Removal of Heavy Metal and Decolorization of Textile Water using Synthesized PAC and Natural Coagulant

Akheel E K, S. Shika

Abstract— This study is aimed to expose and understand the level of pollution and hazardous factors owning to the textile dyeing effluents and to assess the coagulant efficiency of poly aluminium chloride (PAC) prepared from used beverages cans and comparing with efficiency of banana stem bile juice as a natural coagulant agent for treating the textile dyeing effluents. The present work aims at optimizing the dosage and contact period of the coagulants and to understand the removal efficiency of heavy metal (cadmium) along with different water parameters such as color, BOD, COD, TSS, turbidity and pH. Coagulation process was done by preparing a coagulation set up consisting six beakers with six motors running in a fixed speed of 150 rpm for different dosage and contact period. The prior aim of the study was to analyse the removal efficiency of heavy metal (cadmium) and color in the textile water. The removal effiencicy of heavy metal was obtained 81.2% and 80.13% for PAC and banana stem coagulant respectively. Aslo the removal efficiency of colour from textile effluents was 78.35% for PAC and 76.1% for banana stem coagulant. Data gained from the studies verifies that two coagulant agents are efficient, but banana stem coagulant, eventhough a natural coagulant, undergoes fermentation soon after 12hrs of preparation. Hence, PAC is comparatively found be more efficient for decolorization and easy removal of heavy metal from textile waste.

Keywords— Banana stem juice, Beverage cans, Coagulation, Decolourization, Heavy metals, Poly aluminium chloride, Textile effluents.

1 Introduction

The increase of world population results in demands of clothing and apparel increase with the improved fashion and life style standards. A fast growing country like India which is in the second world population rate the demand of textile products is also at its peak [6]. As a result, textile production has become one of the source of income which also contributes to the nations GDP (Gross Domestic Product) but in other hands they also attribute a reason of environmental pollution [1].

Textile industries use more than 2000 types of chemicals and 7000 types of dyes [3]. These effluents are also high in pH and temperature. Textile water effluents discharged to the water bodies without proper treatment can seep through aquifers and pollute the underwater in different ways [5]. Besides displeasing aesthetics presence of color and heavy metals results in negative ecological impacts to the lifes of water as well as deterioration of human health [7].

Heavy metals and dye pigments used in the production in the textile industries can exist in the structures of textile fabrics and can penetrate into fibres and these can be transferred to the environment which are high in toxic and can bioaccumulate in the water life, water bodies and also traps in soil [4]. It is very important to treat the textile waste water and to bring them to industrial and irrigational standards to prevent danger as well as to prevent the damages to the natural environment.

In this work, it is aimed to study the removal efficiency of two different coagulant agents, ie., Poly Aluminium Chloride (PAC) and Banana stem juice. Different water parameters such as color, BOD, COD, TSS, turbidity and pH along with heavy metal (cadmium) were studied and their removal percentages for the same contact period and dosage of these two coagulant agents are carried out and a comparative analysis was done [2]. PAC is prepared from used beverage cans and natural coagulant is made from Banana stem juice. Poly aluminium chloride is known for its coagulant properties and banana stem juice contain substance called inulin which act as coagulant agent mainly for removal of color and heavy metals [10].

The present paper is an attempt to explore the potential of PAC and Banana stem juice as two coagulant agents which are economically very feasible and could be developed in large scale and use its benefits for the treatment of textile water as a remedial measure upto a great extent.

2 Methodology

2.1 Sample collection

Textile sample was collected from Kanjirode weavers' society, situated in Kannur district in Kerala, India, running about last three decades. 10 litres of sample were collected from the effluent collection tank shown in Fig 1. This industry produces nearly 25000 L of effluent water on a daily basis. Different types of dyes are used in different amount on a daily base requirement.

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Fig. 1 Sample collected from effleuent storage tank

So an initial study of sample is done and a synthetic textile sample cooresponding to the collected effluent is prepared for our study.

2.2 Testing of sample

The textile effeluent was analysed and a synthetic sample corresponding to various parametrs in the textile effluents were prepared. 12 litres of stock was prepared for the two sets of testing.

TABLE 1
WATER QUALITY PARAMETERS OF THE SYNTHETIC SAMPLE

Parameters	Initial Concentration	CPCB Industrial Standards
Heavy Metal Concentration (Cd)mg/l	5	0.05
Colour , Abs	3	0.503-0.842
BOD, mg/l	1440	Nil
COD, mg/l	2260.8	≤250
TSS ,mg/l	453	≤100
pH	10.49	7-9
Turbidity, NTU	16.5	≤5

Heavy metal concentration (Cd), color, BOD, COD, TSS, pH and turbidity were checked. The test results of sample are shown in Table 1.

