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Experimental Study on Wastewater Treatment using Bio Rock and Coffee Waste

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Abstract - *The present study demonstrates the experimental study on wastewater treatment using bio rock and coffee waste using Manual approach and standard provisions. It is done by providing screening, grit chamber, sedimentation tank and two filtration systems. The improvement in this project is using bio rock for grey water treatment and coffee waste for heavy metals removal from tannery wastewater. In addition to this Natural coagulant (Okra seed) is used as coagulant in sedimentation process. Various laboratory tests such as pH, turbidity, dosage of coagulant by coagulation and precipitation process, BOD, COD, Hardness, Chloride content, heavy metals – chromium are performed before and after treatment process to achieve the disposal standards for inland surfaces and estimating the efficiency of usage of bio rock and coffee waste as a filter media for waste water filtration and Okra seed as a natural coagulant. The materials used for treatment process are cost effective, economical and organic way of approach.*

Key Words: Natural coagulant; Okra seed; bio rock; coffee waste; Tannery effluent; Grey water.

1. INTRODUCTION

Our project deals with the treatment of wastewater such as grey water and Tannery wastewater using bio rock and coffee waste. The aim of our project is wastewater treatment which is generally to allow household and industrial effluents to be disposed without danger to human health or unacceptable damage to the surrounding environment in organic manner. We are using bio rock as a filter media for grey water filtration and coffee waste for tannery wastewater filtration.Natural coagulant, bio rock and coffee ground filter media used for treating wastewater and to know the comparative removal efficiency of COD, BOD and other heavy metals in small scale process.

Okra seed is used as a natural coagulant for efficient removal of colloidal particles. Bio rock is a material which is used to colonize bacteria to grow and remove the micro organisms. Coffee waste is a filter media used to remove the heavy metals mainly cr (III) ions from the tannery wastewater. The process starts from screening and end with filtration system.

2. OBJECTIVES

- To find a more organic alternative to existing chemicals that are used for coagulation processes in waste water treatment.
- The primary goal of this method is to get rid of the suspended colloidal impurities as well as turbidity present in wastewater.
- To allow beneficial bacteria to colonize and remove waste from the water using bio rock.
- To remove the heavy metals from the waste water using coffee ground and act as a low cost adsorbent.
- To reduce the cost of filtration of water and waste water by utilizing bio rock.
- To find the cheaper alternatives to replace or supplement the conventional treatment chemicals.

3. SCOPE

- Natural coagulants produce less toxic, and therefore cheaper to manage in treatment process.
- The filter media used in this project is very effective and their use would be benefits for the less developed industries.
- Low cost water filtration system.
- This contributes to enhance the quality and clarity of wastewater.

- This method will reduce the chemical consumption and provide way to use the natural plant based material for various treatment processes.

4. LITERATURE REIVEW

a. **H. Djati Utomo and K. A. Hunter, "Adsorption of heavy metals by exhausted coffee grounds as a potential treatment method for waste waters".** The adsorption of the heavy metal ions Cu2+,Zn2+,Cd2+and Pb2+from aqueous solution by used coffee grounds has been investigated as a potential low-cost treatment method for heavy metal-containing waste waters that is based on a readily available natural by-product.

b. **Shristee Mishra, Sneha Singh, Ruchira Srivastava, "Okra Seeds: An Efficient Coagulant".** In the following study the efficiency of natural coagulant, namely Okra seeds, has been checked. The efficiency was defined by the amount of turbidity removal which confirmed an effective range of turbidity removal for a dose of 200 mg/l.

c. **G. Durai and M. Rajasimman, "Biological Treatment of Tannery Wastewater",** Tannery wastewaters are highly complex and are characterized by high contents of organic, inorganic and nitrogenous compounds, chromium, sulfides, suspended solids and dissolved solids. Upflow Anaerobic Sludge Blanket Reactor (UASB) exhibited better performance for treating high strength tannery wastewater effectively, compared with conventional reactors.

5. STUDY OF RAW MATERIAL

GREY WATER

Grey water generated from kitchen contains chemical contaminants such as detergents and cleaning agents which are alkaline in nature and contain various chemicals. It is highly contaminated with Bio-chemical Oxygen Demand. It also includes physical contaminants such as food particles, oils, fats, grease, and turbidity.

TANNERY WASTEWATER

Tannery effluent or waste water is the type of waste water released from the manufacturing of leather products. Tannery effluents are among one of the hazardous pollutants of industry. Tannery waste waters are highly complex and are characterized by high contents of organic and inorganic compounds, chromium, nickel, lead, cadmium, copper, etc.,

BIO ROCK

Bio rock refers to the material formed by bio mineralization of deadly matters dissolved in seawater. In the under ocean, the rock formed from the calcified skeletons of corals provides a suitable media for the beneficial bacteria to grow on and remove bacteria from wastewater, which is what actually processes ammonia , nitrogen and nitrites and is a more natural and organic way of providing biological filtration. The term biological filtration refers to the process of live bacteria grow and converting organic waste.

