



## AN EXPERIMENTAL STUDY ON TREATMENT OF SAGO EFFLUENTS USING NATURAL COAGULANTS TO REDUCE TURBIDITY

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### ABSTRACT

Industrial development had to the damage of environment and ecosystem and it results in the pollution of air, soil and water since water is a universal solvent the industries are using it as trade effluent. A large number of starch factories based on tapioca (sago) are located in three southern states of India- Kerala, Karnataka and Tamil Nadu. Waste water treatment is the process of removing contaminants from wastewater. They are done by physical, chemical and biological process. In this type of treatment process called coagulation. The waste water will contain suspended solids and contains turbidity in high volume. To treat this they will use coagulants by doing flocculation, sedimentation and filtration process. They generally use chemical coagulants such as Alum, Ferric chloride and poly aluminums chloride. In this process we tried as many as 4 products as natural coagulants for the sago water treatment. The dosage levels of all products were taken as same and we calculated their efficiency of removing their turbidity and other concerns such as Characteristics of sago wastewater. Here we had adopted the most efficient natural coagulant for treatment process of sago effluent.

**KEYWORDS:** Sago waste water, natural coagulants, turbidity Jar test, Coagulation.

### INTRODUCTION

In Southeast Asia, approximately 60 million tonnes of sago starch are produced annually

either by mechanical or traditional methods. The rapid growth in industries has resulted in increased in pollution level in all natural forms i.e. by air, water and land get polluted. The primary form pollution will be occur though the effluent (wastewater) mixing with local water bodies and nearby farms and land which results in land and water pollution. Rasipuram is an important taluk in Namakkal district, Nearly 176 sago factories are located in around the Rasipuram taluk. Starch produced in this area will be exported to other parts of India. The sago industries Cassava tapioca tubes are converted into commercial sago utilizing indigenous technologies hence it requires high amount of water. The effluent contains high amount of bio oxygen demand and chemical oxygen demand, obnoxious odour irritating colour. The present study focuses on comprising the coagulant activity of alternatives to treat drinking water with environment friendly plant extract to commonly used coagulant agents. The objective of this study is to investigate the assessment of four different plant materials namely ciceraritenium, Dolicess Lablab, Tar mind seeds and moringaoleifera seeds as natural coagulants.

### WASTEWATER TREATMENT

Wastewater treatment techniques that are widely used are chemical precipitation, lime coagulation, ion exchange, reverse osmosis and solvent extraction Coagulants are used that added to the water to withdraw the forces that stabilizes the colloidal particles and causing the particles to suspend in the water. Various types of coagulants show potential application in

treating water and wastewater. It ranges from chemical to non-chemical coagulant. The coagulant also could be synthetic and solid water material or natural coagulant with the properties of coagulant having +ve charge, these positive charge proteins would bind to the -ve charged particles in the solution that cause turbidity. Coagulants normally in form of natural & synthetic. Both coagulants aim to remove pollutant in form of physical or chemical (BOD & COD). The optimum dosage of pH will lead to the optimum conditions of JAR test.

#### NEED OF COAGULATION

It is one of the important processes in the waste water treatment. Chemicals used in effluent water treatment processes for solid removal, water clarification, lime softening, sludge thickening and solid dewatering. Coagulants neutralize the negative electrical charge on particles. Coagulation is affected by the type of coagulant used, dosage and mass of the coagulant used, initial turbidity of the water that is to be treated and the properties of the pollutants present. The effectiveness of the coagulation process is also affected by the pretreatment process like oxidation.

#### OBJECTIVES

- ✓ To remove the turbidity in the waste water.
- ✓ To determine the effective dosage of the chemical coagulants.
- ✓ To maintain the pH level before and after the treatment process.
- ✓ To avoid the health risk problems.
- ✓ To reduce the various parameters in the raw water such as TS, BOD, COD, sulphides, nitrates etc.,

#### SCOPE

- ✓ Natural coagulants from plants and renewable sources, contributing to a sustainable and economical water treatment.
- ✓ Natural coagulants decrease the volume of sludge
- ✓ Application on a large pH range (4 to 9), without alteration of the effluents pH.
- ✓ The effluents conductivity remains unchanged this is particularly important in cases followed by osmosis process and in cases of closed circuit waters.

