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Comparison of Poly Aluminum Chloride and Chlorinated Cuprous for Chemical Oxygen Demand and Color Removal from Kashan Textile Industries Company Wastewater

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ABSTRACT

Aims Textile wastewaters are the most important health and environmental problems in Kashan. This research was aimed to compare the poly aluminum chloride and chlorinated cuprous efficiency for removal of Chemical Oxygen Demand (COD) and color from Kashan Textile Industries Company wastewater.
Materials & Methods This experimental bench scale study in a batch system was conducted on 20 composed wastewater samples collected from Kashan Textile Industries Company raw wastewater. During 5 months, in the beginning of every week a day was selected randomly and in the day a composed sample was taken and studied. PAC at the doses of 10, 20, 30, 40 and 50mg.l-1 and chlorinated cuprous at the doses of 100, 200, 300, 400 and 500mg.l-1 were applied. The optimum pH also optimum concentration of PAC and chlorinated cuprous were determined using Jar test. The data was analyzed by SPSS 16 using descriptive statistics and Fisher Exact test.
Findings The average concentration of COD in the raw textile wastewater was 2801.56±1398.29mg.l-1. The average COD concentration has been decreased to 1125.47±797.55mg.l-1. There was a significant difference between the effects of these two coagulants efficiency ($p<0.05$). The average COD removal efficiency for chlorinated cuprous and PAC was 58.52% and 72.56%, respectively. Also, the average color removal efficiency by chlorinated cuprous and PAC were 17.23 and 64.45%, respectively.
Conclusion PAC is more efficient than chlorinated cuprous for both COD and color removal from KTIC wastewater.

Keywords Environmental Pollution; Biological Oxygen Demand Analysis; Waste Water

CITATION LINKS

[1] Remediation of dyes in textile effluent: A critical review on current treatment technologies with a proposed alternative [2] The treatment and reuse of wastewater in the textile industry by means of ozonation and electroflocculation [3] Industrial water pollution control [4] Electrocoagulation treatment of black liquor from paper industry [5] Treatment of levafix orange textile dye solution by electrocoagulation [6] Decolourization of textile industry wastewater by the photocatalytic degradation process [7] Decolorization of orange II by electro coagulation method [8] Treatment of textile wastewater by chemical methods for reuse [9] Methods ration of textile wastewater [10] Treatment of textile industry wastewater by supported photocatalysis [11] Polymeric nanofiltration membranes for textile dye wastewater treatment: Preparation, performance evaluation, transport modelling, and fouling control; a review [12] Continuous treatment of textile wastewater by cobined coagulation, electrochemical oxidation and activated sludge [13] The removal of colour from textile wastewater using whole bacterial cells: a review [14] Standard methods for the examination of water and wastewater [15] Color science: Concepts and Methods, Quantitative Data and Formulae [16] Removal of dyes from aqueous solutions by low pressure batch ultrafiltration [17] Decolorization of textile wastewater by electrochemical process in the presence of hydrogen peroxide and poly aluminum chloride [18] Decolorization of C.I. acid blue 9 solution by UV/Nano-TiO2, Fenton, Fenton-like, electro-Fenton and electrocoagulation processes: A comparative study [19] A review on chemical coagulation/flocculation technologies for removal of colour from textile wastewaters [20] Decolorization and COD reduction of dyeing wastewater from a cotton textile mill using thermolysis and coagulation [21] Treatment of composite wastewater of a cotton textile mill by thermolysis and coagulation [22] Evaluation of the potential cationic dye removal using adsorption by graphene and carbon nanotubes as adsorbents surfaces

All keywords and available citations are linked in this page.

Introduction

Kashan is located at the edge of the Central Desert in Iran and it is one of the pioneers in textile production. Kashan has got a long history in both traditional and industrial textile production. In textile production process, large volume of wastewater is generated in dyeing and finishing sector especially, this; nearly contains the consumed materials. Textile wastewater is well-known due to its high concentration of suspended solids, drastic fluctuation in pH, high temperature, Chemical Oxygen Demand (COD) and color. It may contain heavy metals and detergents as well. Release of these materials to the environment will lead to the environmental pollution; water and soil resources will be affected; pollution may come into the food chain affecting the human health distastefully [1, 2].

Discharge of textile wastewater to the municipal wastewater collection systems has a negative effect on wastewater treatment efficacy [3]. Through the dying process, about 5 to 20% of dyes will enter to the wastewater due to lack of complete stability on fibers [4]. Dye wastewater normally contains acids, alkalis, dissolved solids, poisonous compounds and dye materials that must be removed before wastewater removal to water sources [5].

Dyes are apparent contaminants and they remove the limpidity and quality of the surface. They prevent the light penetration to the receptive water. Dyes can cause cancer and mutation and are poisonous for fish, flora and fauna [6, 7]. Usage of color and COD are expected in textile wastewater and make its treatment inevitable. In some cases, color removal from textile wastewater is so intricate and even it may not be achieved by advanced wastewater treatment technologies [8, 9].

Generally, textile dying agents are synthetic and include direct, sulfurous, reactive, chromic, acidic, alkaline and azo dyes [10]. Oxalic, citric, formic and acetic acids are used in dying process [11]. In addition, some other chemical such as alkalis, oxidizing agents, detergents, starchy compounds or sizing (starch and enzymes), emulsifiers, ethanol, organic compounds (formaldehydes) and mineral salts may be used in textile industries [1].

Nowadays, different materials such as coagulants are used to treat textile wastewater. Studies by Sheng *et al.* on dying wastewater from 20 textile mills show that coagulation with Aluminum Sulfate decrease up to 65% of color and 40% of COD. Poly Aluminum Chloride (PAC) $Al_2(OH)_4Cl_2$ is one of the coagulants that its function has been widely considered in treating water and wastewater recently. Chlorinated cuprous is common to treat water and wastewater [10-13].