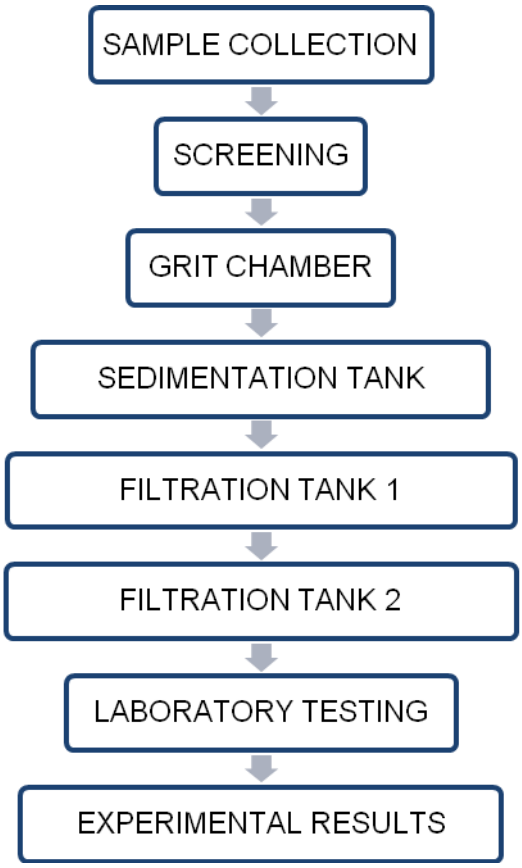
COFFEE WASTE

Coffee waste is made of chemical components that are really good at trapping heavy metals and possess many pores to capture which including the hydroxyl and amino group on the surface of coffee and it is bio elastomeric composite forms.

OKRA SEED

Okra seed (Abelmoschus esculentus) as a natural coagulant. Okra seed has been found not only to be agricultural products but also used as a coagulant in wastewater treatment.

6. METHODOLOGY



I. SAMPLE COLLECTION

- The raw tannery wastewater is collected from vigneshwara tannery industry, Pallavaram.
- The grey water is collected from kitchen sink water, washing machines etc.
- Bio rock is purchased in nearby water treatment system.
- Coffee waste used in our project is purchased from local market.
- Okra seed used as low cost absorbent in our project is purchased from local market.

II. SCREENING AND GRIT CHAMBER

Screens are provided to remove the solid dust particles from waste water. So, we provided screen mesh near the inlet of wastewater in grit chamber tank. Grit chamber is an important component of wastewater treatment system. Slope is provided at the bottom of the tank to control the water flow. This tank also serves for the purpose of aeration and the wastewater will leave for 9 to 12 minutes detention time for settling the solid particles.

III. SEDIMENTATION TANK

Sedimentation cum coagulation tank is provided in our system, in which Natural coagulant such as Okra seed powder is used. The Okra seed is brought from local market and it is washed with distilled water, sun dried for 24 hours and grinded into powder form and sieved. The dosage of coagulant is determined by conducting experiment and it is added to the waste water in sedimentation tank and leaved for 24 hours detention time for flocculation process and the dissolved particles, oils, grease are attracted by coagulant and flocs are formed over the top layer for wastewater.

Fig 1 – okra seed

Fig 2 – Okra seed powder

IV. FILTRATION TANK 1

This is the final process in Grey water treatment. We provided bio rock material as a filter media for treating grey water. Filtration tank 1 consists of three layers of filter media of same material but different in size. First layer is provided with 20mm, Second layer with 12mm and final layer with 5mm.During filtration, the turbidity and colloidal matter of non-settle able type protozoan cysts are also removed. It is to be mentioned that protozoa are stopped in the coarse gravels, the bacteria by the medium gravel and the viruses by the fine.

Fig 3 – Bio rock

V. FILTRATION TANK 2

This is the final process in Tannery waste water treatment. We provided coffee waste as a filter media for treating Tannery waste water. Filtration tank 2 consists of three layers of different materials. First layer is provided with saw dust, Second layer with combination of activated carbon and coffee waste is provided. Final layer provided with pebbles.

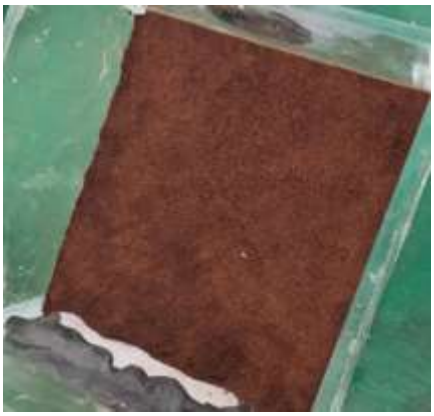


Fig 4 – coffee waste powder

Fig 5 – Activated carbon

7. WORKING MODEL

Fig 6 – Working model of wastewater treatment system

8. WASTEWATER CHARACTERIZATION

The wastewater collected was analyzed to determine the main pollutants present. These parameters were the following.

pH - The materials utilized for test are pH meter, sample solution, electrode.

