Experimental Investigation On Preparation Of Natural Adsorbent For Tannery Wastewater Treatment

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Abstract- *Many toxic substances, such as lime, chromium, zinc, and other heavy metals are found in tannery wastewater. These substances pollute the environment and create human illness. To improve fisheries by lowering BOD, COD, turbidity, total solids, dissolved oxygen, chromium, and increasing the lime content. To minimize the harmful compounds found in tannery wastewater, a variety of natural adsorbents are available. Neem, banana peel, Ocimum tenuiflorum, Ocimum Basilicum, orange peel, and rice husk are the ingredients. Ocimum Basilicum can be used to lower the chromium and lime concentrations in Ocimum Tenuiflorum. Finally, recycled water is used for agricultural purposes. In the Isotherm model, compare the results using the Langmuir methodology.*

I. ADSORPTION

Adsorption is the phenomenon of accumulation of a large number of molecular. The surface species at the surface of liquid or solid phase in comparison to the bulk. Various technologies exist for the removal of such metal, such as filtration, Evaporation, electro-precipitation, chemical precipitation, electrocoagulation, cementing and separation by a membrane, solvent extraction, and the exchange of ions on resins. But these methods are enough expensive. Therefore, recently have been sought a cheaper metal removal from aqueous solutions technology. One of these technologies is adsorption. Adsorption is a fundamental process in the physiochemical treatment of contaminated solutions. Adsorption is a separation process in which certain components of the fluid phase are transferred to the surface of the solid adsorbents. When a solid surface is exposed to a fluid phase the molecules from the bulk of the fluid phase tend to accumulate or concentration at the surface of a solid. Separation occurs because differences in molecular weight, shape, or polarity cause some molecules to be held more strongly on the surface than others or because the pores are too small to admit the larger molecules. The adsorption operation can be batch; semi-back and continuous batch operations are generally conducted when small amounts are to be treated. The equilibrium distribution depends on the contact time in batch operation.

II. TYPES OF ADSORPTION

At the molecular level, adsorption is due to attractive interactions between a surface and the species being absorbed.

a. Physical adsorption or Physisorption:

It is a result of intermolecular forces of attraction between molecules and the adsorbate. In this case, the molecular attractive forces that retain the adsorbent on the surface are purely physical are called Vander Walls forces. This is a readily reversible phenomenon. The energy of interaction between the adsorbate and adsorbent has the same order of magnitudes as but is usually greater than the energy of condensation of the adsorptive. Therefore, no activation energy is needed.

b. Chemical adsorption or Chemisorption:

It is a result of chemical interaction between the solid and the adsorbed substance. It is also called activated adsorption. It may be exothermic or endothermic processes ranging from very small to very large magnitudes. The elementary step in chemisorption often involves large activation energy.

c. Natural adsorbents:

A porous mass of interlacing fibres that forms the internal skeleton of various marine animals and usable to absorb water or any porous rubber or cellulose product similarly used adsorber. In our project Ocimum Tenuiflorum, Ocimum Basilicum is used.

ADSORBENT USED

a). OCIMUM TENUIFLORUM

Ocimum Tenuiflorum is commonly knowns as Holy basil. It is an aromatic perennial plant in the family Lamiaceae. It is native to the Indian Subcontinent and widespread as a cultivated plant throughout the southern Asian tropics.

Kingdom	**Plantae**
Clade	Angiosperms
Clade	Eudicots
Clade	Asterids
Order	Lamiales
Family	Lamiaceae
Genus	Ocimum

b). OCIMUM BASILICUM

It is also called Great Basil or Saint Joseph's wort is a culinary herb of the family lamiaceae.

Kingdom	**Plantae**
Clade	Angiosperms
Clade	Eudicots
Clade	Asterids
Order	Lamiales
Family	Lamiaceae
Genus	Ocimum

LEAVES METHOD:

In leaves methodology, Ocimum Tenuiflorum, (Thulsi), Ocimum Basilicum (Basil) was collected from the field. The leaves were washed by distilled water. Then the leaves were allowed to dry in sunlight till the leaves get its crispy form. After that the leaves are powdered.

a). Collection of leaves

Ocimum Tenuiflorum (Thulsi), Ocimum Basilicum (Basil) was collected from Theni district.

b). Washed by distilled water

Collected leaves were washed 4-5 times using distilled water.

c). Dried in sunlight

Then the leaves were allowed to dry in sunlight for 6-7 days till the leaves get its crispy form.

d). Powdered leaves

Dried leaves were powdered by grinding.

