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Performance Evaluation of Laterite for Adsorption Properties

Akshatha B A[1], Karthikeyan N[2], Basavaraja N H[3], Sudhesh A S[4]

[1,2,3,4] *Asst. Professor's, Dept. of Civil Engineering, Bearys Institute of Technology, Mangalore, Karnataka, India*

Abstract - *The wastewater generated from Kitchen contains fat, oil etc., and waste water from garage usually contains petrol and grease etc. This wastewater was passed into a vertical laterite batch reactor which was filled with laterite grains of size in between 10mm to 4mm and 16mm to 10mm. The experimental unit was constructed near the effluent point of the kitchen and garage. The oil and grease got adsorbed to the surface of the laterite grains. The water samples were collected and tested for oil and grease content, BOD, COD and colour removal. The removal efficiencies were monitored. The various parameters such as flow rate of waste water, height of the pipe column, size of the laterite grains were considered to monitor the performance of laterite. Laterite grains as an adsorbent medium showed a very good COD removal of about 98%, 97% of Oil and Grease removal, 97% of colour removal and 85%of BOD removal.*

Key Words: Laterite Soil, Adsorbent, COD, BOD and Colour Removal, etc.

1. INTRODUCTION

It is very important to consider oil and grease content, COD, BOD and colour in the treatment and handling of the waste water for optimum disposal. The waste water from food service facilities like restaurants, hotels contains some organic materials such as oil, ghee, and fatty materials which are floating on it. In case of garages the oil and grease coming out from vehicle during vehicle service or repair may contaminate the drinking water nearby and affects aquatic and human life. Oil and grease, COD, BOD, colour are the cause of nuisance in the wastewater, if not removed as early as possible from the point of source. Some of the techniques used in waste water or water treatment plants to remove oil and grease, COD, BOD and colour are skimming tanks, oil and grease traps, sedimentation and flocculation etc. But these are not efficient and cost effective, they need frequent maintenance. With these points in view, an efficient alternate method is developed to remove oil and grease, COD, BOD and colour from waste water using adsorption technique with easily and cheaply available laterite as adsorbent material.

2. NEED FOR THE STUDY

Every year a large quantity of waste water is generated from the hotels and garages and accumulated. This waste water is very harmful to humans, animals and aquatic life etc. as it contains oil and grease and some fatty oils in it which get enters into the drinking water source. It will also create nuisance and harm environment. Therefore it is necessary to study that how to treat these waste water in an economic and efficient manner. This present study helps to study an efficient and economic way of treating waste water coming from hotels and garages.

3. OBJECTIVES

- To determine the adsorption characteristics of laterite adsorbent and oil & grease adsorbate interface.
- To verify the rate of adsorption with respect to parameters like time of contact and temperature.
- To determine adsorption efficiency in removing oil and grease, BOD, COD and colour from waste water.

4. STUDY BACKGROUND

Jayantha et al., (2014) made a study by passing synthetic wastewater containing oil and grease, in a channel through zigzag placed locally available material like Laterite. The efficiency of oil and grease removal by adsorption was monitored for various parameters like flow rate, length of the channel, baffle spacing and contact area. The results proved that Laterite was a powerful adsorbent medium. It may be adopted at the source to remove oil and grease and laterite could be conveniently used because of local availability·

Abass., (2007) studied and showed that wastewater treatment techniques currently employed in the removal of oil and grease from the industrial wastewater and municipal water stream are challenging. The results shows that the concentrations of oil and grease injected into the ecosystem are of higher environmental impact and this needs to be given the desired attention. The desired development for effective removal of oil and grease as emerging pollutants of concern (EPC) in wastewater stream are thus proposed.

Sanjoy., (2007) the ability of pulverized walnut-shell to remove oil from aqueous solutions is been studied. It involves two-phase process which consists of using walnut-shell as a filtering bed for the accumulation and adsorption of oil onto its surface. Up to 96% oil removal from synthetic wastewater (Garg et al 1998) samples was achieved while tests results showed that 75% of oil can be removed from the actual wastewater discharged from Al- Duara refinery in the south of Baghdad

5. EXPERIMENTAL INVESTIGATION

The Laterite stones from a quarry were crushed in to two size ranges 16mm to 10mm and 10 mm to 4mm.

In Phase I of the experiment, the study was done on grains 16mm down size. These grains were filled in a vertically positioned polyvinylchloride pipe of diameter 2 inch and length 9 feet, fitted with taps at an interval of 4.5 feet (Tap1) and 9 feet (Tap2) respectively, as shown in Fig.1.