Considering the water resources deficiency, large volume of textile wastewater, environmental problems and consecutive threats to the public health; these types of wastewater must be treated [2].

Due to global limitation of drinking water especially in the hot and dry climates like Kashan, treatment and reuse of wastewater is vital. Therefore, this research was carried out to compare the PAC and chlorinated cuprous efficiency for removal of COD and color from Kashan Textile Industries Company (KTIC) wastewater.

Materials & Methods

This experimental bench scale study in a batch system was conducted on 20 composed wastewater samples collected from Kashan Textile Industries Company wastewater. The sample was taken during 5 months from March to August 2013. In the beginning of every week, a day was selected randomly to take composed sample.

Each composed sample was divided into 10 parts then PAC or Chlorinated Cuprous was added in different dosages to them. PAC at the doses of 10, 20, 30, 40 and 50mg.l^{-1} and Chlorinated Cuprous at the doses of 100, 200, 300, 400 and 500 mg.l^{-1} were applied. According to the JAR test, the optimum pH and dosage of coagulants for more effective coagulation were determined [8]. After 20min settling time a sample was taken from 5cm depth at the top of the Jar with optimum transparency and its remainder COD and color removal percentage were determined. The evaluation criteria for color and COD removal were 80% and 500mgL^{-1} respectively.

COD was measured by returned distillation method [13]. Color removal was calculated as well [15]. For this purpose, after setting and filtration, each sample was took place in the

DR 2000 spectrophotometer (Hach; United States) and in 30 wave length (380-670nm) the past-through light rates were red and color removal percentage for each wave length was calculated using below formula in which R is color removal percentage; Tf is the rate of passed light through raw sample; Tp is the rate of pasted light through settled coagulated sample. The color removal percentage of a sample was the average of R_s [14-15].

$$R = \left[1 - \frac{\log(Tp)}{\log(Tf)}\right] * 100$$

The data was analyzed by SPSS 16 using descriptive statistics and Fisher Exact test used in order to determine the difference between two coagulants for COD reduction bellow $500 mg.l^{-1}$.

Findings

The average concentration of COD in the raw textile wastewater was $2801.56 \pm 1398.29 mg.l^{-1}$ (This ranges from 1200 to 5500 $mg.l^{-1}$. The pH of the composed wastewater samples ranges from 5.50 to 10.20). The average COD concentration has been decreased to $1125.47 \pm 797.55 mg.l^{-1}$ by optimum dosages of chlorinated cuprous. COD has been reduced to $725.5 + 53.8 mg.l^{-1}$ by optimum dosages of PAC.

The optimum dosages of chlorinated cuprous in 20% of the samples (4 cases) reduced the COD bellow its standard in Iran ($500 mg.l^{-1}$) whereas, it was 50% for PAC (10 cases). There was a significant difference between the effects of these two coagulants efficiency ($p<0.05$) (Figure 1).

The average of optimum dosage of chlorinated cuprous for COD removal was 240.12 ± 72.44 $mg.l^{-1}$ and for color removal was $210.73 \pm 139.17 mg.l^{-1}$, whereas, the average of optimum PAC dosage for above purposes are 24.18 ± 10.71 and $21.82 \pm 12.73 mg.l^{-1}$, respectively.

The average COD removal efficiency for chlorinated cuprous and PAC was 58.52% and 72.56%, respectively. Also, the average color removal efficiency by chlorinated cuprous and PAC were 17.23 and 64.45%, respectively.

Discussion

This study was carried out to compare the PAC and chlorinated cuprous efficiency to remove COD and color from Kashan Textile Industries Company wastewater. There were drastic fluctuation in COD and pH that result in some difficulties to treat the wastewater. On the other hand, the PAC as coagulant is more efficient than chlorinated cuprous for both COD and color removal so that the average optimum dosage of PAC for COD removal was 24 and for color removal was 21mg/L whereas, chlorinated cuprous dosage for COD removal was 240 and for color removal was $210 mg.l^{-1}$. Using PAC; the average of COD removal has been calculated 72.56% and that of color removal has been 64.46% whereas; the average of COD removal using chlorinated cuprous was 58.5% and that of color removal was 17.32%.

In comparison with Shinger's *et al.* study, it can be concluded that the PAC efficiency in our research for color removal is approximately the same as Aluminum Sulfate used by Shinger's *et al.* but for COD removal PAC is by far more effective than Aluminum Sulfate [16].

The study on textile wastewater in Iran suggests that PAC is more effective than the other agents [17]. Another study showed that the removal efficiency of COD and color was raised in the presence of PAC [18, 19]. Also, a study for dying wastewater decolorization and COD removal in a cotton textile mill showed that the use of PAC is useful to increase the efficiency of color and COD reduction [20, 21].

A study on black liquor wastewater shows that PAC in dosing rate of $1 g.l^{-1}$ provided 17% of COD reduction [22]. While, in our study PAC in optimum dose (24mg.l-1) provides 72.56% of COD reduction from textile wastewater that depicts better removal efficiency and less needed dosage of PAC which is fairly expensive coagulant.

The main limitations of this study were the quality and quantity variations of raw wastewater and the efficacy of COD. Also, the color removal is not always enough to achieve Iranian standard of effluent. It is suggested that more studies be conducted on co-application of coagulants, oxidation agents and absorbents to treat textile wastewater in Kashan.

Conclusion

PAC is more efficient than Chlorinated Cuprous for both COD and color removal from KTIC wastewater.

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