TANNERY WASTE WATER METHOD:

Tannery waste water was collected from the private small scale industry located at Erode district. The collected waste water were test for physical (pH, Turbidity, Colour, Odour, Total solids) and chemical (DO, COD, BOD, Chromium, Lime) characteristics. Though the test we identified the contents present in the waste sample.

a). Collection of Wastewater
b). Test for Characteristics of Wastewater
c). Result for Capacity of Wastewater

EXPERIMENTAL METHOD:

The consistent amounts of powdered leaves were added to the 250ml of tannery waste water through adsorption method. Then mixed water sample was taken in jar apparatus and stirred well. The characteristics of treated water samples were tested.

a). Leaves powder: Randomly the amount of powdered leaves like 2g, 4g are added.
b). Tannery waste water: 250ml of tannery waste water for the process of mixing.
c). Jar apparatus test: The waste water sample was mixed with different dosage of powdered leaves and placed in the apparatus. Then the sample was allowed to mix for a time period of 15 minutes with the speed of 200 rpm.

1. Collection of Wastewater
2. Characteristics of Wastewater
    a. pH Test
    b. Turbidity Test
    c. Total Solids
    d. DO Test
    e. BOD Test
    f. COD Test
    g. Chromium Test
    h. Lime Test
3. Collection of Adsorbent
4. Preparation of Adsorbent
5. Langmuir method in Isotherm Model
6. Result and Discussion

CHARACTERISTICS OF WASTEWATER TEST PROCEDURE

a. pH TEST

- Litmus paper is used for pH test.
- The Paper is dipped into water the colour can be change.
- Using pH values to determine the water either alkaline or acidic.

b. TURBIDITY TEST

- Turbidity meter is used for turbidity test.
- Fill the distilled water in the glass tube and switch on the turbidity meter.
- Then the glass tube is fixed inside the meter and value is adjusted to zero.
- The glass tube can be removed and it will fill with waste water and to fix it in the meter.
- The value is taken as turbidity value in NTU.

c. DISSOLVED OXYGEN

- Take 500ml of water in a D.O bottle.
- Add 10 ml of alkaline KI and 10ml of MnSO4 into it.
- Stopper the bottle and shake it well.
- Keep the bottle in dark for 5 min and add conical H_2SO_4 till the brown Precipitates are dissolved.
- Take 100ml of the above solution in a conical flask. Titrate against hypo till the colour changes to light yellow.
- Add 2-3 drops of starch in to it and the colour changes to blue.
- The blue colour solution is titrated against hypo solution till blue colour disappeared.
- This is end point of the titration. Repeat this process till to get three concordant Reading

d. BIOLOGICAL OXYGEN DEMAND (BOD)

- The source of dilution water may be distilled water, tap or receiving – stream water free of biodegradable organics and bio inhibitory substances such as chlorine or heavy metals.
- Aerate the required volume of dilution water in a suitable bottle by bubbling clean filtered compressed air for sufficient time to attain DO Saturation at room temperature or at 20°C/27°C before use stabilize the water at 20°C/27°C
- Add 1ml each of phosphate buffer, magnesium sulphate, and calcium chloride and ferric solutions in that order for each litre of dilution water. Mix well. Quality of dilution water may be checked by incubating a BOD bottle full of dilution water for 5 days at 20°C for 3 days 27°C. DO uptake of dilution water should not be more than 0.2mg/Land preferable not more than 0.1mg/L.
- For wastes which are not expected to have sufficient microbial population, seed is essential. Preferred seed is effluent from a biological treatment system. where this is not available, supernatant from domestic wastewater (domestic sewage) settled at room temperature for at least 1hour but not longer than 36 hours is considered sufficient in the proportion 1-2ml/L of dilution water. Adopted Microbial population can be obtained from the receiving water body preferably 3-8 km below the point of discharge. In the absence of such situation, develop an adapted seed in the laboratory.
- Determine BOD of the seeding material. This is seed control. From the value of seed control determine seed DO uptake. The DO uptake of seeded dilution water should be between 0.6 mg/L and 1 mg/L.