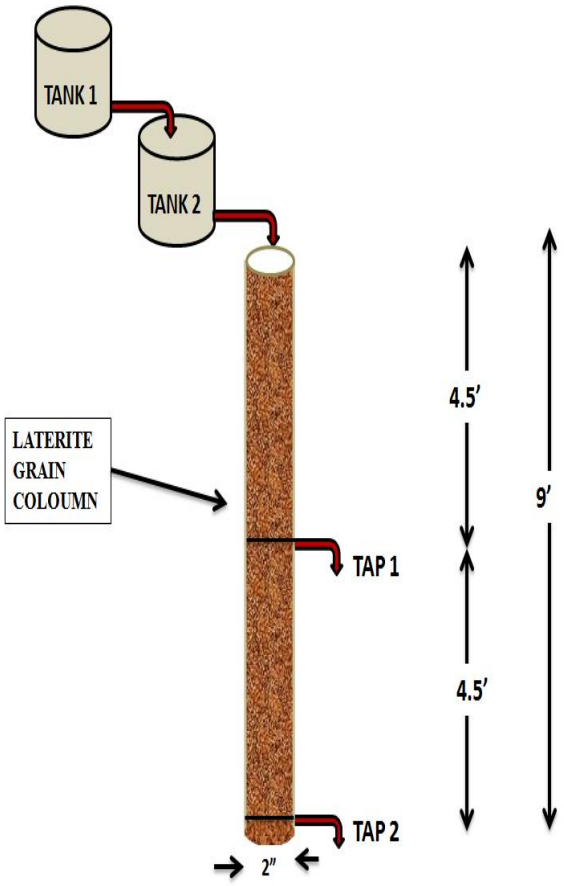

Fig 1: Experimental Setup

The experimental setup was sized to suit the effluent point of the kitchen and garage. Wastewater was collected in a tank and passed through the pipe containing laterite grains. An additional tank containing same wastewater was used to maintain a constant head and constant flow rate of wastewater. When the flow came into contact with the adsorbent in the pipe and stabilized, the samples were collected from different taps provided and tested for oil and grease contents, COD, BOD, and Colour removal. Trials were conducted for flow rates of 0.0125 LPS (Q_1), 0.25 LPS (Q_2), and 0.5 LPS (Q_3).

In Phase II, the same procedure was repeated for grain size range of 10 mm down size and samples were tested. Results were compared to the initial concentration of oil and grease, COD, BOD and Colour in the effluent and percentage removal of oil and grease, COD, BOD and colour was evaluated.

6. RESULTS AND DISCUSSIONS

6.1 COD REMOVAL EFFICIENCY FOR GARAGE WASTE WATER

Table 1: Percentage of COD Removal Efficiency for Garage Waste Water

HEIGHT (Feet)	COD REMOVAL EFFICIENCY (%)											
	SYNTHESISED GARAGE WASTE WATER						REAL GARAGE WASTE WATER					
	16MM			10MM			16MM			10MM		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
0	0 (201.6 mg/l)						0 (320 mg/l)					
4.5	93.20	92.60	91.60	97.20	96.10	95.50	94.10	93.40	92.80	98.14	97.24	96.43
9	94.00	92.90	92.02	98.00	96.90	95.80	94.90	93.80	93.10	98.72	97.90	96.81

Table 1 shows percentage of COD Removal Efficiency for Garage Waste Water when passes through 16mm and 10mm laterite grains. The result indicates that waste water passed through 10mm grains has more COD removal efficiency than 16mm grains. So we can conclude that lesser the size of grain, removal efficiency will be more and also it will vary with the discharge rate and the flow height. COD removal efficiency is more in case of less discharge rate and higher flow height.

6.2. OIL AND GREASE REMOVAL EFFICIENCY FOR GARAGE WASTEWATER

Table 2: Percentage of Oil and Grease Removal Efficiency for Garage Waste Water.

HEIGHT (Feet)	OIL AND GREASE REMOVAL EFFICIENCY (%)											
	SYNTHESIZED GARAGE WASTE WATER						REAL GARAGE WASTE WATER					
	16MM			10MM			16MM			10MM		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
0	0 (180.25 mg/L)						0 (205.85 mg/L)					
4.5	91.76	91.64	91.54	92.26	92.16	92.04	92.03	92.03	92.97	92.40	92.17	92.13
9	93.69	93.65	93.61	94.78	94.75	94.71	94.83	94.82	94.74	94.86	94.82	94.79

Table 2 shows percentage of Oil and Grease Removal Efficiency for Garage Waste Water when passes through 16mm and 10mm laterite grains. The result indicates that waste water passed through 10mm grains has more Oil and Grease removal efficiency than 16mm grains. So we can conclude that lesser the size of grain, removal efficiency will be more and also it will vary with the discharge rate and the flow height. COD removal efficiency is more in case of less discharge rate and higher flow height.