#### TYPES OF COAGULANTS

Coagulants are classified into two types they are natural coagulants and chemical coagulants.

#### CHEMICAL COAGULANTS

The commonly used chemical coagulants fall into two categories those based on aluminum and those based on iron. The aluminum coagulants include aluminum sulphate, aluminum chloride and sodium aluminates and in the case of iron coagulants they include ferric sulphate, ferric chloride and ferric chloride sulphate. They are great efficient one but at the same time they are costly and are harmful to the mankind due to the chemical present in them.

#### NATURAL COAGULANTS

The natural coagulants are used in water treatment include microbial polycharides, starches, cellulose and alginate. Coagulants which carry natural characteristics supposed to be harmless for human health.

#### ADVANTAGE:

- ✓ Eco friendly.
- ✓ Cheap and easy method for developing countries.
- ✓ The efficiency is independent to raw water pH.
- ✓ Safe to human health.
- ✓ The low volume of sludge precipitated is biodegradable.
- ✓ The sludge can be used as good manure for crops.
- ✓ Alkalinity of the waste water can be highly reduced.

#### EXPERIMENTAL SETUP

The coagulation-flocculation experiment was carried out using Jar Test apparatus which consists of six beakers with mixing paddle and a gauge for revolution per minutes (rpm). The experiments were performed using water samples of turbidity 100 NTU. For each water sample, six beakers were filled up to 1000 ml, placed in the jar tester, various dosage of coagulant extracts 5 mg/l, 10mg/l, 20 mg/l, 30 mg/l, 40mg/l were added and then agitated further for 5 min at different speed of 100 rpm, 200rpm, 300rpm. The mixing speed was then reduced to 30 rpm and maintained at slow mixing for 15 min, followed by sedimentation for 20min after which supernatant was collected at approximately 5 cm from the top of water surface for further analysis.

#### PREPRATION OF NATURAL COAGULANTS:

The Seedpods of ciceraritenium, Dolicess Lablab, Tarmind seeds and moringaoleifera seeds are collected, dried seeds

were ground to fine powder and they was sieved through 240 $\mu$ m sieved



Tamarind Seeds



Dolichos Labab



Moringa Olifera



Cicer Artemium

## COAGULATION AND PRECIPITATION PROCESS FOR TREATING SAGO WASTEWATER (JAR TEST)

### PRINCIPLE

Metal salts hydrolysis in presence of the natural alkalinity to form metal hydroxides. The divalent cations can reduce the zeta-potential, while the metal hydroxides are good absorbents and hence remove the suspended particles by enmeshing them.

### APPARATUS REQUIRED

1. Jars mixer
2. Turbid water
3. Beakers
4. Pipettes
5. Turbidity meter
6. p<sup>H</sup>meter

### REAGENTS

Sago waste water

### PROCEDURE

1. 200ml of water sample is taken in each jar. Increasing dose of alum (1%) i.e. 1gm/100ml of distilled water added to supply for 15min allowed to stand for 15min.
2. The jars are observed and the settling of sediments are noted. The quality of alum added to the jar containing the clearest solution is noted.
3. Take the sample out of beaker and test for turbidity in each trial plot the curve on x and y of the graph sheet. Take the alum dosage in ml along x axis and turbidity along -y-axis.



Jar test of moringaolifera seed



Jar test of tamarind seed



Jar test of dolichoslabab

### DETERMINATION OF p<sup>H</sup>:

P<sup>H</sup> can be viewed as an abbreviation for power of hydrogen or more completely, power of the concentration of hydrogen ion. It says that the pH is equal to the negative log of the hydrogen ion concentration, or  $pH = -\log [H^+]$ .

$$p^H = -\log [H_3O^+].$$

$p^H$  values are calculated in powers of 10. The hydrogen ion concentration of a solution with  $p^H$  1.0 is 10 times larger than the hydrogen concentration in a solution with  $p^H$  2.0. The larger the hydrogen ion concentration, the smaller the  $p^H$ .

