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Oil and Grease Removal from Wastewater Using Laterite as an Adsorbent Material

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***Abstract*— The oil and grease coming out from vehicle service stations, workshops, hotels etc. may contaminate the drinking water and affect aquatic life. In addition if present in excess, it may load biological treatment plants. Thus removal of this oil and grease content becomes very much essential. Though the conventional methods like skimming tanks and oil-grease traps remove the oil and grease, but not up to the desired extent. Keeping in view of this, a cost effective study was made 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.**

***Keywords*-- Adsorption, Brick baffles, Flow rate, Laterite, Oil removal efficiency.**

I. INTRODUCTION

One of the most significant sources of pollution to natural waters is non-point source pollution, such as pollution from diverse origin like contaminated urban storm water. Storm water contains a large variety of contaminants, including oil and grease. The failure of some of the conventional wastewater treatment plants is mainly because of presence of excess oil and grease. Most of the sewage treatment plants fail in biological treatments due to this pollutant. Though there are guidelines for removing this pollutant at source it is not completely being removed which may cause significant environmental damage. Vehicle service stations, hotels, garages, oil mills, spillage of oil over roads are the main sources of oil and grease. They result in pollution of land and water bodies. It is observed that waste water from vehicle service stations which are run by state and private agencies contributes significantly to pollution. Improper and unscientific methods adopted in the disposal and treatment has resulted in excessive pollution. This has become matter of great concern over the years. In addition there are no efforts being made to treat this wastewater efficiently to the maximum extent and save it and reuse for different purposes.

Since oil is virtually insoluble in water, it floats and spreads rapidly and forms thin film on the water surface. Oil and grease is toxic to some aquatic organisms.

The oil film also prevents oxygen transfer from the atmosphere and leads to low dissolved oxygen levels in the water due to microbial oxidative attack on hydrocarbon molecules. If present in excess it may interfere with aerobic and anaerobic biological process, leading to decreased wastewater treatment efficiency. Present day techniques to remove oil and grease are to use skimming tanks, oil and grease traps and interceptors in treatment plants. The main disadvantage of these methods is low efficiency of removal. Even after the treatment, the remaining oil may cause the clogging of pipes. This necessitates frequent cleaning of pipes and sometimes replacement of pipe system, thus resulting in increased maintenance and inspection cost.

With these points in view, an efficient alternate method is developed to remove oil and grease from wastewater using adsorption [1], [2], [3] and [4] technique with easily and cheaply available Laterite as adsorbent material [5].

II. METHODOLOGY

The experiment was carried out using the process of adsorption in which Laterite material was used as the adsorbent. A synthetic wastewater sample was used for the study. The study was done by passing this wastewater in a zigzag path through a channel provided with Laterite brick baffles. Various parameters such as wastewater flow rate, length of the flow channel, contact area, baffle spacing and baffle orientation are considered and oil removal efficiency was observed.

A. Experimental Setup

The set-up consists of following parts (Figure 1)

- A fibre tank of 1000 litre capacity for wastewater storage.
- A Poly Vinyl Chloride (PVC) pipe of a convenient length with a diameter of 5cm with necessary fittings.
- A rectangular channel (10 m x 0.5 m x 0.6 m) with the Laterite brick baffles inside.
- Laboratory experimental unit for determining oil and grease content.

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Figure1. The experimental setup

Figure 2. Straight baffles

Figure 3. Inclined baffles

B. Experimental Procedure

The experiment was conducted in different stages by considering two parameters at a time. But flow rate of wastewater was taken as common parameter in all the stages, as shown in Table I.

TABLE I
DIFFERENT STAGES OF THE EXPERIMENT AND PARAMETERS CONSIDERED

Stage	Parameters
I	Baffle Spacing and Flow rate
II	Baffle Orientation and Flow rate
III	Increased contact area and Flow rate

A synthetic wastewater was prepared in every stage and stored in the fibre tank. It was then allowed to pass through the channel. Flows of slow (Q_1=0.435 litres/second), medium (Q_2=0.82 litres/second and faster (Q_3=1.67 litres/second) rates were allowed during different trials.

After stabilization of flow, samples of wastewater were collected from regular intervals of 1.5 m along the length of the channel.

