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Treatment Of Real Textile Wastewater Using Coagulation Technology

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Abstract: In the fiber manufacturing industry the effluent waste water consider the parameter BOD, COD, TDS and pH. The high values of BOD, the untreated textile wastewater can cause rapid depletion of dissolved oxygen if it is directly discharged into the surface water sources. The effluents with high levels of COD are toxic to biological life. The high alkalinity and traces of chromium (employed in dyes) adversely affect the aquatic life and also interfere with the biological treatment process. Dissolved solids in effluent may also be harmful to vegetation and restrict its use for agricultural purpose. In this research paper reduces the value of BOD, COD, TDS and adjusted the value of pH using the poly aluminum chloride chemical coagulation. The key advantage of PAC using the chemical coagulation is the cost effectiveness and produces larger and more readily settleable flocs than alum. The sludge volume generated by PAC is less than that generated by alum. Results evaluated that the percentage removal of BOD 83.34%, percentage removal of COD 64.04%, percentage removal of TDS 62.97% and values of pH adjusted 6.2 to 6.9.
Key words: BOD, COD, *pH*, polyaluminum chloride (PAC), Total dissolved solid.

Introduction

Wastewater reuse in the textile industry is necessary due to the high water consumption required for its processes. This has to be considered, especially in areas that suffer from water scarcity such as Iran. Although several studies have been conducted, in the developed countries, in to the treatment of water and wastewater through Granular Activated Carbons[1,2], adsorbent[3,4], Fenton's reagent[5], wet oxidation[6], coagulation – electro - oxidation[7], and advanced oxidation with biological oxidation[8], developing countries still lack basic technology of water and wastewater treatment. In typical dyeing processes, 50-95% of the dye is fixed on to the fiber, and unfixed dyes from subsequent washing operations are discharged in the spent dye-bath or in the wastewaters[9]. How ever application of textile treatment methods in an industrial plant becomes difficult due to operational problems and costs. Biological treatment by activated sludge offers high efficiencies in COD removal, but does not completely eliminate the color of the wastewater and frequently operational problems such as bulking appear. Chemical oxidation by ozone, or a combination of UV-radiation and ozone and H_2O_2, has great interest, but the costs are still very high due to the high doses required. Among the above mentioned methods, adsorption

is considered to be relatively superior to other techniques because of low cost, simplicity of design, availability and ability to treat dyes in more concentrated form[10,11].

Coagulation - flocculation is also an essential process in water and in industrial wastewater treatment[12,13]. Several studies have been reported on the performance and optimization of coagulants, determination of pH and investigation of flocculants addition[14,13]. Coagulation – flocculation process has been found to be cost effective, easy to operate and energy saving treatment alternatives.[15] Coagulant dosages varies in a wide range aiming at maximum removal efficiency of pollutants using minimum doses at optimum pH[16,17]. Coagulation can be interpreted as the conversion of colloidal and dispersal particles in to small visible floc upon addition of a simple electrolyte.Increasing the concentration of the electrolyte results in a compression of the electrical double layer surrounding each suspended particle, a decrease in the magnitude of the repulsive interactions between particles and destabilization of the particles.
The most common coagulant used in wastewater treatment is alum $Al_2(SO_4)_3.4H_2O$ and PAC (Poly Aluminum Chloride). Flocculation is used to describe the process whereby the size of particles increases as a result of particle collisions. The purpose of flocculation is to produce particles, by means of aggregation, that can be removed by inexpensive particle - separation procedures such as gravity sedimentation and filtration. (Metcalf and Eddy, 2003)[18],Meric *et al.*, (2004)[19] studied the effectiveness of fenton's oxidation (FO) process and ozone (O_3) oxidation compared with coagulation – flocculation (CF) process to remove effluent toxicity as well as color and COD from textile industry wastewater. The FO process removed COD at a higher rate (59%) than O_3 (33%) while color removal was similar (89% and 91%, respectively). The CF process removed both COD and color at rates similar to the FO process[19]. Sources of pollution in textile manufacturing industry asshown in figure1.