- when the  $p^H$  is above 7 the solution is basic (alkaline)
- when the  $p^H$  is below 7 the solution is acidic
- when the  $p^H$  is equal to 7 the solution is neutral

#### APPARATUS REQUIRED:

- $p^H$  meter:  $p^H$  of the solution was monitored by using a digital desktop, and  $p^H$  was adjusted with the help of NaOH and HCL
- Beakers
- Reagents
- Buffer solution of 4.0  $p^H$  (Thallate buffer): 10.2 grams of potassium hydrogen
- Thallate was dissolved in one liter double distilled water.
- Buffer solution of 7.0  $p^H$  (Phosphate buffer): 3.4 gram of borax was dissolved in one liter double distilled water.
- Buffer solution of 9.2  $p^H$  (Borax Buffer): 3.81 gram of borax was dissolved in one liter of double distilled water.

#### PROCEDURE:

- After calibration with buffer solution, rinse the electrode with DDW and wipe gently.
- Take the sample in a beaker. Bring the temperature of the sample to room temperature.
- Deep the electrode in the beaker in such a way that bulb of the electrode deep in to sample. Bring the temperature to homogeneity by stirring.
- Record the reading from display, which will give the  $p^H$  value of the sample.
- Temperature rod is inserted to find temperature of the waste water



**$p^H$  APPARATUS**

#### DETERMINATION OF BOD:

Biochemical oxygen demand or BOD is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period.

#### USES OF BOD INCUBATOR:

##### HEATING:

Indirect heating system is provided in our units, comprising of air heaters made of high grade Kanthal A-1 wires of suitable voltage. The warm air is evenly distributed throughout the chamber through efficient motor fans ensuring a very good temperature sensitivity.

##### COOLING:

An energy efficient cooling unit is installed in our bod incubators to enable bio chemical demand studies at lower room temperatures. We use ISI marked high end CFC free compressors of Kirloskar/Tecumseh make, conforming to latest international standards and guidelines.

##### PRINCIPLE:

BOD is measure of biodegradable organic material present in wastewater and can be defined as the amount of oxygen required by the microorganisms in stabilizing the biologically degradable organic matter under aerobic conditions. The principle of the method involves, measuring the difference of the dissolved oxygen concentration of the sample and after incubation it for 5 days at 200 °C.

#### APPARATUS AND REAGENTS:

- BOD bottles
- BOD incubator

#### PREPARATION OF NUTRIENTS:

- Phosphate buffer: 8.5 g  $KH_2PO_4$ , 21.75 g  $K_2HPO_4$ , 33.4 g  $Na_2H. PO_4.7H_2O$  and

1.7 g  $\text{NH}_4\text{Cl}$  was dissolved in 500 ml distilled water and diluted to 1 liter.

- Magnesium sulphate solution: 82.2 g  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  was dissolved in distilled water and diluted to 1 liter
- Calcium chloride solution: 27.5 g of anhydrous  $\text{CaCl}_2$  was dissolved in distilled water and dilute to 1 liter
- Ferric chloride solution: 0.25 g  $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$  was dissolved in distilled water and diluted to 1 liter.

#### PREPARATION OF DILUTION WATER (AERATED WATER):

About 2ml/ 5 liter seed was added to a required volume of dilution water (distillation water) and aerated about on night to have the sufficient dissolved oxygen in it. After aeration 1 ml each of phosphate buffer,  $\text{MgSO}_4$ ,  $\text{CaCl}_2$ , and  $\text{FeCl}_3$  solution each was added per liter of water.

