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Study of the Effect of Saline Solution on the Extraction of the Tamarind Seed Extracts Active Coagulant for Textile Wastewater Treatment

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Abstract
The use of synthetic coagulants is not regarded as suitable due to health and economic considerations. A new coagulant obtained through polymerization of tamarind seed extract has been characterized in the removal of dangerous dye pollutants. The present study was aimed to investigate the effects of tamarind seed extract as coagulant in treatment of textile wastewater. The coagulant prepared was employed for the removal of sludge at the different doses. The coagulant was found to be capable of removing sludge from wastewater. The color removal capacity of tamarind seed was approximately 100% at normal pH and temperature. From the experimental investigations, the maximum color, sludge removal from the textile industry wastewater was obtained at an optimum coagulant dosage of 25 mg/L of wastewater, with an optimum contact time of 1 h, at room temperature. This result was higher than the results obtained by different process parameters for various coagulants. The transmittance were found to be 83% with an absorbance of 0.07, TDS reduced from 5.15 to 3.3 PPT, BOD too was reduced from 160 to 20 mg/L. Also owing to the coagulation process several other parameters such as chloride, sulfate, iron, COD were also reduced considerably.

Keywords: *tamarind seed extract, natural coagulant agents, dye removal, sludge removal, textile wastewater*

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INTRODUCTION

Industrial effluents are one of the major pollutants of water. Many dyes are carcinogenic and affect the life of aquatic organisms [1, 2]. The worldwide annual growth rates of reactive dyes are four times as much as for conventional dyes [3]. Presence of such dyes in effluents causes a lot of pollution in water. Various challenges have been made to remove these harmful dyes from industrial wastes [4–6]. The conventional biological treatment processes are not very effective in treating textile wastewater due to the chemical stability of the dye components [7]. Various methods have been used to remove color from industrial effluents to decrease their impact on the environment. Biological methods such as biodegradation have been proposed. However, due to the low biodegradability of dyes, conventional biological waste water treatment processes were not very efficient for the treatment of dyeing wastes [8]. Chemical treatment processes (ozonation and chlorination) were more effective [9].

Since the mid-1950s, the development of industrial areas has grown exponentially in the so-called First World and emerging countries. In this scenario, the need to implement new and cheaper water treatment technologies has arisen to keep the aquatic environment clean and safe from pollution concerns [10]. A simple and effective process for wastewater purification is coagulation [11, 12]. It is considered a chemical treatment as it implies the addition of a coagulant. Stable colloids in water normally present negative charges all around their surface. Coagulant is able to cause the neutralization of these charges, so colloidal particles become unstable and tend to settle by gravity [13]. Typical coagulant agents are inorganic salts such as $Al_2(SO_4)_3$ or $FeCl_3$, as well as synthetic polyacrylamides [14]. 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 [15] or cancer. 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, wastewater is collected from Balakumaran dying unit situated in Tirupur district which is a textile industry which has a daily wastage of 20,000 L. The industry consumes about 20,000 L 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.

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 was done at the main collecting tank by using grab sampling method, the sampling bottles were of 20-L capacity which were cleaned three times with tap water, then with distilled water and rinsed fully with 6N HNO3 for removal of any sign of pathogens or odor. Samples collected were used immediately for the study [16].

Analysis of samples

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

Tamarind Seed

The tamarind seeds were collected from local market in Tirupur and were washed repeatedly by using distilled water to remove moisture and soluble impurities. Then tamarind seeds were kept in oven at 110 °C, for 4–6 h. Then tamarind seeds were crushed and screened in 425 micron sieve and stored in bottles. 10 g of tamarind seed powder was taken in a beaker and it was dissolved in 200 mL of distilled water. Then it was mixed thoroughly with the help of jar test apparatus and filtered with the help of filtration assembly. The filtered solution was stored in bottles and then it was used as a coagulant.

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 method 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 were measured for turbidity, for representing an initial concentration. Coagulants of varying concentrations were added in the beakers. The whole procedures in the jar test was conducted in different rotating speed.

Coagulation Process

The dye waste was taken in a clean, dry 500 mL beaker and its initial pH value was fixed. Coagulant which was pre-prepared was added into this with a dosage rate of 5, 10, 15, 20, and 25 mL/L. 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 100 rpm, and thus rapid mixing was 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 Figures 1 to 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 5 to 25 mg/L were measured and the least dose producing maximum removal was designated as optimum coagulant dose.

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

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

RESULTS AND DISCUSSION

A number of investigations were carried out by varying the amount of tamarind seed extract from 5 to 25 mL at the fixed initial dye concentration of 1 L, pH of 11 and room temperature of 25 ± 1 °C. These studies showed an increase in coagulation with the increase in the dose of coagulant. Optimum coagulant dose was found to be 25 mL/L. It was found that the maximum TDS of 3.3 PPT and turbidity 3 NTU. In this study, coagulation processes were used to treat textile industry effluents. The results of this study are in the following figures,

