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Treating textile effluents by coagulation - flocculation method using different dosing compositions

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ABSTRACT

This paper discusses fast yet simple method of treating effluents of textile industry by simple chemicals. Textiles industry produces substantial toxic, often loaded with color (from residues of reactive dyes and chemicals), acidic and alkaline contaminants having high pH, high concentration of organic materials etc, which requires proper treatment before being released into the environment. Removal of such toxic materials from waste water is more important because the presence of small amounts of dyes in effluent disposed into the land and river water reduces the depth of penetration of sunlight into the water environment, which in turn decreases photosynthetic activity and dissolved oxygen (DO). The adverse effects can spell disaster for aquatic life, soil, and detrimentally affects the water quality. In this research work different coagulants like Alum, Lime, Ferrous Sulphate, Ferric Chloride, and poly-electrolytes for flocculation were employed to select the most suitable composition which has optimal removal efficiency. Settling characteristics of the flocs formed in the coagulation process were studied at laboratory scale. Parameters such as colour, COD, Hardness, Total Dissolved Solids (TDS), and Total Suspended Solids (TSS), and settled sludge volume have been studied. The optimal coagulant dose volume and pH were determined by comparing the effectiveness of these coagulants [Amirtharajah, A. M., et. al]. Results showed that coagulant like lime eliminated colour and COD effectively. However ferrous sulphate was chosen as effective coagulant for colour removal as it required lowest coagulant dose, minimum settled sludge volume and maximum decolourization. It was also observed that higher percentage of suspended solids was removed by using a combination of iron salts with lime at pH 10 to 11 as compared to alum in a very short time period.

Key words: Effluent Treatment, Waste Sludge, COD, TDS, Hardness, TSS, Coagulation- Flocculation.

INTRODUCTION

The quality of surface water within a region is governed by both natural processes (precipitation, weathering and soil erosion, lithology of basin, atmospheric inputs, and climatic conditions) and anthropogenic effects (urbanization, industrialization, agricultural activities and human exploitation of water resource). The input of waste into surface water bodies has a negative impact not only on the aquatic life but also affects the self purification property of the water body. The effluents from industries have a great deal of influence on pollution of water body by altering the physical, chemical and biological nature of receiving water body [1]. This further resulted in vast degradation of the surface waters making them worse in their use for agricultural, drinking, industrial, recreation and other purposes [1].

Jodhpur is hub of textile dyeing and printing industry. Pollutants from textile dyeing and printing industries vary greatly and depend on the chemicals used in various dyeing and printing processes. Disposal of untreated / partially treated, or diluted textile industrial effluents on land surface, and on surface water bodies could transfer a large cost to society in terms of environmental pollution and related human health hazards. Broadly, industrial pollutants often alter the physicochemical characteristics, such as temperature, acidity, salinity, or turbidity of receiving water bodies, leading to ecosystem alterations. Thus receiving water thus becomes brackish. Textile dyes are toxic, highly stable and do not degrade easily and are not removed by conventional wastewater treatment methods. Due to the non degradable nature and long time persistence in the environment the toxic waste often accumulates through tropic level causing a deleterious biological effect and higher incidence of water-borne diseases [2]. Now treatment technologies recommended for colour removal are physiochemical treatment methods like adsorption [3], use of ozone [4], oxidation [5], chemical precipitation [6], and coagulation – flocculation [7-8].

MATERIALS AND METHODS

To study the textile effluent, grab effluent samples were collected from different sampling sites in an around Jodhpur. From each sampling site three water samples were collected in one litre double cap acid washed polythene bottles. Prior to sampling each bottle was washed with diluted acid and double distilled water and before actual sampling these bottles were rinsed with waste water to be sampled. pH, and Dissolved Oxygen (DO) was also measured by portable (Water and Soil Analysis kit – Model 161 E (EI Make)), Hardness due to calcium, magnesium (EDTA Method) was measured by titration in the laboratory. Suspended Solids were determined by the difference between the residue left after evaporation of unfiltered sample and of that of filtered sample. All above parameters were measured as suggested by American Public Health Association (APHA) [9]. The analytical results of all the water samples were thus evaluated in accordance with the norms prescribed under Bureau of Indian Standards [10] and World Health Organization (WHO).