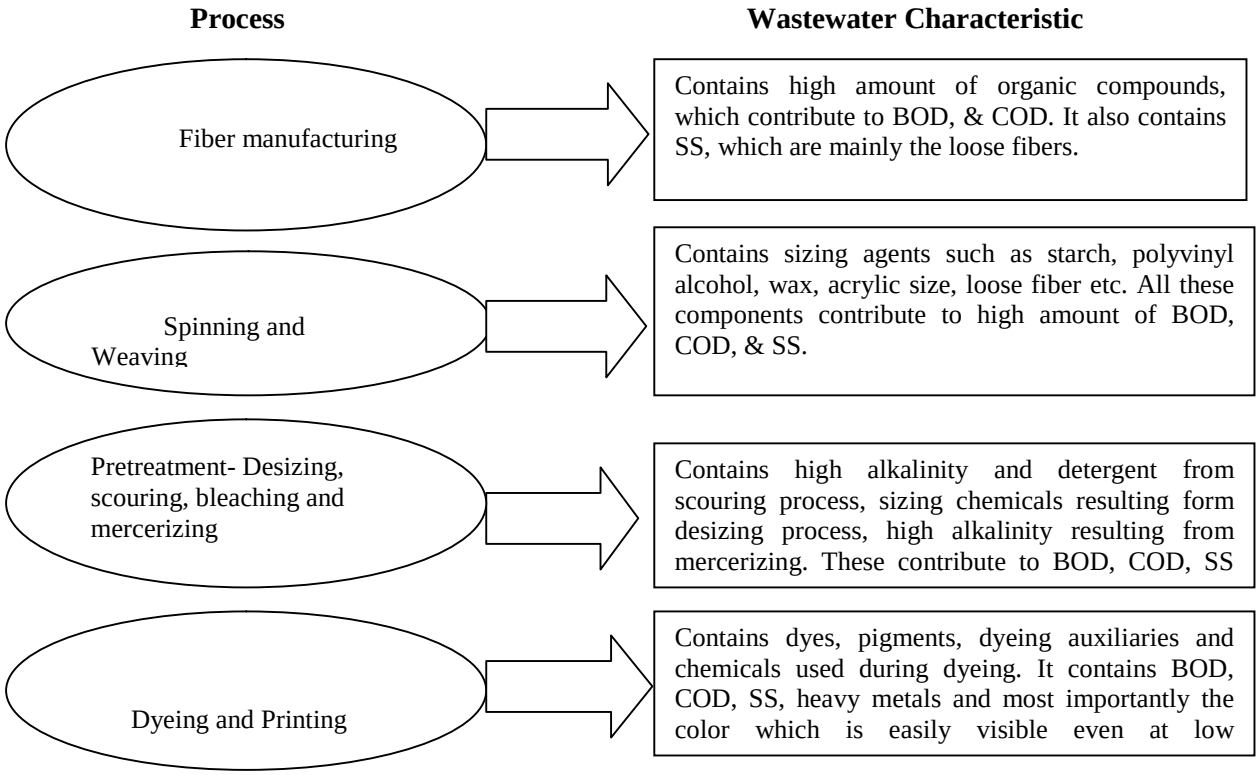

Figure 1: Sources of pollution in textile manufacturing (Source: NIIR Board, 2003b)

Materials and Method

Reagents used for the BOD (biological oxygen demand) test

BOD taste is determined by the dilution method. Distilled water, $MgSO_4$, $CaCl_2$, Phosphate buffer, $FeCl_3$, KI, H_2SO_4, 0.025N Sodium thio -sulphate solution, starch solution.

Reagents used for the COD (Chemical oxygen demand) test

0.25N potassium dichromate, silver sulphate sulphuric acid solution, std. ferrous ammonium sulphate 0.1N, ferroin indicator, potassium acid phthalate for standards.

Coagulant

A commercial grade Poly Aluminum Chloride ($AlCl_3.6H_2O$) is used as coagulant with varying doses of 10 mg/l to 45 mg/l.

Experimental Set up

BOD incubator, COD digestion apparatus Model 2015. TDS meter, Ph meter.