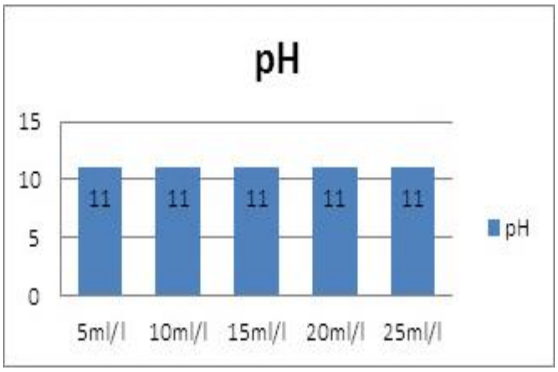

Fig. 1: *pH vs. Adsorbant Dosage.*

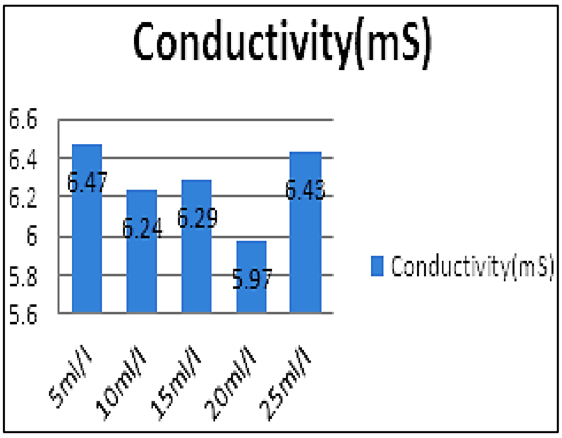

Fig. 2: *Conductivity vs. Adsorbant Dosage.*

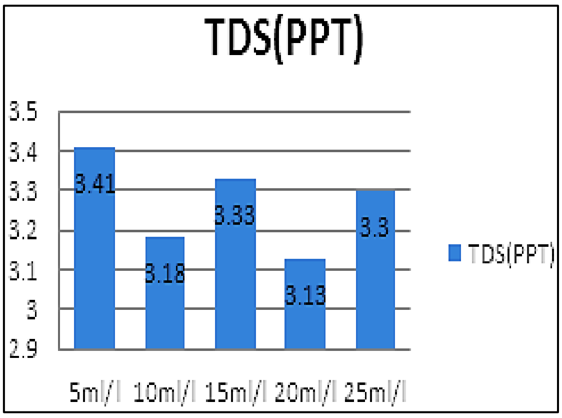

Fig. 3: *TDS vs. Adsorbant Dosage.*

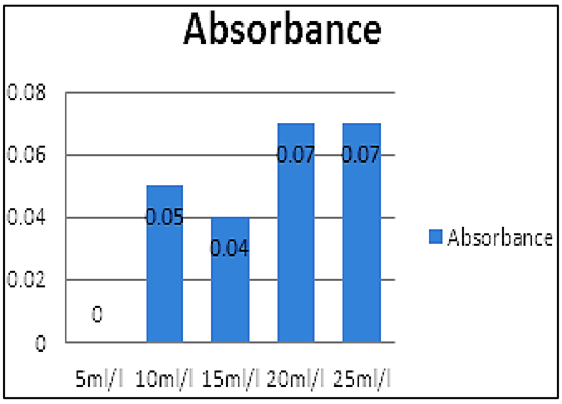

Fig. 4: *Absorbance vs. Adsorbant Dosage.*

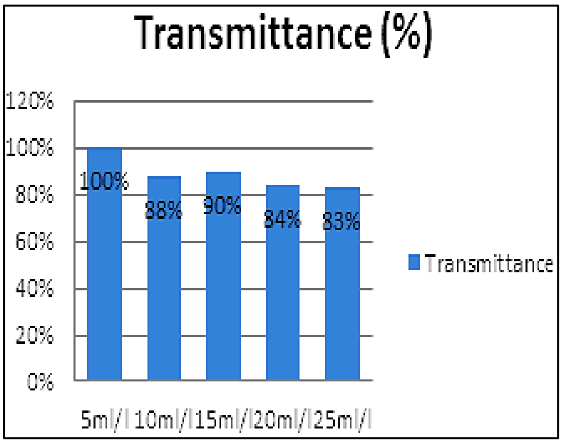

Fig. 5: *Transmittance vs. Adsorbant Dosage.*

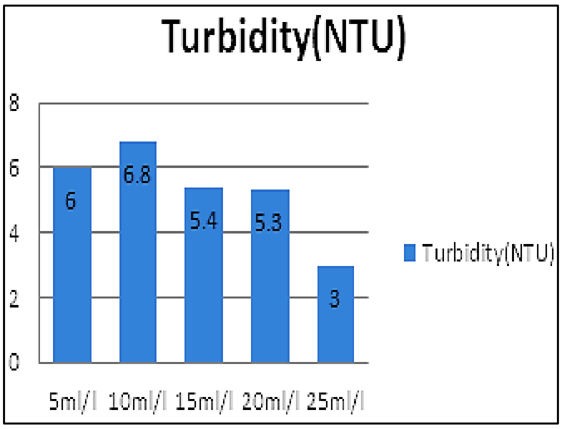

Fig. 6: *Turbidity vs. Adsorbant Dosage.*

Form the above Figure, it is quite evident that the best result occurs in the coagulant dosage of 25 mL/L. It was also observed the coagulant dosage 25 mL/L that formed maximum flocks in 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 pH after 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 acacia gum might be used for wastewater treatment on industrial scale.

CONCLUSIONS

In present work, attempt has been made for studying the color removal efficiency of natural coagulant prepared from acacia gum. From the experimental finding it has been observed that acacia gum can be used as an effective coagulant material which can be used successfully for removal of color.

The maximum color removal efficiency was observed up to 90% for prepared acacia gum extract. It was found that color removal efficiency was achieved maximum a very low dose of 25 mL/L with retention time of 1 h.

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 152.7to 60.3 mg/L (60.5%), chloride content from 1487.4 to 680.2 mg/L (55%), iron from 18.7 to 2 mg/L (90%), BOD from 160 to 20 mg/L and COD from 640 to 240 mg/L, which proved to be a more effective treatment solution, also there is a 78% turbidity reduction and 92% 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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