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Experimental Analysis To Reduce Consumption Of Ferric Chloride For The Treatment Of Effluent Generated From An Automobile Industry

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Abstract — *Our experiment shows that how we can reduce the consumption of coagulant for the treatment of effluent generated from the machining process of an automobile industry. We have referred the method of coagulation and flocculation in which the coagulant is Ferric Chloride ($FeCl_3$) and flocculant is Polyelectrolyte. Since the ferric chloride is hazardous in nature because it is acidic and also the cost for the treatment of effluent in an industry is quiet high, we have tested whether reducing the dilution of ferric chloride in treatment of effluent will be under the permissible limit given by guidelines.*

Keywords-*Coagulant, Flocs, Chemical Oxygen Demand (COD), Effluent, pH (Power of Hydrogen),*

I. INTRODUCTION

Industrial wastewater treatment covers the both mechanisms and processes used to treat wastewater which is produced as a hazardous byproduct after industrial or commercial activities. After treatment of effluent by the method of coagulation and flocculation, the treated industrial wastewater (or effluent) may be reused or released in gardening or in toilets. Approximate all the production industries produce effluent or wastewater although recent trends in the developing world have been to minimize such production which give rise to wastewater or recycle such wastewater within the production process. However, many industries remain dependent on processes that produce wastewaters. Our principal objective of effluent treatment is generally to allow human and industrial effluents to be disposed in a safe way so that it can't be harmful to our environment and human health as well. For treatment of effluent, we are using flocculation and coagulation method. In this type of treatment method, different acidic and basic chemicals are used to remove the hazardous suspended solids and total dissolved suspended solids.

II. METHODOLOGY

First a jar test will be done to approximately find out reduction in quantity of ferric chloride required for PH of 5 instead PH of 4. Then actual experiment will be done to discard the Null Hypothesis
We will work according to the future scenario in which there will be some changes in the composition of effluent because companies are changing the chemicals and oils which are used for the process for cutting or machining of mechanical components.
There might be some changes will make in the rules and regulation of the legal requirement of the establishment of ETP Plants in Mechanical Industry. So, we have to make establishment according to the legal requirements and also for the sludge disposal.
Sludge disposal and usage of chemical for the treatment are the major hazards. Sludge impacts on our environment and also the health of the affected employees.
These above improvements will be done by the implementation of the following:-
Implement safety guidelines of the chemistry of the chemicals which are used in the mechanical plant for cutting of components.
Storage of the chemicals and sludge would be according to the revised Factory's Act 1948.
By giving trainings to the affected employees and also to the operator of the ETP plant will minimize the risk of hazard and severity.
Conducting lab experiments will be taken according to the BSL (Bio Safety Level) in the chemistry lab so that there should be less risk of hazards.
The Major focus on the future plan is on the emergency plan of the ETP.
If in case there will be any fire or disaster happened then what to do in that particular situation because it will definitely damage the property and also harmful for the health of people and serious impacts on our environment.
As we have discussed earlier that we are using coagulation and flocculation method for the treatment of effluent. We are using jar test for doing the sample test.

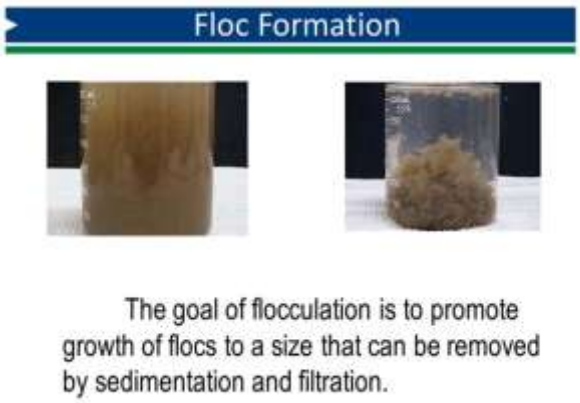
S.No.	Chemical Name	PPE To Be Used	Solution Vs Water
1	Ferric Chloride	• Mask • Goggle • Gum Boots • Chemical Suit • Nitrile Gloves	Ferric Chloride – 60 liters. Water – 40 liters.
2	Lime	• Goggle • Gum Boots • Nitrile Gloves	Lime – 10 Kilograms. Water – 90 liters.
3	Polyelectrolyte	• Goggle • Nitrile Glove	Poly – 10 grams. Water – 100 liters.

- Fill the effluent in reaction tank.
- Transfer effluent by opening the valve to settling tank and allow the settling (final) tank to fill i.e. 1200 liters.
- Do the dosing of ferric chloride ($FeCl_3$) solution and mix properly till the pH value becomes 4. Take the solution in glass beaker and check pH every time and maintain it.
- Do the dosing of lime [$Ca(OH)_2$] solution and mix properly till the pH value become 6.5 to 7.5. Take the solution in glass beaker and check pH every time and maintain it.
- Do the dosing of polyelectrolyte solution and mix properly till the proper formation of clots or flocs.
- Checking of clots – Mix the polyelectrolyte in effluent in small quantity.
- Take the effluent in beaker and check the clot formation.
- Once see the proper formation and then see the settling.
- Settling should be in 5 to 10 min.
- Wait for 2 to 2.30 hours to allow the treated effluent to settle down.
- Once it settle down then start the sludge pump and collect the sludge in drying bed mean while close the valve of equalization tank and open the valve of drying bed.
- Collection of sludge in drying bed till the clear water coming to the bed.
- Once the clear water coming to the bed then close the valve of drying bed and open the valve of equalization tank which is place on drying bed.
- Remove the all treated water from tank and tank is ready to make the next batch of the effluent

