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Pharmaceutical Wastewater Treatment Using Natural And Chemical Coagulants

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***Abstract*—** Pharmaceutical industrial wastewater is hazardous in nature so it needs to be treated before it is discharged in to any water body or on to soil. This paper, deals with the study of the treatment of pharmaceutical wastewater using different coagulants. Experimental investigations are carried with different operational parameters such as pH variation (2-10) and coagulant dosage variation (1-5g/500ml). Alum, Iron sulphate and Moringa oleifera are used as coagulants. Treatment is done for turbidity removal and COD reduction. Among all the coagulants studied, the natural coagulant Moringa oleifera is observed to be efficient in the treatment of pharmaceutical wastewater.

***Keywords*—** *Phamaceutical wastewater; Alum; Iron sulphate; coagulation.*

INTRODUCTION

Rapid industrialization and subsequent urbanization have increased the rate of environmental pollution [1]. Depleting water resources have seriously impacted industrial growth and also the standards of urban dwellers. Major problems are due to wastewater containing high SS concentration, COD and BOD. There is a constant search for finding new methods for the treatment of wastewater.

Pharmaceutical industry is considered as one of the highly polluting industry, generating a huge amount of wastewater [2]. Pharmaceutical products are manufactured in batch mode and this leads to a wide variety of pollutant production from different stages of manufacture. Pharmaceutical compounds enter into potable water through two different sources: Production processes and through usage of the same by human beings [3]. A plethora of toxic compounds are present in pharmaceutical effluents. Reuse of water also contributes towards contamination [4]. To overcome contamination, as well as to cater to the needs of the urban dwellers optimized methods of removal are the need of the hour [5].

Chemical coagulation is usually accomplished with coagulants such as Aluminium sulphate- or Ferrous sulphate. Natural coagulants can also be used to reduce the secondary pollution loads [6].

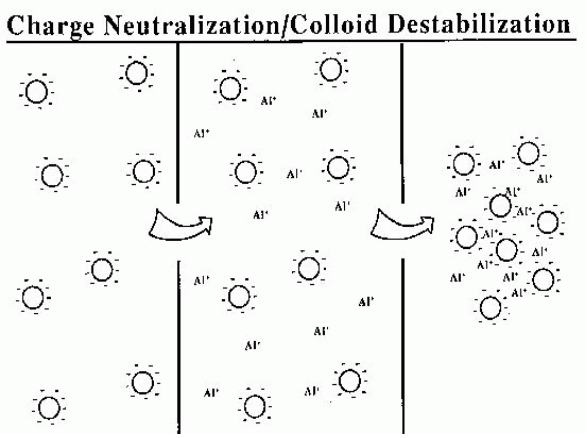

Fig.1 Charge Neutralization and Colloid Destabilization Mechanism

The focus of this work is to study the efficiency of wastewater treatment using suitable coagulants and to determine the values of optimum pH and dosages of FeSO4, Al(SO2).12H2O and Moringa Oleifera for the treatment.

MATERIALS AND METHODS

2.1 Materials

*2.1.1 Wastewater***:** The wastewater used in the present study is obtained from a reputed pharma industry. Initial turbidity, pH, COD and other parameters are to be investigated in this work.

2.12. Chemicals: Alum & Ferrous sulphate are purchased from Sigma Aldrich and Moringa oleifera is collected from nearby local market, Hyderabad.

2.1.3 *Preparation of Moringa oleifera coagulant:* the common name of Moringa is drumstick. The Moringa Oleifera plant seeds are sun dried and ground to fine size (fig.2).

Fresh drumsticks

Sundried drumsticks

Dried seeds of drumstick

Powdered Moringa

Fig.2 Preparation of Moringa coagulant

2.2 Methodology:

Wastewater sample is collected from a reputed pharmaceutical industry to which initial characterization is done. Experiments are run in a batch mode using Jar Test and the total volume of the sample taken is 500ml for each experiment. Optimization of parameters such as effect of pH and

dosage of the coagulant are being studied. pH of the pharmaceutical wastewater [7] is adjusted using diluted Sodium hydroxide (NaOH).The dosage of coagulant is varied from 1g to 4g (1g,2g,3g & 4g). Experiments are run for 30 min, after which they are allowed to settle down [8]. The supernatant is filtered and further analysis such as COD and Turbidity are done for the filtered sample to check the treatment efficiency.

