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Treatment of Textile Wastewater using Bentonite Clay as a Natural Coagulant

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Abstract

The main objective of the present study was treatment of dye waste by coagulation with clay to achieve maximum removal efficiency of color and sludge.The present study was aimed to investigate the effects of bentonite clay as coagulant in treatment of textile wastewater. The coagulant prepared was employed for the removal of sludge at the different doses. The maximum coagulant for removal of colour and sludge was found at an optimum temperature of 27^{o}C with the retention time of 1 hour.This result was higher than the results obtained by different process parameters for various coagulants. The transmittance were found to be 94% with an absorbance of 0.03,TDS reduced from 5.15 PPT to 3.3 PPT, BOD too was reduced from 160mg/l to 40mg/l. Also owing to the coagulation process several other parameters such as chloride, sulfate, iron, COD was also reduced considerably.

Keywords*: Bentonite clay, wastewater, conductivity, Natural coagulant agents, dye removal, sludge removal*

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INTRODUCTION

Textile dyeing processes are among the most environmentally unfriendly industrial processes, because they produce colored wastewaters that are heavily polluted with dyes, textile auxiliaries and chemicals [1].Besides, textile finishing's wastewaters, especially dye-house effluents, contain different classes of organic dyes, chemicals and auxiliaries. Thus they are coloured and have extreme pH, COD and BOD values, and they contain different salts, surfactants, heavy metals, mineral oils and others. Therefore, dye bath effluents have to be treated before being discharged into the environment or municipal treatment plant [2].

The use of synthetic chemical dyes in various industrial processes, including paper and pulpmanufacturing, plastics, dyeing of cloth, leather treatment and printing has increased considerably overthe last few years, resulting in the release of dye-containing industrial effluents into the soil andaquatic ecosystems [3]. Since most of these dyes are toxic in nature, their presence in industrialeffluents is of major environmental concern because they are usually very recalcitrant to microbialdegradation [4]. In some cases, the dye solution can also undergo anaerobic degradation to formpotentially carcinogenic compounds that can end up in the food chain [5]. Moreover, highly colouredwastewaters can block the penetration of sunlight and oxygen, essential for the survival of various aquatic forms [6].

Typical coagulant agents are inorganic salts such as $Al_2(SO_4)_3$ or $FeCl_3$, as well as synthetic polyacrylamides [7]. Although these chemicals were rather effective in removing dyes and suspended matter from the aqueous matrix, several disadvantages have recently arisen, such as their impact on human diseases like Alzheimer's or cancer [8]. These suspicions have already forced the removal of polyacrylamides from drinking water treatment plants in many countries in accordance with the suggestions of the World Health Organization (WHO 2003).

This investigation is focused in advanced water treatment through a new coagulation process that is (1) cheaper than others, (2)

based on a natural product and (3) easy to handle and maintain for unskilled personnel. Environmental equilibrium at global level may need us to make the possibility of becoming clean a universal chance.

STUDY AREA

In this study the wastewater is collected from Balakumaran dying unit situated in Tirupur district which is a textile industry which has a daily wastage of 20,000 lit. The industry consumes about 20,000 lit as its intake and the whole water is becoming waste at the end of dying process. In these water input 100% is converted into wastage is sending to some zero liquid discharge plants or common effluent treatment plants, the initial characteristics of the waste water is given in Table 1 which shows that the values obtained above the discharge norms of pollution control board standards. Also it is evident that this water should be treated before letting it into sewers or letting it for evaporation process. This study aims to introduce newer technologies in the treatment plants to make the treatment process efficient. Most of the industrial wastewater treatment plants involve the units like screening, grit removal, and coagulation with sedimentation, filtration or aeration with biological treatment process, sludge removal, reverse osmosis process.

Table 1: *Initial Parameters of Textile Waste Water.*

pH	11
Conductivity	2.47ms
TDS	5.15PPT
Adsorption	0.24
Transmittance	56%
Turbidity	13.5NTU
BOD	640mg/l
COD	160mg/l
Chloride	1487.4mg/l
Iron	18.7mg/l
Sulfate	152.7mg/l

MATERIALS AND METHODS

Glassware

All glassware used in the present study was Pyrex quality manufactured by Borosil works limited, Bombay. The glass ware cleaned with nitric acid and rinsed with water before use. They were further acid washed and rinsed with water after use and stored for subsequent use in further experiments.

Collection of Samples

Sampling of waste water is done at the main collecting tank by using grab sampling method, the sampling bottles are of 20 liter capacities which are three times with tap water, then with distilled water and rinsed fully with 6N HNO3 for removal of any sign of pathogens or odour. Samples collected are used immediately for the study [9, 10].

