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Reduce the pollutants from primary clarifier inlet wastewater of pulp and paper industry

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ABSTRACT

The primary clarifier inlet of pulp and paper mill wastewater was treated by using Alum and Poly aluminium chloride (PAC) coagulants separately with cationic polyacrylamide. The effectiveness of these coagulants was measured based on the reduction of color, total suspended solids (TSS), chemical oxygen demand (COD) and biochemical oxygen demand (BOD_5). By using Alum with CPAM to treat the wastewater the reduction of color, TSS, COD and BOD_5 is 83%, 92%, 81% and 80% respectively at pH 5.5. The reduction of 89%, 92%, 84% and 81% respectively for the above mentioned parameters when using PAC with CPAM to treat the waste water at pH 6.3.

KEYWORDS: Alum, BOD_5, COD, CPAM, PAC, primary clarifier.

1. INTRODUCTION

The basic raw material for the agro based pulp and paper industry is wood and bagasse. It consumes large quantity of fresh water for pulping, bleaching and paper making. The generation of the wastewater characteristics from the pulp and paper industry is depending upon the production process. Hence, the treatment of the wastewater from different stages is become complicated. Because of the entire mills releases non-identical characteristics of the effluent due to not the same as another one unit processes involved in the production process. Amongst 90% of the pulp and paper mills are adopted elemental chlorine free bleaching technology for bleaching. During pulping, the screened wood/bagasse cooked with liquor contains sodium hydroxide and sodium sulfide at temperature 170°C and that cooking liquor name called white liquor. In this stage, celluloses and hemicelluloses are screened for further bleaching process. Other than cellulosic material fibers, the lignin and other organic components are dissolved in white liquor and it turns to dark brown in color name called black liquor. During cooking most of the lignin can be removed as black liquor and it burned in recovery boilers. Up to this stage, there is a close loop system for chemical recovery. In pulp mill, the effluent drained from bleaching stage. In this high strength colored wastewater contains chloro organics, chloro phenols, resins, fatty acids etc. This pulp mill wastewater causes the color and effluent load of pulp and paper industries effluent. To remove organic and inorganic substance from the wastewater, various treatments like physical, chemical and biological treatment are used.

The physical treatment methods remove settable solids. Non-biodegraded substances are removed by the chemical treatment. The biological treatment such as trickling filters, oxidation pond, aerated lagoon, UASB and activated sludge processes used for organic removal. Most solid/liquid separation systems have difficulty operating when the requirements are to produce high quality water, to remove fine particles, to operate continuously and remove high quantities of fiber. Chemical coagulation is a probed technique for the treatment of high-suspended solids wastewater, especially those formed by colloidal matters. Research and practical applications have shown that coagulation will lower the pollution load and could generate an adequate water recovery.

Coagulation is an essential process in water and industrial wastewater treatment. The coagulation - flocculation method gives the best result in short reaction time when compared with biological treatment. The use of Inorganic metal salts for coagulation process has been well documented. Senthilkumar and Akilamudhan (2016) studied that the paper industry effluent using electro chemical method. They achieved 59.12% COD reduction and observed that the rate of reduction of COD of the effluent increased with increase in supporting electrolyte and current density whereas COD diminished with an increase in reservoir volume and flow rate of electrolyte.

D.Sivakumar, (2015) studied removal of total organic content (TOC) and COD from municipal solid waste leachate using electro coagulation method. At optimum temperature 50°C, optimum agitation speed of 50 rpm and optimum current density of 40 mA/cm^2, they achieved the maximum percentage removal of TOC and COD in a leachate was obtained was 94.7 % and 98.2 % respectively

Pradeep Kumar, (2011) has investigated PAC is found to be a better coagulant in comparison to Aluminum chloride and copper sulfate. The maximum COD and color removal of at pH 4 is 84% and 92% respectively were obtained using PAC as compared to 72 % and 84 % with Aluminum chloride at pH 5 and 74 % and 76 % with copper sulfate at pH of 6.

Anurag Garg (2004) studied that the treatment of pulp and paper mill effluent for the removal of non-biodegradable and toxic compounds by wet air oxidation using heterogeneous catalysts. They found maximum COD reduction of 83% for $(CuO\text{-}ZnO)/CeO_2$ catalyst was obtained in 2 h reaction time at a catalyst concentration of 5 Kg/m^3

W. Chen and N. J. Horan (1998) investigated that remove 70% of the COD and 90% of color using alum from the effluent of an activated sludge plant treating paper mill wastewater. Most of the researchers found COD and color removal using methods like electro coagulation, fungal treatment, chemical oxidation, and ozonation.