III. JAR TEST

The jar test is used to identify the most adapted mix of chemical compounds and concentrations for coagulation and flocculation. It is a batch test consisting of using several identical jars containing the same volume and concentration of feed, which are charged simultaneously with six different doses of a potentially effective coagulant. The six jars can be stirred simultaneously at known speeds. The treated feed samples are mixed rapidly and then slowly and then allowed to settle. At the end of the settling period, measure COD (Chemical Oxygen Demand) of test samples. The jar test – a laboratory procedure to determine:-

- Optimum pH.
- Optimum coagulant dose



Jar Test

Adjusting optimum 5pH in one jar and 4pH in another jar for gaining economic amount of chemical usage for treatment

- Fill the jars with raw water sample
- (1000 mL) – usually 6 jars

- Adjust pH of the jars while mixing
- using $FeCl_3$ (pH: 5.0)

Add same dose of the selected Coagulant ($FeCl_3$) to each jar. Coagulant dose 20ml.

- Rapid mix each jars at 100 to 150 rpm for 1 minute. The rapid mix helps to disperse the coagulant throughout each container
- Reduce the stirring speed to 25 to 30 rpm and continue mixing for 15 to 20 minutes. This slower mixing speed helps promote flocs formation by enhancing particle collisions, which lead to larger flocs
- Turn off the mixers and allow flocs to settle for 30 to 45 minutes.
- Measure the COD(Chemical Oxygen Demand) in each jar

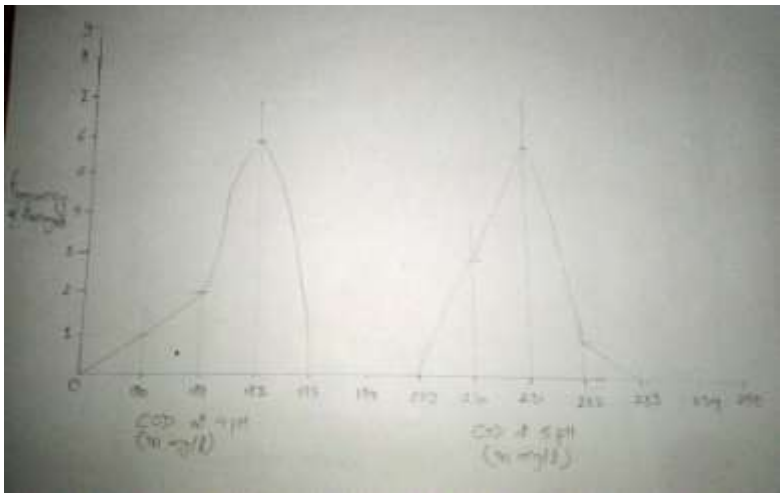
Optimum coagulant dose

- Repeat all the previous steps
- This time adjust pH of all jars at 4pH while mixing using $FeCl_3$. Coagulant dose 35ml.
- Add different doses of the selected coagulant to each jar. Rapid mix each jars at 100 to 150 rpm for 1 minute. The rapid mix helps to disperse the coagulant throughout each container
- Reduce the stirring speed to 25 to 30 rpm for 15 to 20 minutes.
- Turn off the mixers and allow flocs to settle for 30 to 45 minutes.
- Measure the COD(Chemical Oxygen Demand) in each jar

III. COCNCLUSION

We have taken aprox 250 samples of treated effluent for measuring COD at pH of 4 and also pH of 5.

Averages of COD at 4pH in milligram per liter	Averages of COD at 5pH in milligram per liter
182.22	231.49
182.51	231.67
180.95	231.19
181.76	230.42
181.49	230.32
182.20	230.77
182.25	231.21
181.80	231.41
182.12	231.76
182.41	232.42



The pH will be 4 every time and the amount of $FeCl_3$ remains the same. But we are experimenting that if the pH would be more than 4 than it will be safe or not and if it will be safe than this would be going to be economical and less consumption of coagulant in the dosing of the treatment of effluent.

There are several parameters are checked after the treatment of effluent according to IS standards which are mandatory for treat the effluent below the permissible limits which are mentioned in IS standards. And if our treatment is not below the permissible limit or exceeds the limit then the treatment is failure and it would be not safe for environment as well as animals. So due to the limitations we are just taking the COD (Chemical Oxygen Demand) parameter after treatment of the effluent.

According to IS: 3025 and the hazardous waste management system, the COD will not exceed over 250 milligram/liter.

For checking this parameter, we can use calibrated COD meter or we can send the sample to laboratory for testing. Since we have the COD meter so it would be beneficial for us.

Average COD of effluent at 4pH is approximately 180mg/ml.

Average COD of effluent at 5pH is approximately 230mg/ml.
The cost of ferric chloride is Rupees 44/liter. The usage of ferric chloride for treatment of 1 liter of effluent at 4pH is 35 milliliter. Therefore in 1 liter of ferric chloride we are treating 28.57 liter of effluent. Which is good enough but, the usage of ferric chloride for treatment of 1 liter of effluent at 5pH is 20 milliliter. Therefore in 1 liter of ferric chloride we can treat 50 liter of effluent. This will prove that our experiment can save approximate 50% of the ferric chloride which is economical to the industry.

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