiency of removal was 53 % and 40 % for TDS and Turbidity respectively.The removal of BOD and COD at the optimum conditions was 38% and 59% respectively.Scaled up investigation, keeping the proportion effluent volume:coagulant extract as 70 ml, resulted in reducing all the parameters efficiently. The pH was unaltered. The colour and odour were not eliminated effectively.
COD and BOD reduction after 4- hour ozonation was 60% and 82% respectively due to oxidative nature of ozone. pH and TDS remained constant throughout ozonation. However, reduction in TSS was observed to be around 40%.

In combined treatment, COD, BOD and turbidity reduction of 97%, 94.6% and 92.7% respectively was observed. TDS removal was 70% due to effect of natural coagulant extract solution, while ozonation didn't have any effect on TDS removal. pH remained constant throughout treatment.The combined process proved to eliminate color and odor problems also.On the whole, the present study concludes that the treatment method used in the laboratory is much efficient than the treatment methodology adopted at the NCL industry.

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