Experimental method

Coagulation studies were conducted in duplicate using Jar-test Apparatus with five beakers of one liter capacity. The samples were stirred for one minute at 500 rpm followed by 10 minutes slow mixing of 25 to 30 rpm. The contents are then settled for two hours. At the end of two hours, the supernatant is with drawn, filtered and was used for COD analysis and BOD analysis (APHA, 1995). All the experiments were conducted at room temperature of 27 ± 3^0 C.

In experiments obtained the Initial COD = 712 mg/l
Initial BOD = 215 mg/l,
Initial pH = 6.2
Initial TDS (Total dissolved solid) = 5875 mg/l

Result and discussion

1.1 COD removal

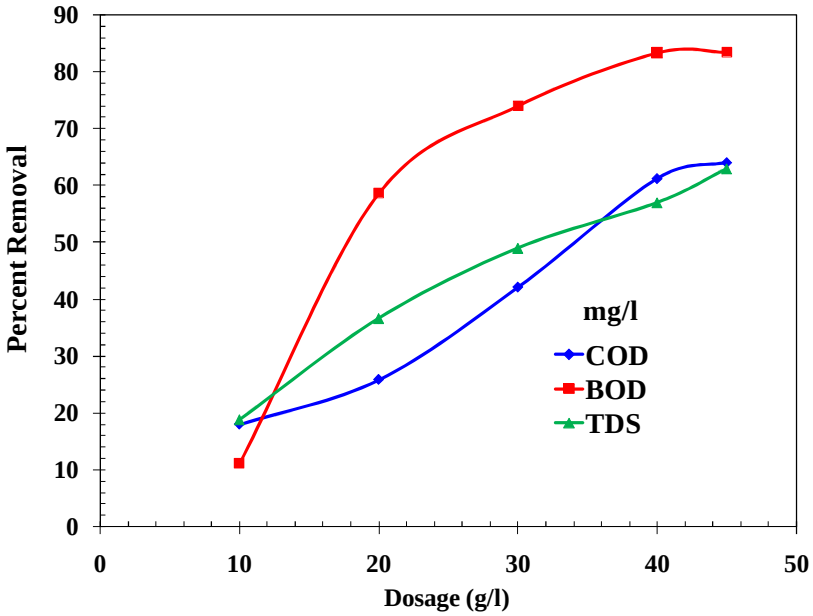

Fig.1.1 % Removal of COD V/S PAC dose mg/l

In figure 1.1 shows the effect of PAC (poly aluminum chloride) dose on percentage removal of COD. Determine the value of COD of fiber waste water by titration method. The initial COD of fiber waste water have obtained the 712 mg/l. The value of COD is high to the permissible limit of COD, because the high value of COD are toxic to biological life and affect the environment. In experiments reduced the value of COD using the poly aluminum chloride coagulation. We have added the different doses of polyaluminum chloride in the fiber waste water from 10 mg/l to 45 mg/l and the value of COD reduced from 712 mg/l to 256 mg/l. We have analyzed the % removal of COD is 64.04%.

The result show that the most effective and economic dose is 45 mg/l. The figure indicates that percentage removal of COD is incrementaly increased with increase in PAC dose.This trend is due to the decrease in concentration of organic material present in the water sample measured by the COD test.

1.2 BOD removal

Figure 4.2 Effect of PAC dose (mg/l) on percentage removal of BOD

It is clear from figure 1.2 that maximum removal of BOD at PAC dose 45 mg/l. Figure reveals that incremental PAC dose that increasing the percentage removal of BOD. Determine the value of BOD of fiber industry waste water by dilution method. The initial BOD of fiber waste water has obtained the 215 mg/l. The value of BOD is high to the permissible limit of BOD. Because of the high BOD, the untreated fiber waste water can cause rapid depletion of dissolved oxygen if it is directly discharged into the surface water sources. We have analyzed the % removal of BOD is 83.34%.

The result show that the most effective and economic dose is 45 mg/l. Which shows the graph reaches almost constant. In this graph the amount of food (or organic carbon) that bacteria can oxidize measured by the BOD test were reduced when added the poly aluminum chloride (PAC) dose.