Turbidity – The test id conducted using Nephelometric turbidity meter, sample solution.

Coagulation and precipitation – The test is conducted using jar test apparatus, natural coagulant, and sample solution.

BOD_5 – The test is conducted using BOD bottle, sample solution, BOD incubator, distilled water, sodium thio sulphate as burette solution, and starch as indicator.

COD – The test is conducted using round bottom flask, reflux apparatus, sample solution, FAS as burette solution and ferroin indicator.

Hardness – The test is conducted using sample solution, EDTA as burette solution and EBT indicator.

TSS – The test is conducted using sample solution, weight balance, hot air oven, muffle furnace, evaporating dish and desiccators.

TDS – The test is conducted using sample solution, weight balance, hot air oven, muffle furnace, evaporating dish and desiccators.

Chloride – The test is conducted using sample solution, $AgNO_3$ as burette solution and K_2CrO_4 as indicator.

Chromium – The test is conducted using Atomic Adsorption spectroscopy (AAS).

9. RESULT AND DISCUSSION

GREY WATER:

There is variation in chemical and microbial quality of grey water depending on source types. The chemical characteristics of grey water typically are presented in **Table 1.**

Table 1: Characteristics of untreated grey water

SL.NO.	PARAMETERS	TESTED VALUES OF UNTREATED GREYWATER SAMPLE	TESTED VALUES OF TREATED GREYWATER SAMPLE	PERMISSIBLE RANGE (Based on IS 2490 – 1974)
1.	pH	5.61	6.81	6.5 to 8.5
2.	Turbidity	443 NTU	180 NTU	5 to 10 NTU
3.	Coagulation and precipitation	10 gm/l	-	-
4.	BOD	188.8 mg/l	17.7 mg/l	20 mg/l
5.	COD	448 mg/l	144 mg/l	250 mg/l
6.	Hardness	5625 mg/l	3125 mg/l	300 to 600 mg/l
7.	Total suspended solids (TSS)	1400 mg/l	200 mg/l	100 to 600 mg/l
8.	Total dissolved solids(TDS)	2400 mg/l	1000 mg/l	500 to 2000 mg/l
9.	Chloride	6382.8 mg/l	2907.7 mg/l	250 to 1000 mg/l

The above discussed wastewater parameter before and after treatment with the bio rock filtration shows the decrease in their values after treatment with bio rock filtration system.

TANNERY WASTEWATER:

There is variation in chemical and microbial quality of Tannery wastewater depending on source types. The chemical characteristics of tannery wastewater typically are presented in **Table 2.**

Table 2: Characteristics of tannery wastewater

SL.NO.	PARAMETERS	TESTED VALUES OF UNTREATED TANNERY WASTEWATER SAMPLE	TESTED VALUES OF TREATED TA NNERY WASTEWATER SAMPLE	PERMISSIBLE RANGE (Based on IS 2490 – 1974)
1.	pH	6.07	6.50	6.5 to 8.5
2.	Turbidity	172 NTU	99 NTU	5 to 10 NTU
3.	Coagulation and precipitation	12 gm/l	53.1 mg/l	-

4.	BOD	247.8 mg/l	256 mg/l	20 mg/l
5.	COD	544 mg/l	6713.87 mg/l	250 mg/l
6.	Hardness	8593.75 mg/l	400 mg/l	300 to 600 mg/l
7.	Total suspended solids (TSS)	2600 mg/l	1800 mg/l	100 to 600 mg/l
8.	Total dissolved solids(TDS)	5200 mg/l	4503.4 mg/l	500 to 2000 mg/l
9.	Chloride	7624 mg/l	1.38 mg/l	250 to 1000 mg/l
10.	Chromium	2.79 mg/l	1.38 mg/l	2 mg/l

The above discussed wastewater parameter before and after treatment with the Coffee waste filtration shows the decrease in their values after treatment with coffee waste filtration system.

10. CONCLUSIONS

In the experimental part in this project the waste water treatment system were designed, constructed and monitored. Wastewater quantities and quality parameters were analyzed and tested. The tested wastewater is within the tolerance limits of Tamil Nadu Pollution Control Board (TNPCB).

It can be thus suggested that we can use locally available coagulant okra seeds and has efficiency of 80% to remove turbid and colloidal particles in waste water which is eco friendly as well as cost effective and naturally available.

Coffee waste act as a best low cost absorbent and effectively reduced the chromium ion upto 51% from tannery wastewater. Increases in the use of bio rock causes drastic decreases in the testing parameters such as pH, BOD, COD, Hardness etc.

Thus the wastewater treatment system will increase overall usage efficiency, reduce costs. Hence, this is an eco – friendly technique, without chemical operation, cost effective and resourceful treatment system.

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