6.3 BOD REMOVAL EFFICIENCY OF KITCHEN WASTEWATER

Table 3: Percentage of BOD Removal Efficiency for Kitchen Waste Water

HEIGHT (Feet)	BOD REMOVAL EFFICIENCY (%)											
	SYNTHESIZED KITCHEN WASTE WATER						REAL KITCHEN WASTE WATER					
	16MM			10MM			16MM			10MM		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
	0 (156.1 mg/l)						0 (199.2 mg/l)					
4.5	81.41	80.02	79.62	84.05	83.10	82.34	81.80	81.12	80.02	84.22	83.52	82.43
9	81.82	80.74	79.98	84.62	83.81	82.91	82.10	81.45	80.98	84.80	83.91	82.62

Table 3 shows percentage of BOD Removal Efficiency for Kitchen Waste Water when passes through 16mm and 10mm laterite grains. The result indicates that waste water passed through 10mm grains has more BOD removal efficiency than 16mm grains. So we can conclude that lesser the size of grain, removal efficiency will be more and also it will vary with the discharge rate and the flow height. BOD removal efficiency is more in case of less discharge rate and higher flow height.

6.4. OIL AND GREASE REMOVAL EFFICIENCY FOR KITCHEN WASTEWATER

Table 3 shows percentage of Oil and Grease Removal Efficiency for Kitchen Waste Water when passes through 16mm and 10mm laterite grains. The result indicates that waste water passed through 10mm grains has more Oil and Grease removal efficiency than 16mm grains. So we can conclude that lesser the size of grain, removal efficiency will be more and also it will vary with the discharge rate and the flow height. Oil and Grease removal efficiency is more in case of less discharge rate and higher flow height.

Table 4: Percentage of Oil and Grease Removal Efficiency for Kitchen Waste Water

HEIGHT (Feet)	OIL AND GREASE REMOVAL EFFICIENCY (%)											
	SYNTHESIZED KITCHEN WASTE WATER						REAL KITCHEN WASTE WATER					
	16MM			10MM			16MM			10MM		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
	0(120.81 mg/l)						0(160.30mg/l)					
4.5	95.20	95.03	94.66	97.50	96.34	95.69	96.19	95.75	95.60	97.30	96.38	96.26
9	96	95.67	95.32	96.33	96.08	95.74	96.19	95.93	95.87	97.36	97.00	97.10

6.5. COLOUR REMOVAL EFFICIENCY FOR KITCHEN WASTEWATER

Table 5: Percentage of Colour Removal Efficiency for Kitchen Waste Water

GRAIN SIZE (mm)	SYNTHESISED KITCHEN WASTE WATER			REAL KITCHEN WASTE WATER		
	Q1	Q2	Q3	Q1	Q2	Q3
10	90	80	59	97	82	72

Table 5 shows percentage of colour Removal Efficiency for Kitchen Waste Water when passes through 10mm laterite grains. The result indicates that waste water passed through 10mm grains has more colour removal efficiency and it will vary with the discharge rate and the flow height. Colour removal efficiency is more in case of less discharge rate and higher flow height

6.6. COLOUR REMOVAL EFFICIENCY FOR GARAGE WASTEWATER

Table 6: Percentage of BOD Removal Efficiency for Garage Waste Water

GRAIN SIZE (mm)	SYNTHESISED GARAGE WASTE WATER			REAL GARAGE WASTE WATER		
	Q1	Q2	Q3	Q1	Q2	Q3
10	84	77	60	70	68	61

Table 6 shows percentage of colour Removal Efficiency for Garage Waste Water when passes through 10mm laterite grains. The result indicates that waste water passed through 10mm grains has more colour removal efficiency and it will vary with the discharge rate and the flow height. Colour removal efficiency is more in case of less discharge rate and higher flow height.

7. CONCLUSIONS

- Removal efficiency is better in case of lower grain size when compared to larger grain size and also removal efficiency in case of lower flow rate is better than that of higher flow rates.
- From the results, it can be concluded that, adsorption depends on flow rate, grain size, contact period, travel distance and type of reactor.
- The results also reveal that a maximum of 97% of oil and grease, 85% of BOD, 98% of COD and 97 % of colour removal observed during the trials.
- In this study treated waste water is in the Permissible limit, that is for Oil and grease maximum of 10 mg/l, for COD 250mg/l and for BOD 30mg/l.
- Since laterite is cheaply available this method becomes economical as compared to other conventional methods.
- Laterite grain as an adsorbent medium can be effectively used for the purpose of pretreatment in wastewater treatment plant.

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BIOGRAPHIES

Mrs. Akshatha B A Completed B.E Degree in Civil Engineering and Master of technology in construction technology from VTU, presently working as Assistant Professor in Department Civil Engineering at Bearys Institute of Technology, Mangalore.

Mr. Karthikeyan N Completed B.E Degree in Civil Engineering and Master of Engineering in construction engineering and management from Anna University, presently working as Assistant Professor in Department Civil Engineering at Bearys Institute of Technology, Mangalore.

Mr. Basavaraja N H Completed B.E Degree in Civil Engineering and Master of technology in CAD Structure from VTU, presently working as Assistant Professor in Department Civil Engineering at Bearys Institute of Technology, Mangalore.

Mr. Sudhesh A S Completed B.E Degree in Civil Engineering and Master of technology in CAD Structure from VTU, presently working as Assistant Professor in Department Civil Engineering at Bearys Institute of Technology, Mangalore.