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COMPARISON OF INORGANIC COAGULANTS FOR THE EFFECTIVE TREATMENT OF PULP AND PAPER MILL AND TANNERY WASTE WATER EFFLUENT

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Abstract: *Industrialization plays an important role for socio-economic development of the country. The wastewater arising from pulp and paper mills and tannery industries are highly polluted and has to be treated before discharged into rivers. Coagulation–flocculation process is one of the techniques used for water and wastewater treatment. The present investigation was carried out to study the efficiency of inorganic coagulants to reduce the Chemical Oxygen Demand (COD) of pulp and paper mill and tannery wastewater. The experiments were carried out in jar tests with different inorganic coagulants (Aluminum Sulphate (Alum) and Poly –Aluminum Silicate –Chloride (PASiC)) with different dosages of Alum 50, 100, 150, 200, 250 mg/L and PASiC 10,15,25,35,40 and 45 mg/L, pH ranges of 5-9, rapid mixing at 2 min, followed by slow mixing at 40 rpm for 15 min with settling time of 30 min. The efficiency of inorganic coagulants with treated wastewater was evaluated based on percentage removal of pollutants of concern (pH and COD) in pulp and paper mill and tannery effluent. By adding 45 mg/l of PASiC, the COD removal is found to be maximum for both the effluents, whereas even by adding 250 mg/l of alum the COD removal is not that effective. The inorganic coagulant PASiC gives better removal efficiencies with respect to COD and appears to be suitable for effluent treatment.*

***Keywords*—Pulp and paper mill, tannery wastewater, coagulation–flocculation, Alum and PASiC, COD**

Introduction

Increased knowledge about the environmental impacts due to the industrial activities leads to the introduction of better techniques and more efficient waste management systems to reduce their environmental impact. The paper and pulp industries and tannery industries are generating more quantities of waste water which forms the major reason for water pollution because of the presence of several persistent and recalcitrant substances. In this study, pulping wastes and tannery wastes have been characterized and found to contain very high COD. Because of the high water consumption in pulp and paper mills and tannery industries, the generation of wastewater is also enormous in quantity, which contains more COD.

Coagulation/flocculation is a frequently applied process in the primary purification of industrial wastewater, as it is efficient and simple for application. Aluminum salts and iron salts are widely used as coagulants in water and wastewater treatment for the removal of impurities from effluent, including colloidal particles and dissolved organic substances. There are many factors that affect the process of coagulation and flocculation such as pH, alkalinity, and zeta potential, dose of coagulant and use of polyelectrolyte. But if they are controlled to the optimum ranges better removal efficiency can be achieved. Therefore the COD removal of paper mill waste and tannery waste is essential for minimizing environmental impacts.

In this study, coagulation-flocculation by Alum and PASiC are applied to pulp and paper mill industry effluents and tannery industry effluent. The optimum dosage and optimum pH are studied. The COD concentrations are used as evaluating parameters. The main purpose was to define whether the application of composite coagulants can exhibit septic advantages for the physic-chemical treatment of these wastewater and to determine the appropriate coagulant and its dosage and optimum pH, as well as the comparison with conventional coagulants alum.

MATERIALS AND METHODOLOGY

Effluents

The paper and pulp effluent is collected from seshasyee paper mill and the tannery effluent is collected from EKM leather industry. Tannery waste

water is collected after equalization tank and paper and pulp waste is collected Before primary clarifier. The physicochemical parameters of the paper and pulp effluent and tannery effluent were analyzed and shown in Table I and Table II respectively.

The pH of the both paper and pulp effluent and tannery effluent are found to be alkaline in nature. The BOD and COD of the tannery waste water are found to be far higher than the paper and pulp effluent. As both the effluents have very high COD values, they should be reduced by some treatment process. The paper and pulp effluent contains more dissolved solids. The chlorides and sulphates are too high in the tannery waste water than in the paper and pulp waste water. The alkalinity is very high in tannery effluent.

Table I. Physicochemical parameters of the paper and pulp effluent

PARAMETERS	**VALUES**
pH	8.21
Biological Oxygen Demand (BOD, mg/l)	275
COD (mg/l)	1495.04
Total Solids (mg/l)	3256
Total Dissolved Solids (mg/l)	3112
Settle-able Solids (mg/l)	26.6
Chlorides (mg/l)	420
Sulphates (mg/l)	328.4
Total Hardness (mg/l as $CaCO_3$)	340
Calcium Hardness (mg/l as $CaCO_3$)	250

Table II. Physicochemical parameters of the Tannery effluent

PARAMETERS	**VALUES**
pH	8.03
Biological Oxygen Demand (mg/l)	5150
COD (mg/l)	9200
Total Solids (mg/l)	2480
Total Dissolved Solids (mg/l)	2120
Total Volatile Solids (mg/l)	2600
Chlorides (mg/l)	4200
Sulphates (mg/l)	9280
Alkalinity (mg/l as $CaCO_3$)	3900
Color	Ash

B. Coagulants

The experiments were carried out using the jar test apparatus with different inorganic coagulants such as Aluminum Sulphate (Alum) and Poly –Aluminum Silicate – Chloride (PASiC).

