# Industrial water treatment using coagulants

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**Abstract**
*Most of the industries use a large amount of water for their chemical processes and for steam generation. Surface waters, have both dissolved and suspended particles. Coagulation processes is used to separate the suspended solids. The suspended particles are different depending on their source, composition, charge, particle size, shape, and density. A right application of coagulation processes and selection of the coagulants is based upon the interaction among these factors. The small particles are stabilised by the action of physical forces on the particles themselves. One of the forces playing a dominant role in stabilisation results from the surface charge present on the particles. Suspended particles in water possess a charge and, if they have the same type of surface charge, they repel each other as they come very close together. Therefore, they remain in suspension instead of join together and settle down. The present study aims to treat a sample of industrial water(river source) for the removal of impurities by the addition of coagulant Alum.. The treatment efficiencies of coagulant at different levels have been compared for maximum removal of impurities.*

**Key words:** *Industrial water, Coagulant, stabilization.*

## I.INTRODUCTION

Industrial water should be free from suspended particles and other impurities like hardness, alkalinity, etc. But river water contains suspended particles and dissolved impurities. Coagulation method is widely used to separate the suspended solids from the water. The suspended particles are different depending on their source, composition charge, particle size, shape, and density. A right application of coagulation processes and selection of the coagulants is based upon the interaction among of the newly formed microflocs should be clear, otherwise more coagulant has to be added to neutralize the charge of the particles. Industrial waters contain pollutants that are present is colloidal form. In such cases the colloidal suspension may contain organic materials, stable emulsions and material producing turbidity. The primary purpose of the coagulation process is the removal of turbidity from the water. The chemical and electrical means of water treatment was achieved by using coagulation as the most important physicochemical operation [2].

these factors**.**. Suspended particles have a negative charge and since they have the same type of surface charge, they repel each other as they come very close together**.** Therefore, suspended solids remain in suspension instead of join together and settle down of the water, unless proper coagulation is used.

Coagulation occurs slowly in step by step, allowing particle collision and growth of particle size(flocculation). This is followed by sedimentation. If coagulation is incomplete, flocculation step will be unsuccessful, and if flocculation is incomplete, sedimentation will be unsuccessful. Flocculation, a gentle mixing stage, increases the particle size from submicroscopic to visible suspended particles. Microfloc particles collide, causing them to bond to produce larger, visible flocs. Floc size continues to build with additional collisions and interaction with added inorganic polymers or organic polymers(coagulants). High molecular weight polymers, called coagulant aids, may be added to bind, and strengthen the floc, add weight, and increase the size and thereby increasing settling rate. Once floc has reached it optimum size and strength, water may be allowed to go for sedimentation. The usage of Alum was noticed by early Romans even though it was not specifically used for waste water treatment [1] or any other industrial water treatment.

Coagulant chemicals with charges opposite those of the suspended solids are added to the water to neutralize the negative charges on non-settable solids (such as clay and color-producing organic substances). Once the charge is neutralized, the small suspended particles can come closer and join together. These slightly larger particles are called microflocs. Water surrounding

In addition to removing turbidity from the water, coagulation and flocculation is beneficial in other ways. The process removes many bacteria which are suspended in the water and can be used to remove color from the water. Turbidity and color are much more common in surface water than in groundwater. As surface water flows over the ground to streams, through streams, and then through rivers, the water picks up a large quantity of particles. As a result, while aeration is more commonly required for groundwater, treatment involving coagulation is typical of surface water. The commonly used metal coagulants fall into two general categories: those based on aluminum and those based on iron. This paper deals with the aluminum based coagulants, The most widely used metal coagulant is probably the potassium aluminum sulphate, which has been used for water treatment during the past decades. The application of simple metal coagulants (conventional) is widespread, especially due to the relatively low cost and the simpler application method. However, they exhibit several disadvantages, such as the need for pH adjustment, the sensitivity to temperature changes, the need for higher dosages because the charge neutralization is not usually sufficient, the sensitivity to sample specific characteristics and composition, as well as the excessive sludge production due a large dosage. The work on coagulation reported that the agglomeration of colloidal particles bridge together to form microflocs which turned into macrofloc masses.

