Comparative study of Alum and Ferric chloride in reducing TDS-Effluent waste water

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ABSTRACT *The ultimate aim of this study is efficiency comparison of inorganic coagulant Alum and Ferric Chloride for treatment of leather factory wastewater. Suspended particles vary in source, charge, particle size, shape, and density. Correct application of coagulation and flocculation depends upon these factors. Suspended solids in water have a negative charge and since they have the same type of surface charge, they repel each other when they come close together. Therefore, suspended solids will remain in suspension and will not clump together and settle out of the water, unless proper coagulation and flocculation is used. This is then followed by sedimentation. If coagulation is incomplete, flocculation step will be unsuccessful, and if flocculation is incomplete, sedimentation will be unsuccessful. Results showed that the ferric chloride has more removal efficiency than alum in removal of COD, TSS and dye. The optimum pH 7 and 5 were obtained for alum and ferric chloride respectively. Based on the results, it can be concluded that COD, TSS and dye removal using ferric chloride has higher efficiency than alum. Therefore, application of ferric chloride in the same conditions is preferred than alum.*

Keywords: *wastewater treatment, leather wastewater, coagulant, Alum, ferric Chloride*

INTRODUCTION

India is rich in natural resources and leads first among major livestock holding countries and its accounts for about 10 percent global supplies of raw skins and hides. Water is the precious gift to mankind by nature is water In order to sustain water is most necessary component of life [1]. Everywhere there is water no doubt and is very important in our earth and life inhabiting it. Water is known as Elixir of Life. [3] Water important for all a form of life covers 71% of Earth. However, as 97% of it is sea water it cannot be consumed for drinking and agricultural purposes. Water holds a unique position in tanneries. In chemical processing water is used as a solvent [2]. Water also contains impurities such as dissolved gases of the surrounding atmosphere, dissolved inorganic salts and bio-degradaded organic substances [3].

For many cities and towns large rivers are the principle source of water supply. Rivers may be non-perennial as well as perennial [4]. Water flows in perennial rivers for all the seasons because such rivers are snow fed. Either partially or completely the non-perinnial rivers get dried in summer on the other hand in monsoon, it flooded with water. For nearby cities the vital roles of rivers are the main source of water supply. They were used for navigation and irrigation purposes [5]. They can serve as an agent of purification of wastes. They can be used as water bodies for dumping various effluents from industries. They can also act as a centre of entertaining actions such as bathing, fishing, boating, fountains etc [6].

Nowadays, the necessities of water to the tanneries are widely increased. Industries have a major responsibility to practice water audit and conservation of water [7]. Effluent waste water has contamination such as suspended solids, biodegradable dissolved organic compounds. Inorganic solids, nutrients metals and pathogenic microorganism. Inorganic solids in waste water consist of surface sediments and soil as well salts and metals [8].

OBJECTIVE OF THE STUDY

Both dissolved and suspended particles were present in the groundwater and surface water. In order to remove the suspended solids from the water coagulation and flocculation process were used. Density, shape, charge, source and particle size which differ the suspended particles [9]. Depending upon these factors coagulation and flocculation can be tune. If not suitable coagulation and flocculation were used suspended solids cannot be settle down properly in water [10]. Because suspended solids in water contains negative charge and it have same type of surface charge which led to repel each other when it come closer. As a result suspended solid particles remains in suspension and it will not form clump together and settle out in water. In water treatment coagulation were followed by flocculation which allows the particle to collision and increase of flow. After this sedimentation step were followed [11].

Coagulation, flocculation and sedimentation are the successive step. If coagulation step is unfinished further steps will be unsuccessful. Coagulation is very important in waste water treatment [12]. If the turbidity of water go beyond 40ppm one can adopt the coagulation process. Due to coagulation process turbidity is decreased from 40ppm to 20ppm were the fine particles get removed quickly. The bacteria load is also reduced by 5%. It should be noted that coagulation simply assists plai sedimentation process were followed by the filtration process [13]. The general perceptive, about alum and ferric chloride is that alum is more efficient and cheaper when compare to ferric chloride. But, this study was done to analyise whether ferric chloride gives a efficient results compared with alum [14].

COAGULANT SELECTION

The best choice of coagulant chemical depends upon the type of suspended solid to be removed, raw water conditions, facility design, and cost of chemical to be used. Jar testing and plant scale evaluation should be done for the final selection of coagulant (or coagulants)[14].Consideration must be given to effluent quality, effect upon downstream treatment process performance, cost, method and cost of sludge handling and disposal, and cost of the dose required for effective treatment.