These samples were tested for oil and grease concentration in the laboratory by using suitable method. Then oil removal efficiency was determined.

In Stage I, initially a baffle spacing of 0.25 m centre to centre (c/c) was adopted, with straight orientation (Figure 2). Samples were collected for different flow rates. Trials are repeated for 0.33 m and 0.44 m c/c spacing. In Stage II, orientation of baffle was changed and baffle bricks were placed at an inclination of 45^0 to channel wall (Figure 3). Experimental trials were conducted for various flow rates. In Stage III, extra bricks were placed in such way that flowing wastewater touched the underneath portion of the baffles. Thus contact area between wastewater and adsorbent increased. Collected samples were tested and analysed for oil and grease concentrations.

III. Results And Discussions

The experiment was conducted in various stages by varying flow rates, baffle spacing and contact area. The samples collected are analysed for oil concentration and oil removal efficiency in the laboratory. The results obtained in various stages are shown in Table II and Table III.

TABLE II
OIL AND GREASE REMOVAL EFFICIENCIES IN STAGE I

Stage I		
Baffle Spacing (m)	**Flow rate**	**Oil and Grease Removal Efficiencies (%)**
0.25 m	Q_1	97.7
	Q_2	93.5
	Q_3	91.0
0.33 m	Q_1	90.4
	Q_2	75.0
	Q_3	66.4
0.4 m	Q_1	86.4
	Q_2	80.7
	Q_3	67.6

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TABLE III
OIL AND GREASE REMOVAL EFFICIENCIES IN STAGE II AND STAGE III

Stage	Flow rate	Oil and Grease Removal Efficiencies (%)
II (Inclined Baffles)	Q_1	86.8
	Q_2	80.1
	Q_3	74.7
III (Increased Contact Area)	Q_1	96.3
	Q_2	95.3
	Q_3	85.8

It was observed that, in stage I, for the given spacing, oil removal efficiency decreased with the increase in the flow rate. This shows that adsorption process depends on time of contact. It was also observed that with the increase in the spacing between baffle bricks, the oil removal efficiency decreased. It can be inferred that, as spacing is increased contact area is decreased, thus decreasing the efficiency. In stage II, efficiency of removal decreased with increased flow rate. However, an efficiency of 86.8 % could be seen for slower flow rate in stage II and it was comparable with the efficiency achieved in the 0.44 m spacing of stage I, straight orientation. But in Stage III, the maximum efficiency reached to 96.3 %, which was comparable with the efficiency achieved for 0.25 m c/c spacing in Stage I.

Even for the medium flow rate condition, efficiency still remained as high as 95.3 %. Figure 4 shows various oil removal efficiencies in different stages of the experiment. Also, it was observed that, as the length of channel increased, oil removal efficiency increased and oil concentration decreased. Thus more the time of travel and more the time of contact, the removal efficiency increases. Figure 5 shows the variation of oil removal efficiency and oil concentration at different intervals of channel length.

Further, it was also observed that in all the three stages, the efficiency increased with the length of the channel, as seen from Table IV.

TABLE IV
VARIATION OF OIL REMOVAL EFFICIENCY ACROSS THE CHANNEL LENGTH

Channel Length (meters)	Flow Rate Q_1 (liters/ Second)	Oil and Grease Removal Efficiency (%)
Start	0.435	0
1.5		50.5
3.0		52.7
4.5		55.5
6.0		67.4
7.5		79.9
9.0		91.2
End		97.9