e. TOTAL SOLIDS

- Take a known volume of a well-mixed sample in a tarred dish ignited to constant weight (W1)
- Evaporate the sample to dryness at 103-105°C for 24 hrs.
- Cool in desiccator, weigh and record the reading (W2).
- Ignite the dish for 15-20 minutes in a muffle furnace maintained at 550$\pm$50°C. Cool the dish partially in air until most of heat has been dissipated, and then transfer to a desiccator for final cooling in a dry atmosphere and record final weight (W3).
- The concentration is to be calculated in present by weight.

f. CHEMICAL OXYGEN DEMAND (COD)

- Place 0.4 g HgSO4 in a 250 ml reflux sample.
- Add 20 ml sampler or an aliquot of sample diluted to 20 ml with distilled water. Mix well.
- Add clean pumice stones or glass beads.
- Add 10 ml 0.25 N (0.04167M) $K_2Cr_2O_7$ Solution and mix.
- Add slowly 30 ml concentrated H_2SO_4 containing Ag_2SO_4 mixing thoroughly. This slow addition along with swirling prevents fatty acids to escape due to generation of high temperature. Alternatively attach flask to condenser with water flowing and then add

H_2SO_4 slowly through condenser to avoid escape of volatile organic substance due to generation of heat.

- Mix well. If the colour turns green, either take fresh sample with lesser aliquot or add more potassium dichromate and acid.
- Connect the flask to condenser. Mix the contents before heating. Improper mixing will result in bumping and blow out of flask content.
- Reflux for a minimum of 2 hrs. Cool and then wash down condenser with distilled water.
- Disconnect reflux condenser and dilute the mixture to about twice its volume with distilled water. Cool to room temperature and titrate excess $K_2Cr_2O_7$ with 0.1M FAS using 2-3 drops of ferroin indicator. The sharp colour change from blue green to reddish brown indicates endpoint or completion of the t itration. After a small time gap, the blue green colour may reappear. Use the same quantity of ferroin indicator for all titrations.

g. CHROMIUM TEST

- Prepare a water sample for testing by placing 10 ml of water in a test tube.
- Test a Sample of tap water and the sample labelled polluted water.
- Add 12 drops of 3M sulphuric acid to the sample.
- Pipet 0.5 ml of diphenylcarbazide solution into the test tube and allow 5 minutes for color development.
- Determine the amount of Cr present by measuring the absorbance of the sample at 540 nm of Cr.

h. LIME TEST

- Take 1g of the material ,accurately weighted, in a glass stoppered conical flask and add about 30 ml of boiling water.
- Shake for 5 to 10 minutes.
- Cool the solution and an amount of iodine solution sufficient to provide an excess of about 5 ml and stir occasionally until the lime has gone the solution.
- Appearance of milky white colour.

CHARACTERISTICS OF TANNERY WASTEWATER

The tannery wastewater parameters are analyzed in our laboratory and its Parameters are listed below.

S.NO	PARAMETERS	PERMISSIBLE VALUE	OBTAINED VALUE
1	pH	5.5-8.5	9
2	Turbidity	5-10	25
3	Total solids	50-1000	1200
4	Dissolved Oxygen	5-9	20
5	BOD	100	120
6	COD	500-1500	2000
7	Lime	40-60	35
8	Chromium	30-45	100

RESULT VALUE USING ADSORBENTS

S.NO	TEST CONDUCTED	RAW WATER	OCIMUM TENUIFLORUM	OCIMUM BASILICUM
1	pH	9	7	7
2	Turbidity	25	9.5	8.8
3	Total solids	1200	650	520
4	Dissolved Oxygen	20	8.5	8.8
5	BOD	120	55	50
6	COD	2000	1250	1150
7	Lime	35	42	45
8	Chromium	100	30.5	32

Units:

1. Turbidity - NTU
2. Total Solids - mg/l
3. Dissolved Oxygen - ppm
4.BOD,COD,Lime,Chromium - mg/l

ISOTHERM MODEL

It is used for analyzing and compare the samples and to get the result.

Methods:

1. Langmuir method
2. Freundlich method
3. Adsorption Kinetics

LANGMUIR METHOD (% OF REMOVAL EFFICIENCY)

The experimental work is carried out to find the removal efficiency. The removal efficiency is found from the initial (Co) and final (Ce) concentrations.