1.3 pH values of treated water

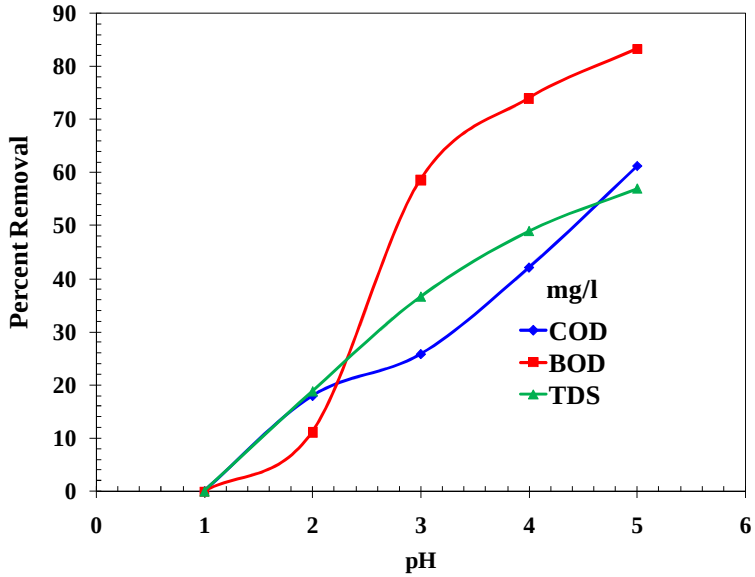

Figure 1.3 Effect of PAC dose (mg/l) on pH values of treated water

In figure 1.3 shows the effect of PAC dose on pH values of the treated water. Determine the pH value of the fiber industry waste water by pH meter. The initial value of the waste water pH is 6.2. We have added the poly aluminum chloride dose in the waste water to adjust the value of pH. Because the value of pH is low (acidic). Added the poly aluminum chloride dose in the waste water from 10 mg/l to 45 mg/l. Poly aluminum chloride is the cost effectiveness and it is very good coagulation to increase the value of pH. It is abatement from figure the higher the PAC dose the higher pH after coagulation become. The PAC coagulant has the advantage of being more effective at lower temperature and a broader pH range than alum.

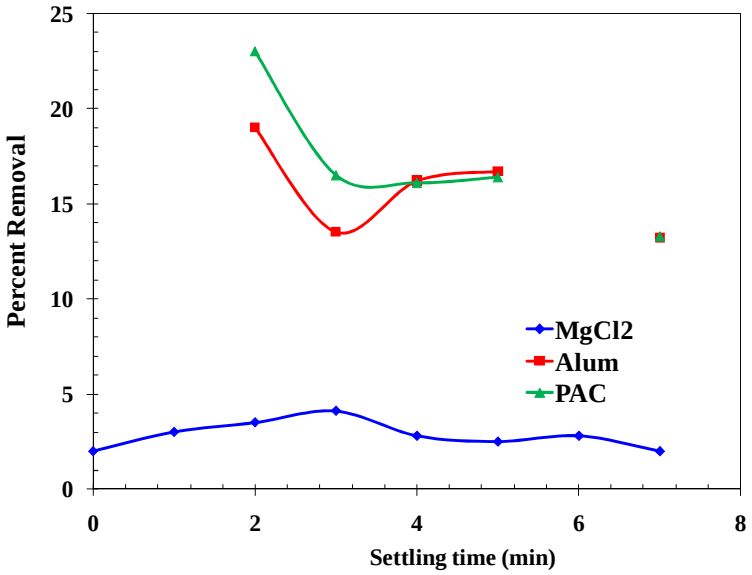

Figure1.4 % Removal with settling time

Figure shows the settling time of the flocs as function of the coagulant dosages of different coagulant. The settling time of the flocs treated with PAC and Alum are about the same, in the range of 15-17 min whereas for magnesium chloride the settling time is less than 3 min.