## II. MATERIALS AND METHODS

To find the optimum parameters in the coagulation process Jar test method was adopted. Each beaker contained 200ml of raw water. After adding appropriate volume of the alum solution, the water was mixed at 200 rpm for 1 min, 50 rpm for 10 min, 20 rpm for 30 min and settled for 3 hours. Then the top layer of water in each beaker was collected with a pipette and measured in terms of, turbidity andpH.The beakers were filled with sample water. One beaker was used as a control and the other beakers were adjusted depending on what conditions are being tested. The pH of the beakers were adjusted at different pH between 4.5and 8.0 with 4N sulfuric acid. The Turbidity values were measured against each pH.

The coagulant dosage ranging from 20ppm to 200 ppm was added to each container and stirred at approximately 200 rpm for 1 minute. The stirring speed was reduced to 50 rpm and continued mixing for 10 minutes. Finally the speed is reduced to 20rpm and continued mixing for 30 minutes The rapid mix stage helped to disperse the coagulant throughout each container. The slower mixing speed helped promote floc formation by enhancing particle collisions which led to larger flocs. The mixers were turned off and allowed the containers to settle for 3hours. Then the final turbidity in each container was measured.

The final turbidity against coagulant dosage was then plotted and optimal conditions were determined. The values obtained through the experiment were correlated and adjusted in order to account for the actual treatment system. The water was obtained from river source. Alum stock solution of 10 gpl was prepared and different alum dosages were prepared from stock.

**Table 1 properties of raw water**

| S.No. | Parameter | Values |
|---|---|---|
| 1 | pH | 8.5 |
| 2 | Colour | Light green |
| 3 | Turbidity | 75 NTU |
| 4 | Total Suspended solids | 810ppm |
| 5 | Alkalinity | 250 ppm |
| 6 | BOD | 167 ppm |
| 7 | COD | 352 ppm |

## III. RESULTS AND DISCUSSION

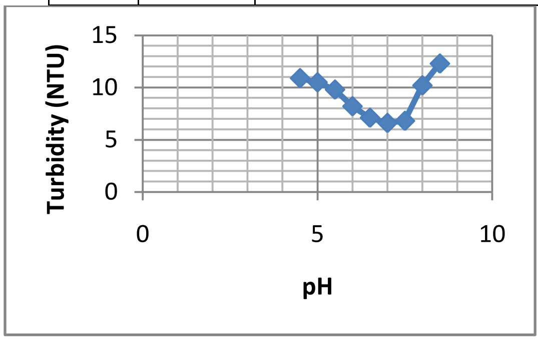
The properties of raw water sample is shown in table-1. The raw water is alkaline with light green colour having high BOD, COD, and turbidity values which needs to be treated before using for operations. It was reported that the neutralization of the ionic charges of particles causes the particles to join together [3]. The raw water sample has been treated with different concentrations of alum ranging between 20and 200 ppm. The pH of the water has been adjusted with sulfuric acid from 4.5 to 8.5 to obtain the optimum pH. The Determination of optimum pHwas shown in Table 2 and it was observed from the graph-1 that the optimum pH was **7.0 to 7.5**

Table 3 shows the deteminationofoptimum Alum dosage and this was done with different dosage of Alum from 20 ppm to200 ppm. It was observed that the optimum dosage of Alum was noted to be 80ppm as shown in graph-2. This experiment has only been done for the particular river water with the optimal concentration of 80 ppm of alum. We can see from the graph that the pH which allows the best either color and turbidity removal is around 7.0. At this pH the color removal and the turbidity removal is around 85 %.

| | | |
|---|---|---|
| 8 | Sulphide | 180ppm |
| 9 | Nitrogen | 235 ppm |
| 10 | Phosphate | 250 ppm |

