Performance studies of alum in waste water treatment

SutanukaNath[1],Tongchin Drema[2], Tenzin Chonzom[3],Imlirenla Longkumar[4]

[1,2,3,4]Don Bosco College of Engineering and Technology, Assam Don Bosco University
Airport Road,, AZARA, Guwahati - 781017, Assam. INDIA.
sutanuka888@gmail.com , dtongchin5@gmail.com, tenzchoezom@gmail.com ,aren143@gmail.com

Abstract:*In this study, coagulation-flocculation process was used to treat waste water sample collected from Brahmaputra River (Bharulumukh) with alum as coagulant. The experiments conducted with the water sample are chloride ion test, Hardness test, Dissolved oxygen, BOD test, Alkalinity test, iron test, turbidity test and Jar test. Jar test was performed to find the optimum coagulant dosage which was found to be 22ppm from the graph drawn for turbidity versus alum dosage. The results of the waste water characterization showed that the concentration of organic matter expressed by the biochemical oxygen demand was high before the jar test but was low after the experiment was repeated using the result obtained from jar test. Addition of coagulant aids provided higher removal efficiencies. After jar test when all the particulate matter has been settled down due to the addition of alum followed by coagulation and flocculation process, the turbidity test as well as iron test and BOD test were performed to check the effectiveness of the jar test. The difference between the results obtained before and after jar test indicates the effectiveness of the experiment in removal of the biological oxygen demand to an extent.*

Keywords: Turbidity, BOD removal, coagulation, flocculation

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1. Introduction

Wastewater from sewage treatment plants often contains organic materials that are decomposed by microorganisms, which use oxygen in the process (The amount of oxygen consumed by this organisms in breaking down the waste is known as the biochemical oxygen demand or BOD). BOD is essentially a measure of the biological and the chemical component of the waste water in terms of the DO needed by the aerobic systems in the waste waters to break down the wastes under defined conditions. As the water is getting polluted day by day the amount of dissolved oxygen is also reducing, which represents a hazardous impact on the aquatic life. So BOD removal is important to increase the amount of dissolved oxygen present in the water body. The ultimate goal of wastewater management is the protection of the environment with public health and socio-economic concerns. Here we present our recent work on removal of BOD by coagulation and flocculation process. In this process alum dosage are used to remove the turbidity. Determination of pH level and alkalinity is important because all metals have a pH at which there solubility lies in between 7.5-11. Since most waste water contains a variety of metals, the optimum pH is maintained 6-7 at which there solubility is minimal. Alkalinity test is performed before initiating the jar test to determine whether alkalinity supplement is required or not.

2. Literature Review

Some researchers have discussed this process using different coagulants. In some paper Researchers have discussed about the use of aluminum coagulants.Their paper deals with the aluminum based coagulants, The most widely used metal coagulant is probably the aluminum sulfate ("alum"), 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 route [1].whereas, some other researchers have discussed this process using another coagulant. The aim of their paper is to provide an overall description of coagulation-flocculation process and its applications in water and wastewater treatment. The significance of coagulation – flocculation in the area of water and wastewater treatment is reviewed and evaluated, emphasizing on the series of applications employed, including destabilization of colloids, removal of inorganic and organic matter (particulate and/or dissolved),removal of metals and anions (arsenic, phosphate etc), as well as removal of pathogen microorganisms [2]. Some other paper attempts to discussed the systematic study was to optimize the coagulation-flocculation process and investigate the effect of wastewater initial pH, affects the type of coagulant and coagulant dosage, Temperature and mixing conditions in order to enhance the efficiency of the coagulation -flocculation process especially focusing on the optimal turbidity removal [3].A third order polynomial model has beenused to describe the influence of pH, coagulant dose and initial water turbidity on coagulation-flocculation efficiency, based on Response Surface Methodology. This method allowed to establish the optimum parameters for coagulation – flocculation process. A neutral pH, moderate coagulant doses and a higher load in suspensions of raw water presented a favorable influence on suspension removal efficiency [4]. After doing study on coagulation and flocculation process we have tried to show the effectiveness of alum as coagulant and how it can be useful for waste water treatment.

3. Literature Review

The sample is collected from Brahmaputra river i.e. Bharalumukh. Water quality parameters are listed in the table so and so.

TABLE 1: PROPERTIES OF THE SAMPLE WATER

pH	**6**
color	**brown**
alkalinity	**8.3mg/L**
hardness	**564mg/L**
BOD	**7.92mg/L**
turbidity	**118.3 NTU**
Iron concentration	**4.92 µg**

Optimum coagulant dosage was found out using jar test apparatus for the collected water samples. Totalalkalinity was determined by titrating the sample with 0.02 N H_2SO_4 using methyl orange as indicator and hardness by EDTA titrimetric method. Concentration of chloride was obtained by Argentometric method. DO was determined by the modified wrinkler method and BOD by BOD method. Determination of iron was carried out by spectrophotometric method with o-phenanthrolene reagent, aluminum using eriochrome cyanine-R. All the parameters were determined following recommended analytical methods of APHA 2012. Hardness, Chloride, DO and BOD were analyzed following the titration methods discussed in the Standard methods (APHA, 1998).After obtaining the optimum dosage removal efficiency of alum for other parameters were tested adding the optimum dosage of alum.