#### PROCEDURE:

Two bottles for sample and two bottles for blank were filled up by the dilution water to get the required dilution factor. One set of dilution sample and blank was kept in BOD incubator at 25°C for 5 days, and DO contend in another set was estimated on the same day. After 5 days DO was also estimated from the second set of the sample and blank from the incubator.

#### REAGENTS:

- Manganese sulfate solution: 100 mg of  $\text{MnSO}_4 \cdot \text{H}_2\text{O}$  was dissolved in boiled distilled water, filter and diluted to 1 liter.
- Alkali-iodide-aside reagent: Dissolve 500 g of  $\text{NaOH}$  and 135 g  $\text{NaCl}$  in distilled water and dilute to 1 liter. Add 10 g  $\text{NaNO}_3$  dissolved in 40 ml of distilled water.
- Starch Solution: 1 g of starch was added in 100 ml of warm (80°C-90°C) distilled water and a few drop of formaldehyde solution were added.
- Sulphuric acid:  $\text{H}_2\text{SO}_4$ , concentration (sp gr. 1.84) Standard Sodium Thiosulphate solution (0.025N): 24.82 g of  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  was dissolved in boiled distilled water and made volume to 1 liter and 0.4 g of  $\text{NaOH}$  pallet added as stabilizer. Then the solution was diluted to 4 times with boiled distilled water to prepare 0.025 N solutions.

#### PROCEDURE:

2 ml manganese sulfate solution followed by 2 ml alkali-iodide-aside reagent were added to the sample collected in 300 ml BOD bottle and mixed by inverting the bottle for complete fixation of DO as brown color manganese hydroxide precipitation. Then 2 ml conc.  $\text{H}_2\text{SO}_4$  was added and dissolved the precipitation by gentle inversion. This solution was titrated with 0.025 N sodium sulphate solution using starch indicator and end point was blue to colorless.

#### DETERMINATION OF COD:

The COD is considered mainly the representation of pollution level of domestic and industrial wastewater or contamination level of surface, ground and potable water. This is determined in terms of total oxygen required to oxidize the organic matter to  $\text{CO}_2$  and water. The COD values include the oxygen demand created by biodegradable as well as non-biodegradable substances because it involves oxidation of organic matter with strong oxidizing chemicals. As a result, COD values are greater than BOD and may be much greater when significant amounts of biologically resistant organic matter is present.

#### APPARATUS REQUIRED:

- Close refluxing unit.
- Titration assembly

#### PROCEDURE:

- Mercuric Sulphate,  $\text{HgSO}_4$
- Ferroun Indicator: Weigh 1.485g of 1, 10-phenanthroline monohydrate and 0.695g  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ . Transfer both the chemicals to a 100 ml volumetric flask. Dissolve in DDW. Dilute up to the mark with DDW.
- Potassium dichromate solution, 0.25N: Dry an adequate quantity of  $\text{K}_2\text{Cr}_2\text{O}_7$  in an oven set at 103°C for 2 hours. Cool to room temperature. Accurately weigh 12.259g dry and cool  $\text{K}_2\text{Cr}_2\text{O}_7$  and transfer to a 1 liter volumetric flask. Dissolve in DDW. Add 0.12g of sulfamic acid to the concentrated dichromate solution. Dilute up to the mark concentrated sulphuric acid,  $\text{H}_2\text{SO}_4$ .
- Sulphuric acid concentrated with silver sulphate,  $\text{H}_2\text{SO}_4 - \text{Ag}_2\text{SO}_4$  catalyst: Weigh 22g of silver sulphate ( $\text{Ag}_2\text{SO}_4$ ) and add to a 2.5 liter concentrated

H<sub>2</sub>SO<sub>4</sub> bottle. Keep this solution on magnetic stirrer. Stir for 1-2 days for complete dissolution of Ag<sub>2</sub>SO<sub>4</sub>.