Coagulation/ flocculation is not only the economic but also the effective method for removal of COD and color from pulp and paper mill wastewater. In this present work, the primary clarifier of the pulp and paper industry wastewater was treated separately with Alum and PAC with CPAM and found the suitable coagulant for pollutant removal.

2. EXPERIMENTAL

The wastewater sample collected from the primary clarifier unit in an integrated pulp and paper mill, Tamilnadu, India. The sample was characterized and the physico-chemical analysis was performed by using prescribed Indian Standard IS 3025 standard methods are given in Table 1.

Jar test procedures carried out using 1000 ml of the wastewater samples with the various dosages of selected coagulants like Alum and PAC. The selected coagulants were added to 1000 ml of wastewater, it was stirred for a period of 5 minutes at 100 rpm, and it was followed by further slow mixing of 2 minutes at 50 rpm. The flocs formed and settled within 20 minutes due to the addition of CPAM. After settling, the pH, Color, TDS, TSS, COD and BOD_5 were analyzed. The analysis repeated for 12 days for getting average values using Indian Standards IS 3025 standard methods.

3. RESULTS AND DISCUSSION

The coagulant was chosen by depends on the nature of pollutants presents in effluent. Normally pulp and paper mill has strong anionic nature due to the major source of lignin/ chromophore derivatives contained pulp mill bleach effluent. So CPAM has been used for quick settling. The removal of pollutants was achieved through two simultaneous mechanisms, which included coagulation by charge neutralization and flocculation by bridging.

Table.1. Physico- chemical characteristics of the untreated and treated wastewater sample

Particulars	Units	Untreated wastewater	Alum with CPAM	PAC with CPAM
pH	-	7.6	5.5	6.3
Color	PtCo	460	80	50
TDS	mg/L	2452	2348	2292
TSS	mg/L	388	30	30
COD	mg/L	755	144	123
BOD_5	mg/L	344	70	67

When the wastewater treated using alum with CPAM, the resulting color, TDS, TSS, COD and BOD_5 is 80, 2348, 30, 1444 and 70 at pH 5.5 from the untreated wastewater values 460, 2452, 388, 755 and 344 at pH 7.6. From this, the significant reduction was found in color, TSS, COD and BOD_5. When treated using the PAC with CPAM, it shows the best results compare with the Alum treatment at pH 6.3, the resulting color, TDS, TSS, COD and BOD_5 is 50, 2292, 30, 123 and 67 (Fig1).

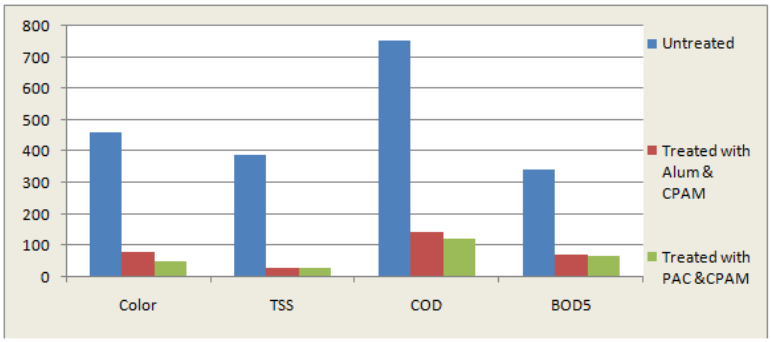

Figure.1. Characteristics comparison from untreated with treated wastewater

The selection of coagulant and flocculants are one the most important decision for the wastewater treatment. Because all the coagulants and flocculants are not performing in all types of wastewater. Depending on the wastewater characteristics, the coagulants and flocculants are chosen for this study. The selection of raw material for this wastewater treatment, both are Aluminum based coagulants. But the functionality of the Alum and PAC may differ when applied in the wastewater treatment. From this result, PAC works with broad pH levels and effectively remove the pollutants when compare with alum. Because of PAC having high basicity when compare with alum has no basicity. The characteristics of Alum and PAC are given in table 2 and table 3 respectively.