C. Experimental Setup

The jar test is carried out by rapidly mixing the coagulant with the effluent for 2 min, followed by slow mixing for 15 min with settling time of 30 min at 40 rpm by varying the dosage and the pH. The different dosages of alum and PASiC such as , 100, 150, 200, 250 mg/L and 10,15,25,35,40 and 45 mg/L are added respectively by varying the pH from 5 to 9.

III. COD REMOVAL FOR PAPER AND PULP EFFLUENT

A. pH INFLUENCE ON ALUM

The better COD removal is obtained for the paper and pulp effluent by adding alum at a pH of 6. They are shown in Table III and Fig.1.

Table III. COD removal for paper and pulp effluent by varying pH and adding alum

Ph	PERCENTAGE REMOVAL (%)
5	54
6	61
7	58
8	57
9	54.5

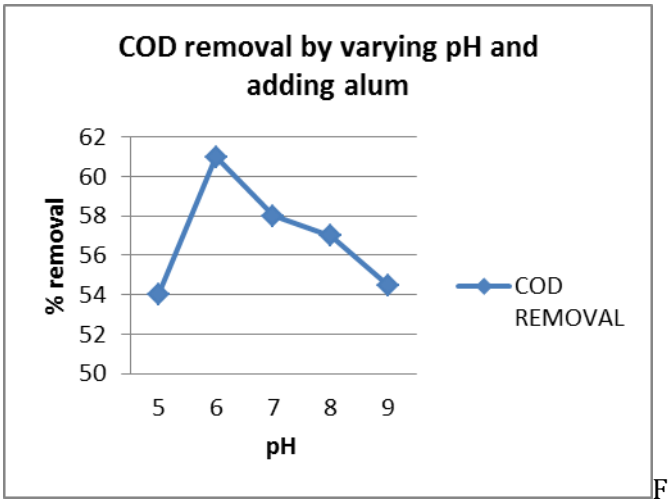

Fig.1. COD removal for paper and pulp effluent by varying pH and adding alum

B. pH INFLUENCE ON PASiC

At a pH of 7, the COD removal is found to be maximum with the addition of PASiC for the paper and pulp effluent and they are as shown in Table IV and Fig.2.

Table IV. COD removal for paper and pulp effluent by varying pH and adding PASiC

pH	PERCENTAGE REMOVAL (%)
5	71
6	77.24
7	81
8	79.04
9	76.18

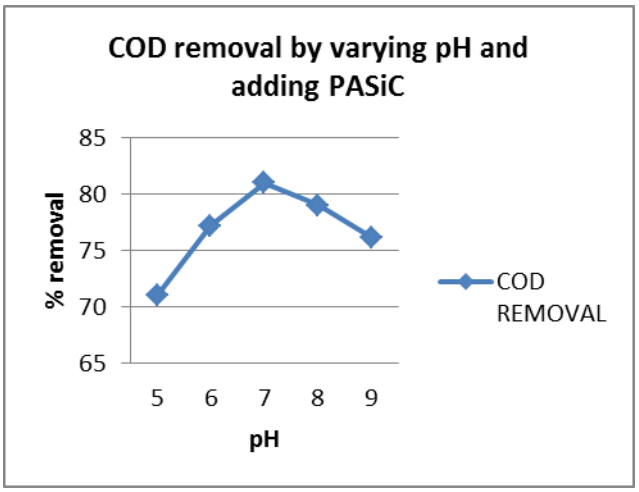

Fig.2. COD removal for paper and pulp effluent by varying pH and adding PASiC

C. COD REMOVAL W.R.T DOSAGE FOR ALUM

By altering the alum dosage, the maximum COD removal from the paper and pulp effluent is found to be at 250 mg/l and are shown in Table V and Fig.3. The COD removal increases with increase in the alum dosage.