INORGANIC COAGULANTS

Aluminum and iron salts are the generally used inorganic coagulants. These highly charged ions neutralize the suspended particle in water. Microfloc formation can be enhances by the formation short polymer chains which formed from inorganic hydroxide [15]. Inorganic coagulants generally recommend the lowest cost per pound, are widely available. One can effectively remove the majority of suspended solids when applied properly. Inorganic coagulants have an advantage to entrap bacteria because of large volumes of floc formation take place. On the other hand an inorganic coagulant also removes the portion of organic precursors. The organic precursors combine with chlorine to form disinfection by-products [16].

While inorganic coagulants consume alkalinity which alter the pH of the water. When it is applied in a lime soda ash softening process, alum and iron salts generate demand for lime and soda ash[17]. They also require corrosion-resistant storage and feed equipment. Large volumes of settled floc have to be disposed in environmentally tolerable manner is more important because alum, $Fe_2 (SO_4)_3$ and $FeCl_3$ which lower the alkalinity.

LIMITATION OF THE STUDY

- Effluent waste water is collected only from nearby tanneries.
- It is a comparative study of Alum and Ferric chloride in reducing TDS in effluent waste water.
- Only ferric chloride is taken for the comparative study with alum and no other salts.

MODE OF OPERATION

Effluent waste water was collected from the tanneries of Vellore district. It was equally filled in five beakers i.e. approximately 100ml water in each beaker and alum was added. Eventually the same tannery effluent waste water was collected in another five beakers and added with Ferric chloride. First five set of beaker was added with alum of appropriate amount as mentioned in the first tabular column [18]. As such $FeCl_3$ was added in another set of five beakers as mentioned in the second tabular columns.

According to the addition of 5gram of Alum in fifth beaker, the TDS level was constantly reduced but there was a increase in its PH level. The solution becomes acidic media. To reduce the PH level (acidic nature) 500gm of NaoH was added to the solution. After this process the solution becomes base media [19].PH level is 8.1(due to the addition of NaoH). Atlas, 1.19g of HCL was added to make the PH value to attain normal level(show as figure 2). Now the TDS level and PH level were balanced. The process of standardization is over. (Refer table 1.1& 1.2)

According to the study undergone in the comparison process of Alum and Ferric chloride in treating effluent waste water, Ferric is the way more superior than alum, but it depresses alkalinity when compared with Alum. Alum produces less sludge compared to ferric based coagulants and it is more tolerant to temperature and also the optimum range is wider for Alum based coagulant. Results showed that the ferric chloride has more removal efficiency than alum in removal of COD, TSS and dye. The most removal of COD, TSS and dye using alum was obtained 37, 19 and 67.8% while for ferric chloride was obtained 72, 61 and 97.6% respectively. The optimum pH 7 and 5 were obtained for alum and ferric chloride respectively (show as figure 2). Based on the results, it can be concluded that COD, TSS and dye removal using ferric chloride has higher efficiency than alum. Therefore, application of ferric chloride in the same conditions is preferred than alum [20].

Table 1: The value of TDS and P^H in Alum

ALUM	TDS	P^H
100mg	1852	3.5
500mg	1756	4.2
1g	1523	5.5
2g	1011	6.2
5g	850	6.9

Table 1.1:- The value of TDS and P^H in NaoH

NaoH	TDS	P^H
100mg	1563	4.3
500mg	1436	4.8
1g	1354	5.6
2g	1247	6
5g	1058	8.1

Table 1.2:- The value of TDS and P^H in HCL

HCL	TDS	P^H
1.19g	1456	2.5
2.38g	1365	3.8
4.76g	1235	4.3
7.14g	1158	5.7
9.52g	1054	6.8