Percentage of removal efficiency = $\frac{(Co-Ce)}{Co}$ x 100

i. pH efficiency

C_o = 9 (Raw Water) : C_e = 7 (Ocimum Tenuiflorum) : C_e = 7 (Ocimum Basilicum)

Percentage of removal efficiency = $\frac{(9-7)}{9}$ x 100

Percentage of removal efficiency = 22.2%

ii. Turbidity Efficiency

C_o =24.6 (Raw Water) : C_e = 9.5 (Ocimum Tenuiflorum) : C_e = 8.8 (Ocimum Basilicum)

For Ocimum Tenuiflorum

Percentage of removal efficiency = $\frac{(24.6-9.5)}{24.6}$ x 100

Percentage of removal efficiency = 61.3%

For Ocimum Basilicum

Percentage of removal efficiency = $\frac{(24.6-8.8)}{24.6}$ x 100

Percentage of removal efficiency = 64.2%

iii. Total Solids Efficiency

C_o = 1200 (Raw Water) : C_e = 650 (Ocimum Tenuiflorum) : : C_e = 520(Ocimum Basilicum)

For Ocimum Tenuiflorum

Percentage of removal efficiency = $\frac{(1200-650)}{1200}$ x 100

Percentage of removal efficiency = 45.8%

For Ocimum Basilicum

Percentage of removal efficiency = $\frac{(1200-520)}{1200}$ x 100

Percentage of removal efficiency = 56.6%

iv. Dissolved Oxygen Efficiency

C_o = 20 (Raw Water) : C_e = 8.5 (Ocimum Tenuiflorum) : C_e = 8.*8* (Ocimum Basilicum)

For Ocimum Tenuiflorum

Percentage of removal efficiency = $\frac{(20-8.5)}{20}$ x 100

Percentage of removal efficiency = 57.5%

For Ocimum Basilicum

Percentage of removal efficiency = $\frac{(20-8.8)}{20}$ x 100

Percentage of removal efficiency = 56%

v. BOD Efficiency

C_o = 120 (Raw Water) : C_e = 55 (Ocimum Tenuiflorum) C_e = 50 (Ocimum Basilicum)

For Ocimum Tenuiflorum

Percentage of removal efficiency = $\frac{(120-55)}{120}$ x 100

Percentage of removal efficiency = 54.1%

For Ocimum Basilicum

Percentage of removal efficiency = $\frac{(120-50)}{120}$ x 100

Percentage of removal efficiency = 58.3%

b. Vi. COD Efficiency

C_o = 2000 (Raw Water) : C_e = 1250 (Ocimum Tenuiflorum) : C_e = 1150(Ocimum Basilicum)

For Ocimum Tenuiflorum

Percentage of removal efficiency = $\frac{(2000-1250)}{2000}$ x 100

Percentage of removal efficiency = 37.5%

c. For Ocimum Basilicum

Percentage of removal efficiency = $\frac{(2000-1150)}{2000}$ x 100

Percentage of removal efficiency = 42.5%

vii. Chromium Efficiency

C_o = 100 (Raw Water) : C_e = 30.5 (Ocimum Tenuiflorum) : C_e = 32 (Ocimum Basilicum)

For Ocimum Tenuiflorum

Percentage of removal efficiency = $\frac{(100-30.5)}{100}$ x 100

Percentage of removal efficiency = 69.5%

For Ocimum Basilicum

Percentage of removal efficiency = $\frac{(100-32)}{100}$ x 100

Percentage of removal efficiency = 68%

REMOVAL EFFICIENCY

S.No	TEST CONDUCTED	OCIMUM TENUIFLORUM	OCIMUM BASILICUM
1	pH	22.2	22.2
2	Turbidity	61.3	64.2
3	Total Solids	45.8	56.6
4	DO	57.5	56
5	BOD	54.1	58.3
6	COD	37.5	42.5
7	Chromium	69.5	68

III. CONCLUSION

- This experimental study was analyzed with different parameters of tannery wastewater such as COD, BOD, pH, Total solids, lime, Chromium, etc.,
- From the present study, it can be concluded that physiochemical parameters of tannery wastewater collected from Erode region were stands to be quite higher than the recommended value set by IS standard.
- It should be treated to reduce the higher concentration and can further reuse for irrigation purposes.
- The treated waste water was found to be useful for irrigation and fishery purposes.
- The pH,Turbidity,Total solids, DO, BOD, COD, Chromium reduced upto 22.2%,61.3%,45.8%,57.5%,54.1%,37.5%,69.5% in Ocimum Tennuiflorum and 22.2%,64.2%,56.6%,56%,58.3%,42.5%,68% in Ocimum Basilicum respectively.
- Thus the project opens a new door to be a cost effective and eco-friendly technology for tannery wastewater treatment.

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