Table V. COD removal for paper and pulp effluent by varying dosage of alum

DOSAGE (mg/l)	PERCENTAGE REMOVAL (%)
50	55
100	71.04
150	72.61
200	76.4
250	77.54

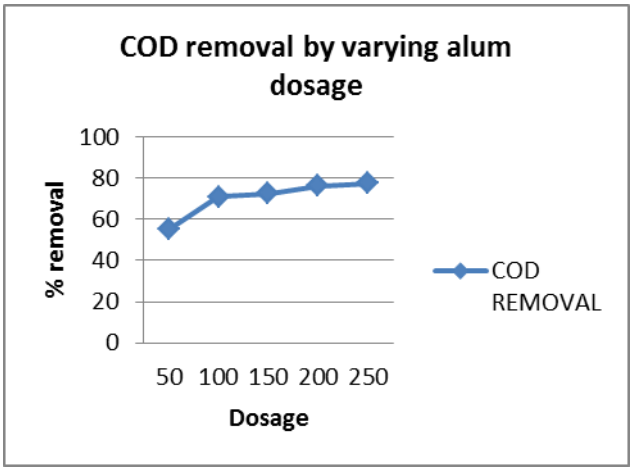

Fig.3. COD removal for paper and pulp effluent by varying dosage of alum

D. COD REMOVAL W.R.T DOSAGE FOR PASiC

As shown in Table VI and Fig.4. the optimum PASiC dosage is found to be 45 mg/l for paper and pulp effluent. With increase in the PASiC dosage, the COD removal also increases.

Table VI. COD removal for paper and pulp effluent by varying dosage of PASiC

DOSAGE (mg/l)	PERCENTAGE REMOVAL (%)
10	56
15	61.8
25	74.6
35	89.18
40	90.82
45	91.82

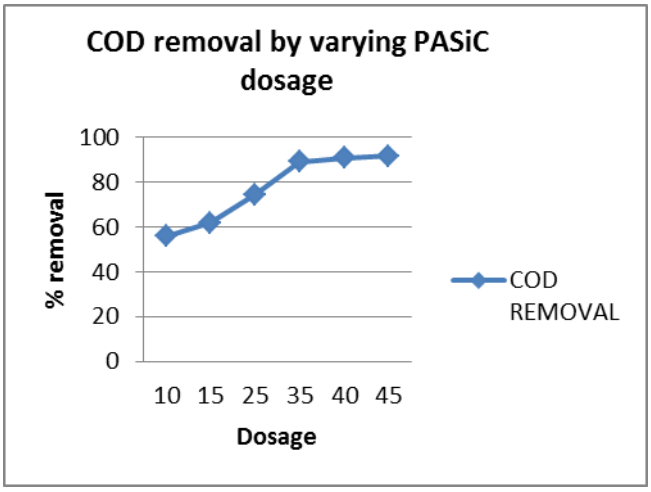

Fig.4. COD removal for paper and pulp effluent by varying dosage of PASiC

IV. COD REMOVAL FOR TANNERY EFFLUENT

A. pH INFLUENCE ON PASiC

The optimum pH is found to be 7 for the removal of COD from the tannery effluent, which are illustrated in Table VII and Fig.5.

Table VII. COD removal for tannery effluent by varying pH and adding PASiC

Ph	PERCENTAGE REMOVAL (%)
5	52.69
6	64.38
7	74.16
8	71.36
9	67.34

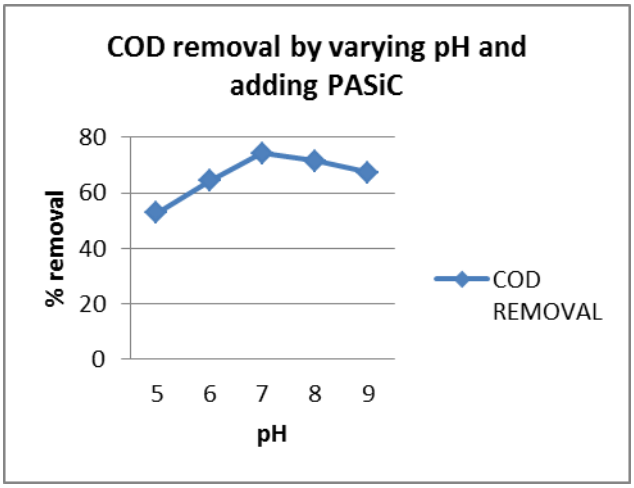

Fig.5. COD removal for tannery effluent by varying pH and adding PASiC

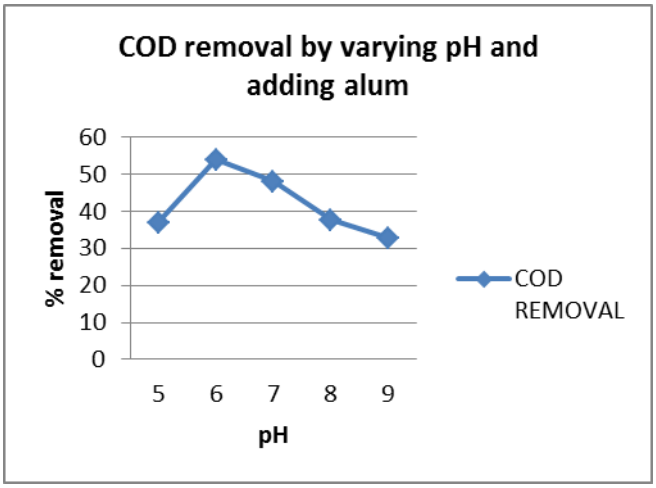

Fig.6. COD removal for tannery effluent by varying pH and adding alum

B. pH INFLUENCE ON ALUM

At a pH of 6, the COD removal is found to be maximum with the addition of alum for the tannery effluent and they are as shown in Table VIII and Fig.6.