Analysis of Samples

The effluent samples which contain several metals and organic compounds were analyzed to measure their pH, electrical conductivity, dissolved oxygen, Turbidity and chemical oxygen demand (COD), using standard methods.

EXPERIMENTAL SETUP

Jar Test Apparatus

All coagulation experiments were carried out by using a conventional jar test apparatus. Jar test is the most widely used experimental methods for coagulation-flocculation. A conventional jar test apparatus was used in the experiments to coagulate sample of turbid water using natural coagulant. It was carried out as a batch test, accommodating a series of six beakers together with six-spindle steel paddles. Before operating the jar test, the sample was mixed homogenously. Then, the samples ought to be measured for turbidity, for representing an initial concentration. Coagulants of varying concentrations were added in the beakers. The whole procedures in the jar test were conducted in different rotating speed.

PROCEDURE OF COAGULATION PROCESS

The dye waste is taken in a clean, dry 500 ml beaker and its initial pH value is fixed. Coagulant which is pre-prepared is added into this with a dosage rate of 2gm, 4gm, 6gm, 8gm, and 10 gm per litter. The beakers were initially stirred with a glass rod for mixing simultaneously. Then put that beaker in jar test apparatus and Switch on the motor and adjust the speed of paddles to about 100rpm, and thus rapid mixing is done for 10–15 min.

Switch off the motors and allow it to settle for 20–60 min. This corresponds to sedimentation or settling of impurities. Collect the supernant from each beaker with the help of pipette, without disturbing the sediment and checked for pH, conductivity, TDS, turbidity, transmittance, absorbance, BOD, COD, chloride, sulfate as per APHA standards. All the tests are done in triplicate and the concordant values were taken for the results comparison, which are given in figure 1 to figure 6. For the full study analytical grade chemicals were used from, Merck, loba chemic and fisher scientific. Turbidity removals corresponding to various doses of natural coagulant ranging from 2 to 10gm/l were measured and the least dose producing maximum removal was designated as optimum coagulant dose.

RESULTS AND DISCUSSION

A number of investigations were carried out by varying the amount of bentonite clay from 2 to 10gm at the fixed initial dye concentration of 1 liter, pH of 11 and room temperature of 25±1℃. These studies showed an increase in coagulation with the increase in the dose of coagulant. Optimum coagulant dose was found to be 2gm/l. it was found that the maximum TDS of 3.3 PPT and turbidity 6.2 NTU.

In this study, coagulation processes were used to treat textile industry effluents. The results of this study are in the following Table 2,

Table 2: *Final Parameters of Textile Waste Water.*

Parameters/dosage	1gm	2gm	3gm	4gm	5gm
pH	11	11	11	11	11
Conductivity	6.32ms	6.14ms	6.71ms	5.83ms	6.46ms
TDS	3.3PPT	3.25PPT	3.55PPT	3.08PPT	3.47PPT
Absorbance	0.03	0.05	0.02	0.14	0.11
Transmittance	94%	89%	93%	72%	76%
Turbidity	6.9NTU	7.4NTU	8.2NTU	10.3NTU	11.2NTU

From the above figure it is quite evident that the best result occurs in the coagulant dosage of 2 gm/l. It was also observed the coagulant dosage 2gm/l that formed maximum flocksin pH 11. These flocks settled in quick time.On reducing pH below 11 results in decrease flocks size which did not settle sludge effectively. It is also observed that COD, BOD, TDS was maximum in this dosage. To select the best coagulant in addition to above mentioned parameters, it should be considered parameters such as required coagulant dose, coagulant cost, and optimum pHafter reaction for discharging into environment. It was concluded that the industrial effluents should be treated before to be drained into the natural water bodies so that it may not cause water and soil pollution and bentonite clay might be used for wastewater treatment on industrial scale.

CONCLUSIONS

In present work attempt have been made for studying the colour removal efficiency of natural coagulant prepared from bentonite clay. From the experimental finding it has been observed that bentonite clay can be used as an effective coagulant material which can be used successfully for removal of colour. The maximum color removal efficiency was observed up to 90% for prepared bentonite clay. It was found that colour removal efficiency was achieved maximum a very low dose of 2gm/l with retention time of 1 hour. The result of pH study shows that the coagulant was effective at pH 11. It is also found that natural coagulant acacia gum extract reduced the sulfate content from 152.7 mg/l to 56.3 mg/l (63%), chloride content from 1487.4 mg/l to 420.2 mg/l (72%), iron from 18.7mg/l to 6 mg/l (68%), BOD from 160mg/l to 40mg/l and COD from 640 mg/l to 320 mg/l. Which proved to be a more effective treatment solution, also there is a 49% turbidity reduction and 87.5% absorbance reduction in this study. Thus it is proved that acacia gum extract can be effectively used as a low cost natural coagulant.

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