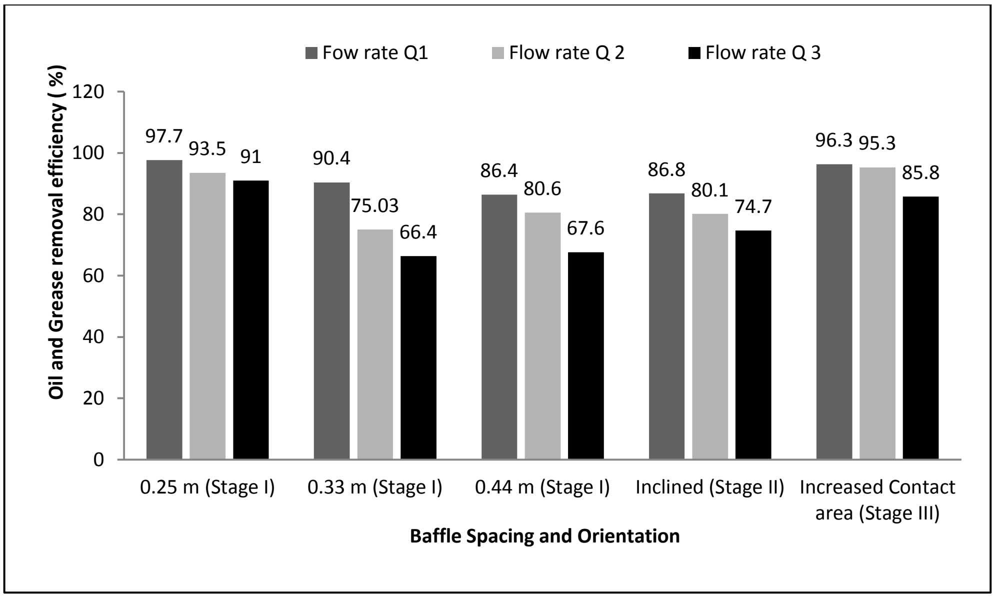

Figure 4. Oil removal efficiencies in different stages.

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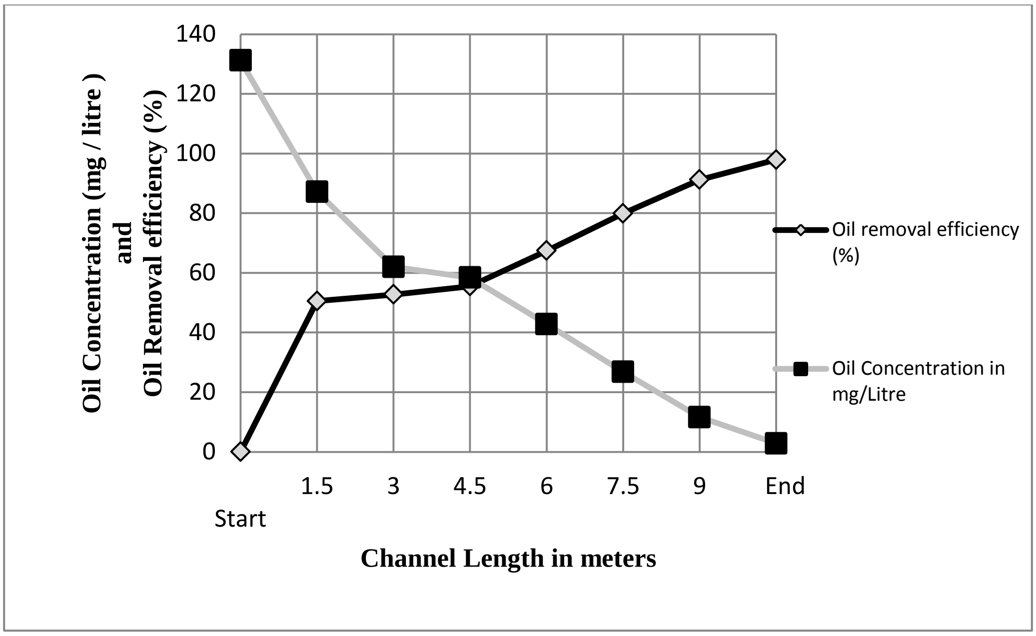

Figure 5. Oil removal efficiency and oil concentration along the channel length.

IV. CONCLUSION

Based on the results obtained in the different stages of this experiment, it is quite evident that Laterite is a powerful adsorbing medium. For closer baffle spacing and slower flow rates, the contact period with adsorbent increased and thus efficiency increased. In addition, as the length of channel increased efficiency also increased. Thus optimum results may be obtained for slower flow rates, closer baffle spacing and higher channel length. Since Laterite is cheaply and easily available, expenses and maintenance incurred are very low as compared to other system. Hence this method can be conveniently employed in the vehicle service stations and may be adopted as pretreatment unit in biological treatment plants. However further investigations may be necessary on performance of adsorbent for continuous wastewater flow and its reuse potential.

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