Table.2.Characteristics of the Alum

Particulars	Units	Results
pH of 5% solution	-	2.6
Water soluble Aluminium compounds as Al_2O_3	%	16.8
Water soluble Iron compounds as Fe	%	0.01

Table.3.Characteristics of the PAC

Particulars	Units	Results
pH of 5% solution	-	3.3
Bulk density	g/ml	0.71
Aluminium as Al_2O_3	%	29.8
Chlorides as Cl^-	%	30.2
Basicity	%	77.6

Due to the high alumina content and high basicity of PAC, the pollutant removal efficiency is encouraging and it consumes less alkalinity in this wastewater. Due to the consumption of less alkalinity, the optimum dosage of PAC is low 600 mg, but in case of alum is 900 mg for this wastewater. Moreover, the CPAM may bind with anionic functional groups, which was presented in this wastewater, and to create an insoluble complex. These complexes adsorbed into the hydrolyzed aluminum hydroxide forming the insoluble amass and remove the color from this wastewater without resolublizing.

4. CONCLUSION

The purpose of this work to overcome the problem of disposal of colored high strength wastewater released from integrated pulp and paper industries. In this work, the reduction efficiency of color, TSS, COD and BOD_5 from the wastewater can be greatly noticeable along with it is applicable for pulp and paper industries. Color is the visible pollutant for common man. In this particular work, the color of the wastewater is much reducing during treatment. Moreover, the same work highly useful to come out from the problem of TDS of the wastewater during treatment. During the treatment of this wastewater, much better reduction efficiency has found using with PAC and CPAM when compared with alum treatment. In addition, the optimum dosage is low when using PAC as compared with alum due to their characteristics. Both the treatment gives closure to the reduction efficiency at the optimum dosage but the pH may acidic in alum. Optimum dosage at close to neutral pH of the PAC treatment was most apt for this wastewater stream.

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REFERENCES

Aguilar M.I, Saez J, Llorens M, Soler A, Ortuno J.F, Nutrient removal and sludge production in the coagulation–flocculation process, Water Res, 36, 2002, 2910–2919.

Aguilar M.I, Saez J, Llorens M, Soler A, Ortuno J.F, Nutrient removal and sludge production in the coagulation–flocculation process, Water Res, 36, 2002, 2910–2919.

Al-Mutairi N.Z, Hamoda M.F, Al-Ghusain I, Coagulant selection and sludge conditioning in a slaughterhouse wastewater treatment plant, Bioresource Technol, 95, 2004, 115–119.

Anurag Garg, Narayana V V V S S, Parmesh Chaudhary, Shri Chand, Treatment of pulp and paper mill effluent, Journal of Scientific and Industrial Research, 63, 2004, 667-671.

Chen W, Horan N.J, The Treatment of a High Strength Pulp and Paper Mill Effluent for Wastewater Re-Use, Env Tech, 19, 1998, 173-182.

Karthik V, Saravanan K, Bharathi P, Dharanya V, Meiaraj C, An overview of treatments for the removal of textile dyes, Journal of Chemical and Pharmaceutical Sciences, 7, 2014, 301-307.

Lewis R, Nothrop S, Chow CWK, Everson A, van Leeuwen JA, Colour formation from pre and post-coagulation treatment of Pinus radiata sulfite pulp mill wastewater using nutrient limited aerated stabilisation basins. Separation and Purification Technology, 114, 2013, 1-10.

Pradeep Kumar, Tjoon Tow Teng, Shri Chand, Kailas L. Treatment of Paper and Pulp Mill Effluent by Coagulation, Int J of Chemical, Molecular, Nuclear, Materials and Metallurgical Engineering, 5, 2011, 715-720.

Ramiah Gunasekaran, Sellappa Kanmani, Risk Assessment of Chlorinated Effluents from Pulp and Paper Industry and Their treatment by Advanced Oxidation Process, Asian Journal of Chemistry, 25, 2013, 8015-8018.

Senthilkumar K, Akilamudhan P, Treatment of paper industry effluent using electrochemical method, Journal of Chemical and Pharmaceutical Sciences, 9, 2016, 265-267.

Sivakumar D, RajaganapathyJ, Anand R, Mariavensa S, Preethi S, TOC and COD removal from municipal solid waste leachate using Electrocoagulation method, Journal of Chemical and Pharmaceutical Sciences, 8, 2015,745-749.

Vaithegi K, Treatment Of Bagasse Based Pulp And Paper Industry Effluent Using Moving Bed Biofilm Reactor, International Journal of ChemTech Research, 5, 2013, 1313-1319.