- Ferrous ammonium sulphate (FAS) solution, Fe(NH<sub>4</sub>)<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>·6H<sub>2</sub>O, approx. 0.25N: Weigh 98g FAS and transfer to a 1 liter volumetric flask. Dissolve in about 500 ml DDW. Add 20 ml conc. H<sub>2</sub>SO<sub>4</sub>. Dilute to 1 liter with DDW and cool it.
- Ferrous ammonium sulphate (FAS) titrant, 0.10 N: Measure 400 ml of the 0.25 N FAS solution in a 1 L volumetric flask. Dilute to 1 L with DDW. Standardize this solution daily before estimation.

### STANDARDIZATION:

#### FAS titrate, 0.10 N:

- Fill the burette with 0.10 N FAS titrant.
- Accurately measure 10 ml of 0.25 N K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solutions into a clean Erlenmeyer flask and add 90 ml DDW into the flask.
- Dispense 30 ml concentrated H<sub>2</sub>SO<sub>4</sub> with constant stirring and cool the solution.
- Add 0.5 ml ferroin indicator.
- Titrate with FAS titrant till the endpoint is achieved. First the solution turns bluish green and then attains a reddish brown color at endpoint.



**COD Titration**

### DETERMINATION OF AMMONIA NITROGEN IN SAGO WASTEWATER

#### PRINCIPLE

Ammonia ion reacts with Nessler's reagent (K<sub>2</sub>HgI<sub>4</sub>) to form a brown colour substance and can be determined calorimetrically. Most of the natural water and wastewater have interfering substances; therefore, the stream distillation of ammonia becomes essential.

#### APPARTUS REQUIED

1. Measuring Jar
2. Conical flask
3. Burette
4. Pipette

#### REAGENTS

1. Phosphate Buffer Solution
2. Boric Acid
3. Methyl Orange Indicator
4. Sulphuric Acid 0.02N (1ml contains 0.28mg of nitrogen)

#### PROCEDURE

1. Take 50ml of the sample in a conical flask.
2. Add 5ml of phosphate buffer solution and 10ml of boric acid solution.
3. Add 3-5 drops of methyl orange indicator.
4. Titrate against 0.02N of sulphuric acid till end point is changes from orange to yellow.

### DETERMINATION OF CALCIUM IN THE SAGO WASTE WATER BY EDTA METHOD

#### PRINCIPLE

When EDTA (Ethylene-dimine tetra acetic acid) is added to the water containing calcium and magnesium it combines first with calcium. Calcium can be determined directly with EDTA when p<sup>H</sup> is made sufficiently high such that the magnesium is largely precipitated as hydroxyl compound (by adding NaOH and isopropyl alcohol). When murex idee indicator is added to the solution containing calcium all the calcium gets completed by the EDTA at p<sup>H</sup> 12-13. The end point is indicated from a colour change from pink to purple.

#### APPARATUS REQUIRED

1. Burette
2. Pipette
3. Conical flask
4. Beakers
5. Droppers

#### REAGENTS

1. **Sodium hydroxide (8%):** 8g of sodium hydroxide is dissolved in 100ml of distilled water.
2. **Murex idee indicator (ammonium purports):** 0.2g of murex idee is ground well with 100g of sodium chloride thoroughly.
3. **Standard EDTA titrant, 0.01M: 3.723g** of EDTA (disodium salt) is dissolved in distilled water and made up to 100ml with the same.

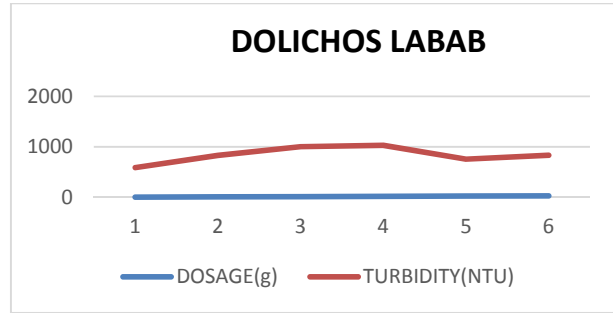
#### PROCEDURE

1. A known volume (50ml) of the sample is pipette into a clean conical flask, to which 1ml of sodium hydroxide and 1ml of isopropyl alcohol is added.
2. A pinch of murex idee indicator is added to this mixture and titrated against EDTA until the pink colour turns to purple.