2.3 Preparation of coagulant agents

PAC was synthesized from used beverage cans. Twenty cans were collected, their paints removed using sand papers, made into thin aluminium sheets and pulverized into fine powdered form shown in Fig 2. Aluminium solution was prepared by dissolving 30g of can powder in 105 ml of HCL solution which was pre heated at 75°C. The following reaction takes place when PAC is treated with HCl [9].

$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

These prepared aluminium chloride of 0.25M is taken in 100 ml is heated at 85°C in water bath. After 20 minutes 240ml of 0.25M sodium hydroxide (2.4gm) is added slowly and continuously stirred and the flocculant developed is PAC.

Fig. 2 Synthesised PAC from used beverage cans

The inulin concentration in the banana stem was examined to be 1.225 mg/ml [8]. Matured banana stem plants were collected and pith of stems were separated.

Fig. 3 Banana stem bile juice

100gm of stem with 10ml of distilled water was mixed with mixer and juice was collected shown in Fig 3. In order to keep the freshness, they were stored below 7°C and all the tests were carried on the same day to avoid fermentation.

2.4 Setting up of coagulant unit

A coagulation unit is provided consisting of 6 DC motors with 150 rpm as shown in Fig 4. The aim of the study was to optimize the doasge and contact period of coagulant agent.

Fig. 4 Coagulation Setup

Coagulantation was done for different dosages (10 ,20, 30, 40, 50 and 60 mg/l) and different contact periods (0.5, 1, 1.5, 2, 2.5 and 3 hrs). Six beakers of 1litre capacity were provided for the experiment and power was supplied using switched mode power supply (SMPS).

3 Results And Discussion

The performance of the integrated coagulation treatment system was investigated under different loads of coagulants and contact period in six different runs. These 6 different runs of water sample gave 36 test results for each parameter.

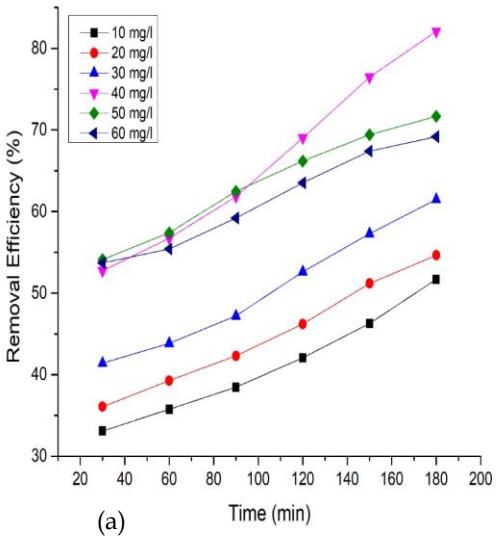
TABLE 2
REMOVAL EFFICIENCY OF VARIOUS PARAMETERS BY USING PAC AND BANANA STEM.

Parameters	PAC optimum	Bana-na stem	Removal Efficiency (PAC) (%)	Removal efficiency (Banana stem)
Heavy metal,mg/l	0.94	0.99	81.2	80.13
Color, Abs	0.213	0.285	78.35	76.1
BOD	198	239	86.25	83.40
COD	300	321	86.72	85.79
pH	7.34	7.1	Opt 7	Opt 7
TSS	163	190	67.4	62
Turbidity	2.25	2.87	86.36	82.60

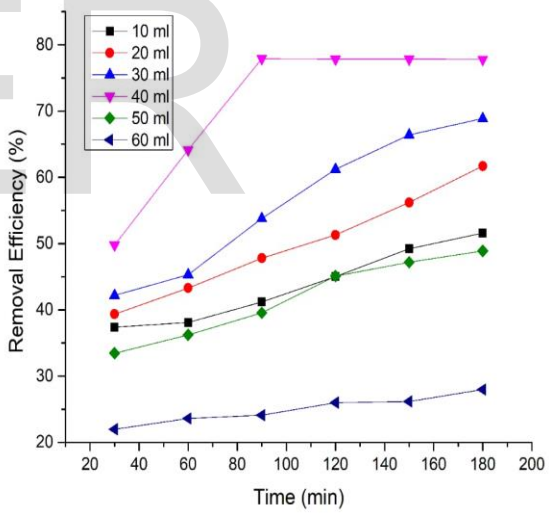
The most acceptable values of different parameters were analysed are the optimum values are shown in table2 The detailed analysis is discussed in the following sections.