All the experiments were conducted using the jar testing method to determine the optimum pH value and coagulant dose. In treating textile effluents with coagulants, positive ions with high valence are preferred. Glass jars apparatus were positioned on magnetic stirrers and 0.5 litre of effluent was treated with a specified dose of coagulant. The sample was stirred rapidly for 90 seconds and then stirred slowly for 20 minutes for flocculation. To promote the formation of flocs in water that contains suspended solids, polymer flocculants (poly-electrolytes) were applied. These polymers have a very specific effect, dependent upon their charges, their molar weight and their molecular degree of ramification. The polymers are water-soluble and their molar weight varies between 10^5 and 10^6 g/mol. Flocs formed were allowed to settle for an hour minutes before withdrawing the sample. The effect of poly-electrolyte on effectiveness colour removal, and maximum sludge sedimentation in short time period was analyzed by using of very low amount of dosing chemicals. The compositions of dosing chemicals employed are as follows:

a. Lime (10% Sol) + Ferrous Sulphate (5% Sol) + Poly-electrolyte (0.1% Sol)
b. Lime (10% Sol) + Aluminum Chloride (5% Sol) + Poly-electrolyte (0.1% Sol)
c. Caustic (10% Sol) + Ferric Chloride (5% Sol) + Poly-electrolyte (0.1% Sol)
d. Lime (10% Sol) + Alum (5% Sol) + Poly-electrolyte (0.1% Sol)

All these tests were performed at temperature (25ºC ± 2) because temperature is one of the effective parameters on density, viscosity and therefore retained volume of coagulant used.

(Note: 0.5 litre of waste water sample (textile effluent) was run in glass jar apparatus with different dosing compositions)

RESULTS AND DISCUSSION

In this study, coagulation – flocculation process are used to treat textile industry effluents. The results of this study are tabulated below:

Table 1: Different parameters like COD, TSS, Hardness, TDS, and Water: Sludge (Mg/L) of Textile Wastewater Samples (Effluents) before and after treatment with different compositions

Parameters For Textile Effluents	*Chemical Oxygen Demand (COD) (mg/L)*		*Total Suspended Solids (TSS) (mg/L)*		*Hardness (mg/L)*		*Total Dissolved Solids (TDS) (mg/L)*		*Water : Sludge (In %)*
Treatment	Before	After	Before	After	Before	After	Before	After	After
Composition A	600	240	3400	1700	520	135.5	2450	3234	90 : 10
Composition B	600	300	3400	1360	520	78	2450	3160.5	70 : 30
Composition C	600	260	3400	1360	520	62.4	2450	2744	75 : 25
Composition D	600	300	3400	1394	520	78	2450	3356.5	60 : 40

Table 2: Different parameters like COD, TSS, Hardness, TDS, and Water: Sludge ration in (Mg/L) of Textile Wastewater Samples (Effluents) and percentage reduction

Parameter	**Composition A**	**Composition B**	**Composition C**	**Composition D**
COD	60% Decrease	50% Decrease	40% Decrease	50% Decrease
TSS	50% Decrease	40% Decrease	40% Decrease	41% Decrease
Hardness	26% Decrease	15% Decrease	12% Decrease	15% Decrease
TDS	32% Increase	29% Increase	12% Increase	37% Increase
Colour	Light Green	Green - Yellow	Yellow - Black	Black
Water: Sludge	90% : 10%	70% : 30%	75% : 25%	60% : 40%

Form the above table it is quite evident that Composition A (Lime (10% Sol) + Ferrous Sulphate (5% Sol) + Poly-electrolyte (0.1% Sol)) gave the best results. It was also observed that composition A formed maximum flocks between pH 10 and 11. These flocks settled in quick time when dosed with polyelectrolyte which is a highly viscous solution. On reducing pH below 10 results in decrease flocks size which did not settle sludge effectively. It is also observed that COD, TSS, Hardness decrease was maximum is composition A. However TDS increases. This may be due to addition of lime which makes light weight floating flocks, whose specific gravity is very low, so they float at water surface and will not settle properly. The flock produced by iron salt with lime is heavier and can remove more percentage of Suspended Solids than Alum [11].

Finally the sedimentation results are very quick when we use iron salts and therefore we get best water: sludge ratio. Being good oxidizing agents, the Iron salts can remove Hydrogen sulphide, hydrogen, sulphate and its corresponding odour and tastes from water [12-14]. To select the best coagulant in addition to above mentioned parameters, it should be considered parameters such as required coagulant dose, coagulant cost, and optimum pH after reaction for discharging into environment. It was concluded that the industrial effluents should be treated before to be drained into the natural water bodies so that it may not cause water and soil pollution and iron salts might be used for wastewater treatment on industrial scale.

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