JAR TEST RESULT

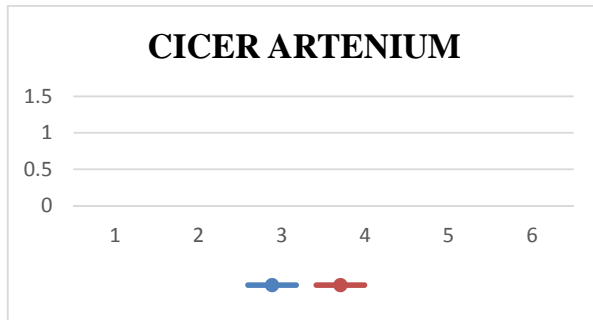
CICER ARTENIUM

S.NO	DOSAGE (g)	TURBIDITY(NTU)
1	5	614
2	10	558
3	15	690
4	20	730
5	25	800
6	30	820



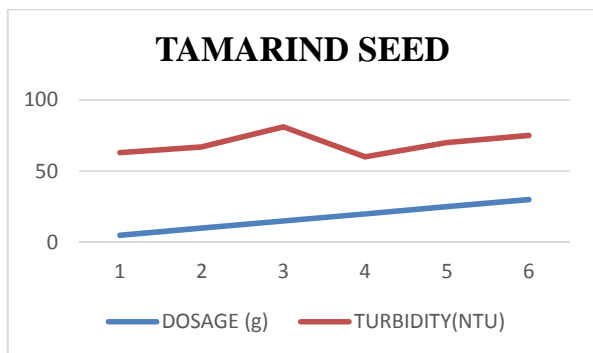
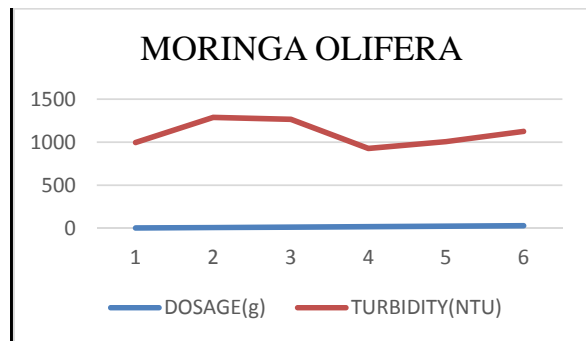
MORINGA OLIFERA

S.NO	DOSAGE(g)	TURBIDITY(NTU)
1	5	996
2	10	1288
3	15	1265
4	20	928
5	25	1007
6	30	1125



TAMARIND SEED

S.NO	DOSAGE (g)	TURBIDITY(NTU)
1	5	63
2	10	67
3	15	81
4	20	60
5	25	70
6	30	75



DOLICHOS LABAB

S.NO	DOSAGE(g)	TURBIDITY(NTU)
1	5	590
2	10	830
3	15	1004
4	20	1030
5	25	756
6	30	835

CHARACTERISTICS OF SAGO WASTEWATER

S.NO	PARAMETERS	VALUE
1	pH	5.98
2	COD(mg/l)	57000
3	BOD(mg/l)	32300
4	CALCIUM(ml)	20
5	AMMONIA NITROGEN(ml)	2.9

CONCLUSION

Using some locally available natural coagulants for example moringaoleifera, cicer arietinum , dolichoslabab and tamarind seeds significant improvement in removing turbidity and turbidity from wastewater was found .maximum turbidity reduction was found for highly turbidity water.

✓ After dosing , water soluble extract of moringaoleifera, cicer arietinum, Dolichoslabab and tamarind seed reduced

turbidity to 928 in 20g, 558 in 10g, 756 in 25g, 60in 20g.

✓ It was also found that thus natural coagulants reduced about 89-95% of turbidity. Among the natural coagulants used in the study for turbidity reduction, tamarind seed was found most effective.

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