Table VIII. COD removal for tannery effluent by varying pH and adding alum

pH	PERCENTAGE REMOVAL (%)
5	37
6	54
7	48.12
8	37.68
9	32.84

C. COD REMOVAL W.R.T DOSAGE FOR ALUM

The optimum alum dosage is found to be 250 mg/l for the COD removal from the tannery waste water and it is shown in Table IX and Fig.7.

Table IX. COD removal for tannery effluent by varying dosage of alum

DOSAGE (mg/l)	PERCENTAGE REMOVAL (%)
50	29.68
100	31.26
150	34.2
200	38.5
250	41

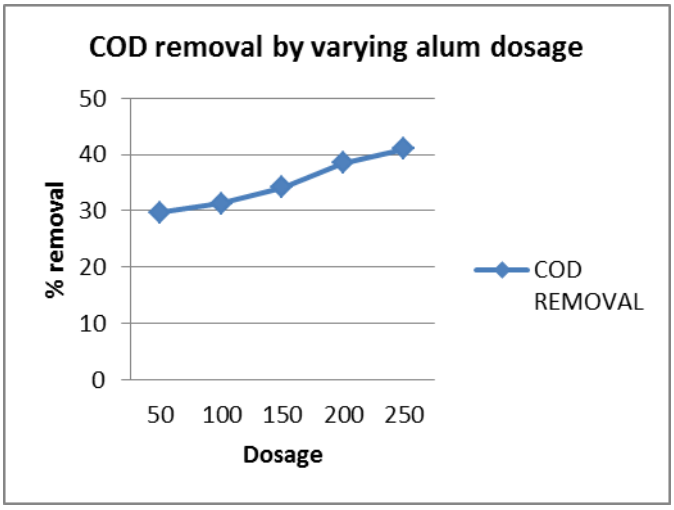

Fig.7. COD removal for tannery effluent by varying dosage of alum

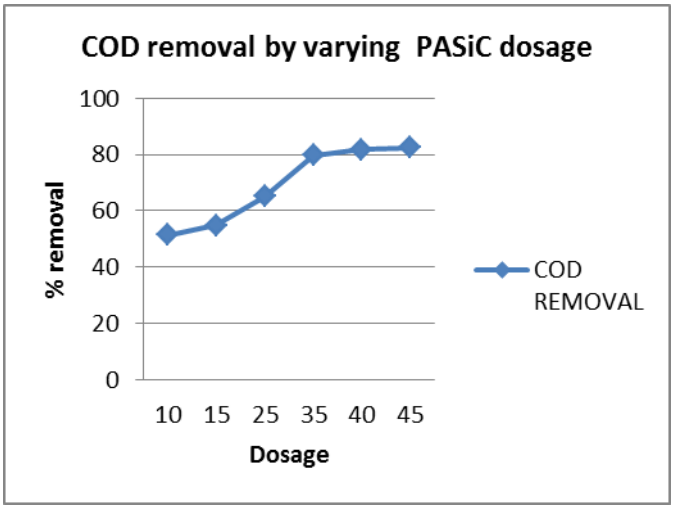

Fig.8. COD removal for tannery effluent by varying dosage of PASiC

D. COD REMOVAL W.R.T DOSAGE FOR PASiC

By altering the PASiC dosage, the maximum COD removal from the tannery effluent is found to be at 45 mg/l and are shown in Table X and Fig.8. The COD removal increases with increase in the PASiC dosage.

Table X. COD removal for tannery effluent by varying dosage of PASiC

DOSAGE(mg/l)	PERCENTAGE REMOVAL (%)
10	51.38
15	54.86
25	65.16
35	79.64
40	81.68
45	82.5

V. CONCLUSION

Based on the application and economy, the easiest way of removal of COD is through the coagulation and flocculation process. For the paper and pulp effluent, at the optimum coagulant dosage of PASiC, the COD removal efficiency was found to be 91.82% and for tannery waste water it is found to be 82.5%. For the paper and pulp effluent, at the optimum coagulant dosage of alum, the COD removal efficiency was found to be 77.54% and for tannery waste water it is found to be 41%. It is observed that the COD removal efficiency of the PASiC with 45 mg/l as optimum coagulant dosage is highly effective than the COD removal efficiency of the alum even with 250 mg/l as coagulant dosage, for both the paper and pulp waste water and tannery waste water. Hence the PASiC is the best inorganic coagulant for both the paper and pulp and tannery effluents

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