4. Materials and Methods

Jar test is conducted to determine the optimum coagulant dosage required to remove the impurities from the waste water. Optimum coagulant dosage reduces turbidity, iron concentration and hardness of water.A typical jar test apparatus is operated to simulate a mixing, flocculation and settling cycle. Thus rapid mix is followed by 20-40 minute period. By addition of this optimum dosage the suspended and colloidal materials are removed and filtration has done, BOD is also removed. The common coagulants in water treatment are trivalent salts of iron and aluminum. Organic polymers, such as polyacrilamides are usually used as flocculants, in addition to the metallic slats, to improve floc formation.

Figure 1: Jar test apparatus

By plotting the turbidity vs. alum dosage graph we find the optimum coagulant dosage is 21 ppm.

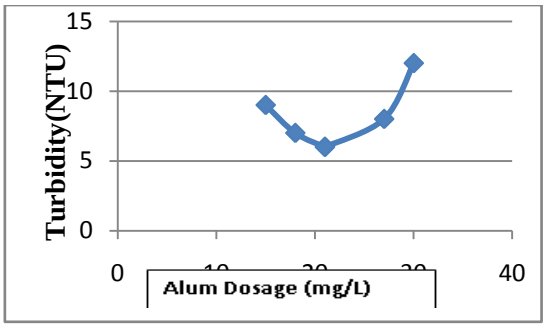

Figure 2: Turbidity VS Alum dosage

5. Results and discussions

Thus we can see from the above comparison (Table: 2) that the value of turbidity decreases from 118.33 NTU to 8 NTU, this concludes that after performing the jar test the suspended particles have settled down due to the addition of alum followed by coagulation and flocculation process which indicated that the turbidity is within the permissible range 1 NTU -10 NTU. The value of BOD has decreased from 7.98 mg/L to 4.02 mg/L after performing the jar test. This indicates that the project undertaken was useful in reducing the BOD value up to some extent when taking the coagulant (alum) dosage as 21ppm. The hardness of water is also gets reduced. Before jar test hardness was 564mg/L and after jar test it is in permissible value i.e. 268mg/L. The dissolved oxygen is also increased after jar test. The concentration of iron is also reduced from 4.92µg/l to 0.8µg/L. The results indicated that coagulation and flocculation processes had contributed bigger roles in the integrated treatment system. The use of the flocculent to pH 6 in the removal of suspended particles is effective but requires a high dose (21 ppm flocculent).

TABLE 2: COMPARISON OF THE RESULTS

Experiment name	***Before jar test***	***After Jar test***	***Percentage efficiency***	***Before jar test***
Turbidity	118.33 NTU	8 NTU	93.24%	118.33 NTU
BOD	7.98 mg/L	4.02 mg/L	49.62%	7.98 mg/L
Iron test	4.92µg/L (concentration) 93.23% (Transparency)	0.8µg/L (concentration) 120.35% (Transparency)	83.74% 27.12%	4.92µg/L (concentration) 93.23% (Transparency)
Hardness	564mg/L	268mg/L	52.48%	564mg/L
DO	5.133 mg/L	8.27mg/L	37.93%	5.133 mg/L

6. Summary

We established that BOD of the water sample is removed or reduced by jar test i.e. by coagulation and flocculation technique. Here we found that after performing jar test BOD is reduced from 7.92mg/L to 4.02mg/L. As a result dissolved oxygen value is increased this makes the water more effective for the aquatic life. Apart from turbidity alum dosage can also reduce the concentration of iron, hardness from the water

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Authors Profile

SutanukaNath, Btech (in Civil) .She is currently pursuing her Btech degree in the department of civil engineering at Assam Donbosco university, Azara, India. She competedher 12th from Dharmanagargirls Higher secondary school, Tripura, India in 2012.

TongchinDrema,(Btech in civil), She is currently pursuing her Btech degree in the department of civil engineering at Assam Donbosco university , Azara , India. She completed her 12th from Nilgiris Higher secondary school, TamilNadu , India in 2012.

Tenzin Chonzom,(Btech in civil), She is currently pursuing her Btech degree in the department of civil engineering at Assam Donbosco university , Azara , India. She completed her 12th from Nilgiris Higher secondary school, Tamil Nadu, India in 2012.

ImlirenlaLongkumar , Btech in civil), She is currently pursuing her Btech degree in the department of civil engineering at Assam Donbosco university , Azara , India She competed her 12th .Queen Mary Higher Secondary School.