% removal of COD/Turbidity = $\{(C_i-C_f)/ C_i\}X100$

Where,

C_i - initial concentration of COD/Turbidity

C_f - Final concentration of COD/Turbidity

3. Results and Discussion:

The studies of effects of pH and coagulant dosage with different coagulants are conducted in order to investigate the efficiency of Coagulation process in the treatment of Pharmaceutical wastewater. COD of wastewater is a good indicator of the strength of pollutants. Also the physical parameters like turbidity of wastewater are estimated.

3.1 Characterization of wastewater: The initial characteristics of the wastewater from pharmaceutical industry are as follows:

S. NO	**Parameters**	**Characteristics of the wastewater**	**Standards for disposal (mg/l**
1	pH	3.	6.5 – 8.5
2	BOD	45	10
3	COD	105	25
4	TS	149	210
5	TS	59	10
6	TD	98	10
7	Chloride	10	25
8	Alkalinity	20	60
9	Acidity	46	20
10	Turbidity	46	40

3.2 Effect of pH: pH of wastewater changes surface charge of coagulants and affects stabilization. pH value plays a prominent role in solubility of pollutants in wastewater. The study of pH plays a prime role in working of wastewater treatment system. At a coagulant dose of 2g/L, rapid mixing was done at a rate of 250 rpm for 10 minutes and slow mixing was done at a rate of 30 rpm for 20 minutes. Later, the solution was allowed to settle for about 30 minutes. The results obtained were analyzed by plotting the parameters and is presented in Fig.3.The range of pH tested was between 3 and 10, which indicates vthe effects of pH on percentage of COD. The initial turbidity and COD are observed to be 460NTU and 1050 mg/l respectively [9]. At an acidic pH 3 and basic pH 10 the removal % found very low. At the pH studied, pH 8 showed maximum removal efficiency of turbidity of 81, 11, 85% and COD of 78, 2.8 and

85% with Alum, Iron sulphate and Moringa (Fig.3) respectively. So, the maximum pH value by using alum as coagulant is 8.

S. No	Types of coagulant	Reduction in COD (%)	Cost in (Rs)
1	Alum	81.9	150.00
2	Ferrous sulphate	1.33	300.00
3	Moringa olefeira	**87**	**5.00**

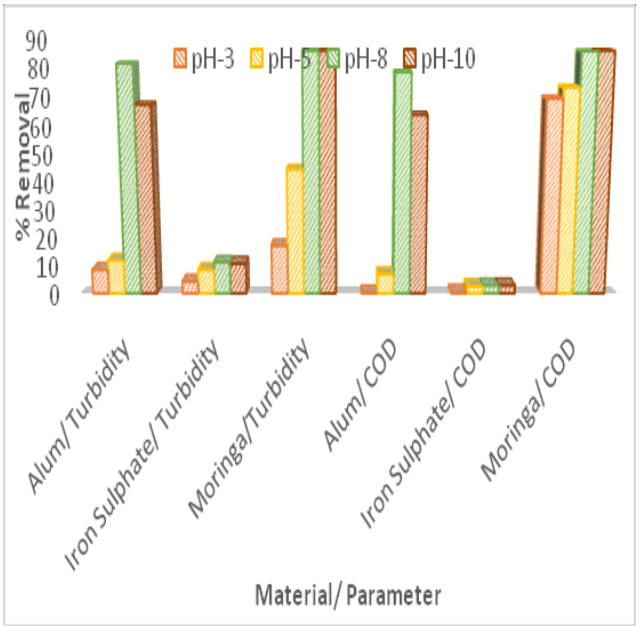

Fig.3:Influence of initial pH on turbidity and COD. Volume of sample = 500ml, pH

variation = 3, 5, 8, 10, Dosage of the coagulant =2g

3.3 Influence of dosage of coagulant

The impact of coagulant range on the treatment of pharmaceutical wastewater is studied by varying the dosages from 1g-5g at a constant pH of 8 (fig.4). From the figure, it is clearly observed that with an increase in the dosage of coagulant, there is an increase in the percentage removal of turbidity and COD. Maximum percentage removal of turbidity of 83, 86, 86.8 and COD of 81, 2.3, 87 is observed with Alum, Iron sulphate and Moringa compounds. The removal efficiency of turbidity stabilized and in case of COD, it decreased when the dosage of alum is increased above 3g.

3.3 Effect of dosage of coagulant

The effect of coagulant dosage on the treatment of pharmaceutical wastewater is studied by varying the dosages from 1g-5g at a constant pH of 8 (fig.4). From the figure, it is clearly observed that with an increase in the dosage of coagulant, there is an increase in the percentage removal of turbidity and COD.