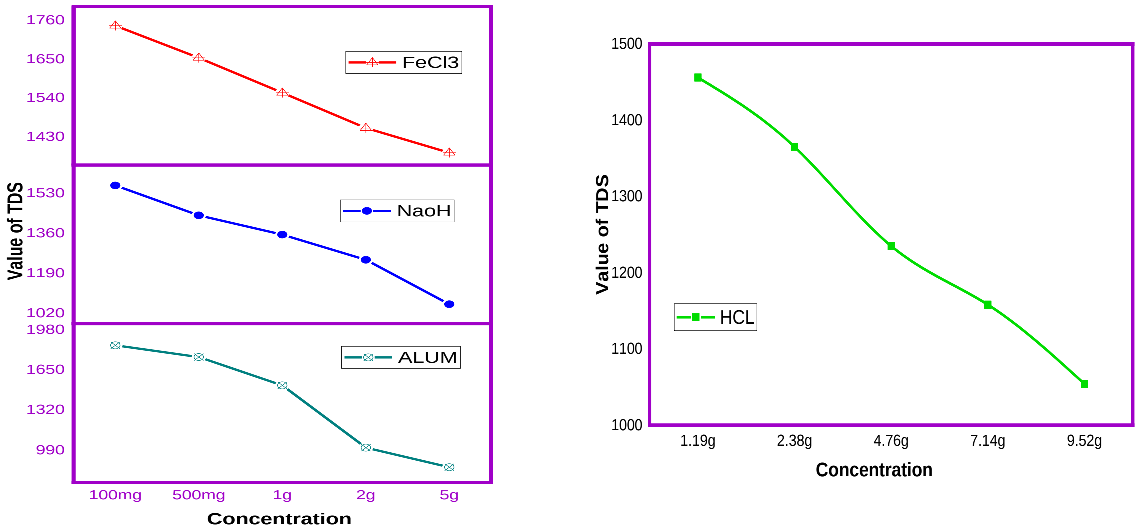
Table 2:- The value of TDS and P^H in $FeCl_3$

$FeCl_3$	TDS	P^H
100mg	1745	3.5
500mg	1654	3.9
1g	1555	5.5
2g	1455	7.2
5g	1385	8.1

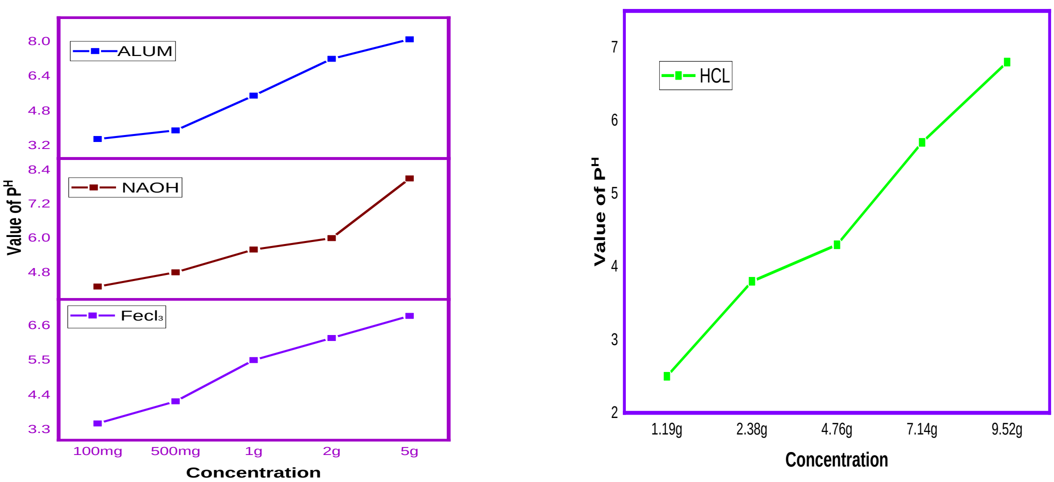
Ferric works as well or better than most other coagulants. It also seems to form a heavy floc that settles nicely. But it is well noticed that it depresses alkalinity. (Refer table 2)

Ferric Chloride

$$2FeCl_3 + 3Ca(HCO_3)_2 \longrightarrow 2\,Fe(OH)_3 + 3CaCl_2 + 6CO_2$$



Figures 1:- Influent and Effluent TDS for Alum, NaoH, FeCl3 and HCl



Figures 1:- Influent and Effluent P^{H} for Alum, NaoH, FeCl3 and HCl

RESULT AND DISCUSSION:

Based on the findings, the performance of Alum was observed at pH 7 over the selected range of turbidity [21]. When compared with performance decreased to some extent at pH values of 5 and 9. The coagulation efficiency of alum at pH9 was almost dose to pH7. At pH 7, the highest turbidity removal was obtained. However it is considered that coagulation with alum may increase Aluminum concentrate that coagulation and texts. The highest turbidity removal efficiency for ferric was constant [22]. Coagulation and flocculation process is cost efficiency and a primary process in effluent waste water treatment. It is used to remove turbidity when operational condition is optimized.

CONCLUSION:

According to the study undergone in the comparison process of Alum and Ferric chloride in treating effluent waste water, Ferric is the way more superior to alum, but It depresses alkalinity when compared with Alum. Alum has a promising quality on comparison with ferric based coagulants. Alum generates less sludge when compared with ferric based coagulants. Alum is more tolerant to temperature. On the other hand the optimum range is wider for Alum based coagulant. Both Alum and Ferric was very promising in removal of turbidity from effluent waste water.

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