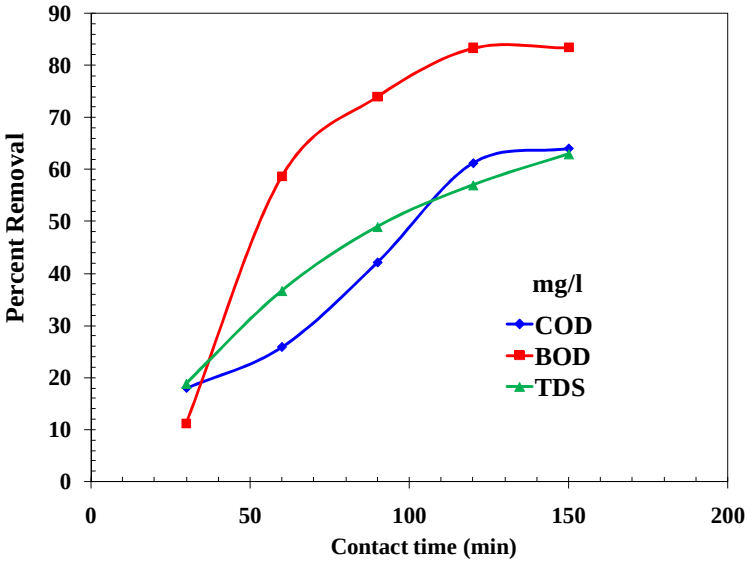

Fig.1.5 % Removal with contact time

Figure 1.5 shows the graph of percentage removal of COD, BOD, and TDS with contact time at adsorbent dose of 10 mg/l at a room temperature and agitator speed of 400 rpm. The result shows rate of BOD removal are higher at the beginning, also straight line shows that the equilibrium at 150 min.

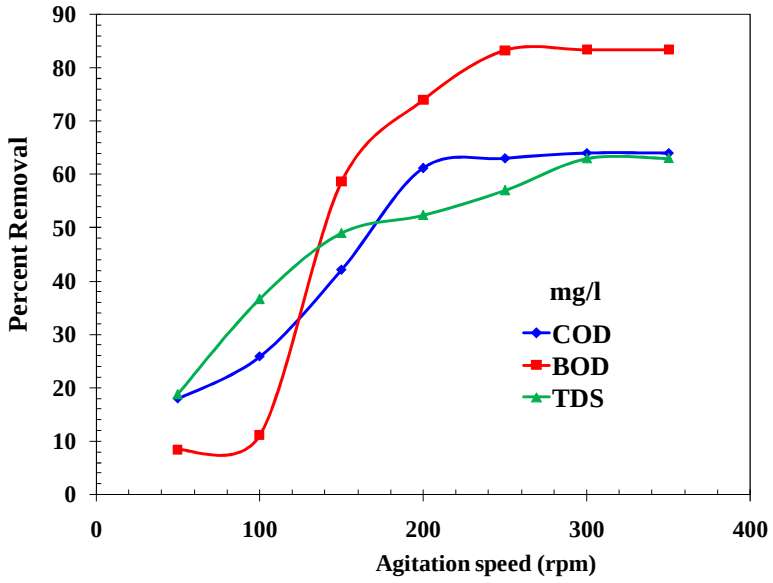

Fig.1.6 % Removal with Agitator Speed

Conclusion

The waste water from the textile industry is characterized by high values of biological oxygen demand (BOD), chemical oxygen demand (COD), color, and pH. In experimentation used the treatment of wastewater PAC (Poly Aluminum Chloride), due to its effectiveness in treating a wide range of wastewater type and relatively low cost. The use of performed polymerized forms of Al has become more common as alternative coagulants, such as poly aluminum chloride and poly aluminum sulphate. The higher charge density of poly aluminum chloride species often results in a decrease in the coagulant dose and the associated solids production.

The most common coagulant used in wastewater treatment is alum $Al_2(SO_4)_3.4H_2O$ and PAC (Poly Aluminum Chloride), due to its effectiveness in treating a wide range of wastewater type and relatively low cost. The use of performed polymerized forms of Al has become more common as alternative coagulants, such as poly aluminum chloride and poly aluminum sulphate. The higher charge density of poly aluminum chloride species often results in a decrease in the
coagulant dose and the associated solids production. These coagulants have the advantage of being more effective at lower temperatures and a boarder pH range than alum (Exall and Vanloon, 2003).

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