3.1 Effect on contact period and dosage for removal of heavy metal

For analysing the optimum contact period 6 different time intervals were selected starting from 30 mins to 3 hr with interval of 30 mins each. In case of PAC, maximum removal efficiency for heavy metal was attained at 3hr with 81.2% (Fig. 5a) and for banana stem juice it was 80.13% in 1.5hr (Fig. 5b).



(a)



(b)

Fig. 5 Removal efficiency of heavy metal with time using **(a)** PAC **(b)** banana stem juice

When tearted with PAC, the graph plotted for 40mg/l was found to have a quick increase while reaching 3 hrs, when compared with other concentrations. In case of banana stem coagulant, the concentration of 40 mg/l did not have any increase in efficiency after 90mins. For both cases the coagulant concentration of 40mg/l showed maximum removal efficiency. For PAC maximum efficiency was 81.2% at 3hrs and 80.13 at 1.5 hrs for banana stem coagulant.

3.2 Effect on contact period and dosage for removal of colour

For depicting the maximum removal efficiency of colour from the effluent, the same procedure was adopted. The removal efficiency of colour using banana stem coagulant was observed to have a gradual increase when compared to PAC.

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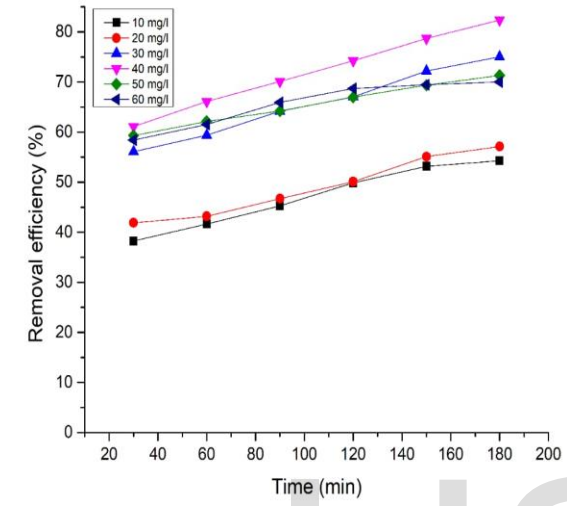
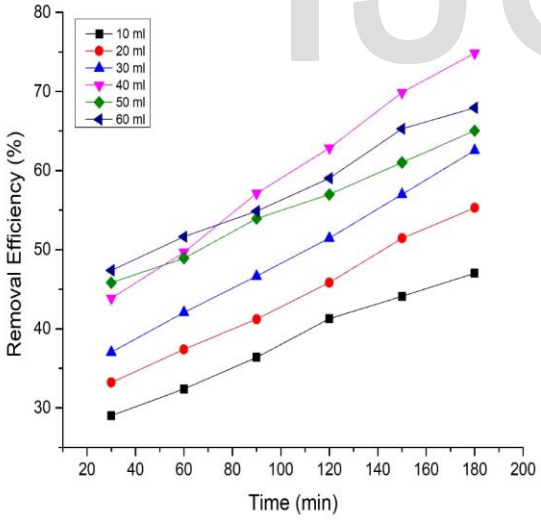


(a)



(b)

Fig. 6 Removal efficiency of colour with time using **(a)** PAC **(b)** banana stem juice

Here also the coagulant concentration of 40mg/l showed maximum removal efficiency. The removal efficiency was 78.35% for PACand 76.1% using banana stem at 3hrs (Fig 6 a & b)

4 Conclusions

Treatment of textile waste water using the two coagulant agents via, PAC and banana stem was carried out, which showed good removal potentials in water parameters. The removal effiencicy of heavy metal was obtained 81.2% and 80.13% for PAC and banana stem coagulant respectively. Also the removal efficiency of colour from textile effluents was 78.35% for PAC and 76.1% for banana stem coagulant. The study shows that two coagulant agents are efficient, but banana stem coagulant, eventhough a natural coagulant, undergoes fermentation soon after 12hrs of preparation. Hence, PAC is comparatively found be more efficient for decolorization and easy removal of heavy metal from textile waste.For both the cases a dosage of 40mg/l of coagulant was found to be optimim.

This work shows the enhanced textile waste water treatment ability which is economically feasible and readily available and can be accepted as remedial choice of water treatment compared to other high demanding economic methods.

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