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Alum, Iron sulphate and Moringa compounds. The removal efficiency of turbidity stabilized and in case of COD, it decreased when the dosage of alum is increased above 3g. It can be due to reversal of charge. Hence, the optimum dosage of alum for the treatment system is 3g (9).

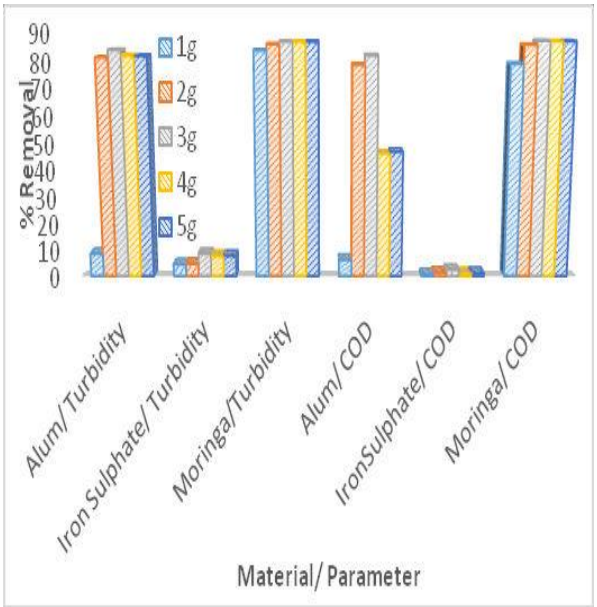

Fig.4: Influence of coagulant dosage on Turbidity and COD removal from pharmaceutical wastewater Conditions: Volume of sample = 500ml, pH =
8, Dosage variation= 1g, 2g, 3g, 4g & 5g

3.4 Comparative study: In this section, a comparative study is done between the different types of

coagulants on the treatment of Pharmaceutical wastewater in terms of percentage reduction in COD and also cost of operation. Among all the coagulants studied, ferrous sulphate is found to be the least efficient in the removal ofCOD while alum showed much higher removal efficiency than ferrous sulphate. However, huge amounts of sludge is formed which is again a problem for disposal as it is a chemical sludge and nonbiodegradable. In the present study, as shown in table 2, the natural coagulant Moringa oleifera is observed to be more efficient. A maximum of 85.7% COD reduction is achieved with this coagulant. In terms of cost also, this coagulant is found to be economically feasible. Moreover, less amount of sludge is formed which is easily biodegradable.

Table 2 Comparative study of various coagulants studied

The final characteristics of the pharmaceutical wastewater are given in table 3. It shows both initial and final characteristics of the wastewater with Moringa oleifera as the coagulant. All the parameters are found to be within the standard limits of disposal. Hence, Moringa oleifera can be effectively used as the coagulant for the treatment of industrial wastewaters.

Table 3 Characteristics of the pharmaceutical wastewater before and after the treatment with Moringa oleifera as coagulant

S NO	**Parameters**	**Initial (mg/l)**	**Final (mg/l)**	**Standards for disposal (mg/l)**
1	pH	3.0	8	**6.5 – 8.5**
2	BOD	450	85	**100**
3	COD	1050	135.4	**250**
4	TS	1490	180	**2100**
5	TSS	590	100	**100**
6	TDS	900	80	**100**
7	Chloride	100	35.4	**250**
8	Alkalinity	200	354	**600**
9	Acidity	460	150	**200**
10	Turbidity (NTU)	460	60.4	**100**

Note: all the parameters are given in mg/l except for pH and turbidity (NTU)

4. Conclusions:

- Pharmaceutical wastewater has the initial characteristics of pH-3, Color-milky white, COD- 1050 mg/l and turbidity- 460 NTU, also the remaining parameters are found to be above permissible limits.

- The optimum pH in coagulation process for Alum, Ferrous sulphate and Moringa oleifera seed powder is found to be 8.
- The optimum dosages of Alum, Ferrous sulphate and Moringa oleifera seed powder as coagulant are found to be 3g/500ml, 3g/500ml and 2g/500ml respectively at an optimum pH of 8.
- Of all the coagulants used in the present analysis, optimum turbidity decrease is found to be 86% and optimum COD decrement is 87% with Moringa Oleifera

Therefore, we can interpret that as compared with remaining coagulants, Moringa Oleifera is the best coagulant in removal of pollutants from pharmaceutical wastewater.

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