**Table 2 Determination of optimum pH**

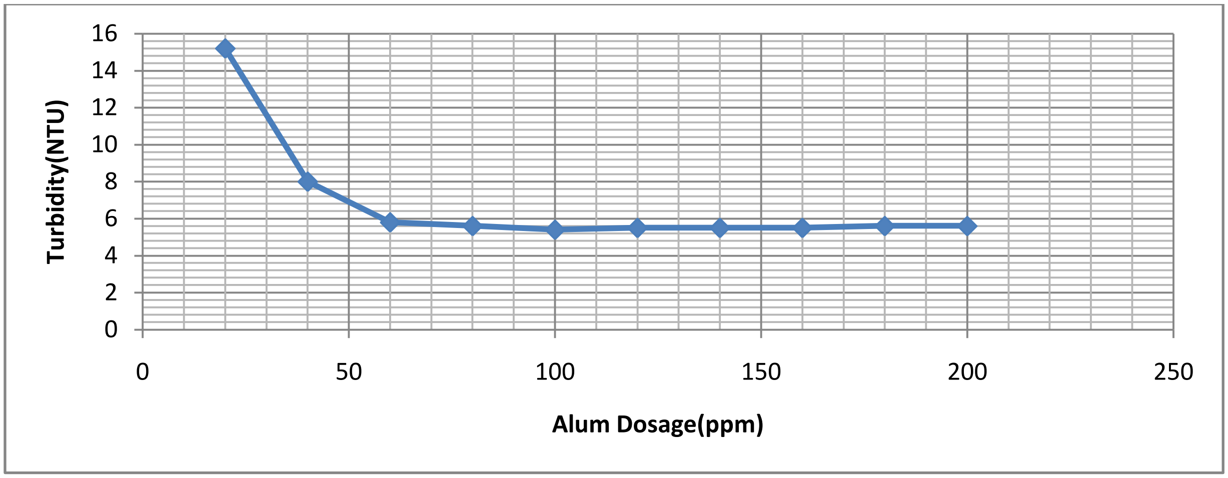
| S.No. | pH | Turbidity (NTU) |
|---|---|---|
| 1 | 4.5 | 10.9 |
| 2 | 5.0 | 10.5 |
| 3 | 5.5 | 9.8 |
| 4 | 6.0 | 8.2 |
| 5 | 6.5 | 7.1 |
| 6 | 7.0 | 6.6 |
| 7 | 7.5 | 6.8 |
| 8 | 8.0 | 10.2 |
| 9 | 8.5 | 12.3 |




**Graph-1.pH vs Turbidity**

**Table 3 Determination of Alum dosage**

| S.No | Alum Dosage(ppm) | Turbidity(NTU) |
|---|---|---|
| 1 | 20 | 15.2 |
| 2 | 40 | 8.0 |
| 3 | 60 | 5.8 |
| 4 | 80 | 5.6 |
| 5 | 100 | 5.4 |
| 6 | 120 | 5.5 |
| 7 | 140 | 5.5 |
| 8 | 160 | 5.5 |
| 9 | 180 | 5.6 |
| 10 | 200 | 5.6 |




**Graph-2. Alum dosage vs Turbidity**

## IV. CONCLUSION

This experiment was carried out for the river water with the optimal concentration of 80ppm of alum. Since we want to use optimum amounts of alum as for as possible and the best efficiency as possible, we decided to use the alum concentration of 80ppm. Several studies have been reported on the examination of coagulation for the treatment of industrial water treatment, aiming at performance optimization, i.e. selection of the most appropriate experimental conditions, and assessment of pH effect and investigation of flocculants addition. Literature indicated that the mechanism of coagulation for aluminum salts is controlled by the hydrolysis speciation. It was observed from the experiment that Alum at the concentration of 80ppm is found to be more efficient in the pH range of **7.0 to 7.5** . Suspended particle removalis increased with an increasing alum dose and alum doses higher than **80ppm** has no effect in the removal of impurities by coagulation.

## REFERENCES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