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# Economical Oil Separator for Automobile Service Stations in Sri Lanka

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**Abstract -** *In spite of the legitimate controls imposed by the Central Environment Authority, the disposals of untreated wastewater to the environment keep on increasing. Automobile service stations are one such source of pollution that has not been focused very much by the public. At present many of the automobile service stations look attractive with colourful signboards displayed. However at the back yard, unnoticeably the untreated wastewater either flows to a stream or to road side drains.*

*On identifying the problem the necessity of developing a suitable system for wastewater treatment for vehicle service stations came to light. However, there are many methods adopted in vehicle service stations to cater for controlling oil. This study was aimed to develop an economical method to remove oil from wastewater and implement the developed method in vehicle service stations. On considering the high percentage of the disposal of oil in wastewater from automobile service stations, a prototype system to separate oil from wastewater was developed and tested. The developed system removes oil completely and directed the oil free wastewater into secondary treatment process.*

**Keywords -** *Automobile service stations, oil and grease, removing oil, prototype, wastewater*

## 1 INTRODUCTION

Onsite wastewater treatment is one of the methods proposed by the Central Environment Authority of Sri Lanka (CEA) to reduce environment pollution, especially to inland water ways. The challenge in treatment of wastewater is to select an appropriate treatment process that is economical and simple.

Oil and grease and detergents including biodegradable detergents can be poisonous to fish, zooplankton and phytoplankton. The presence of cleaning agents and disinfectants can have detrimental impacts on wastewater treatment process. Oil and fuels are the second most frequent type of pollutant of inland waters in England as reported by the Environment Agency UK. However since the introduction of oil storage regulations the incidents reported have been halved compared to ten years ago.

Oil is a highly visible pollutant that affects the water environment. It can reduce levels of dissolved oxygen in water. The effect can be long term in oil polluted surface water and adversely affect drinking water supplies. Further the oil effortlessly spread throughout a surface of large volume of water from where the oil dispersed. The laboratory experiments showed that dispersant increased toxic hydrocarbon levels in fish by a factor of up to 100 and may kill fish eggs (Fominyen, 2010). Dispersed oil droplets infiltrate into deeper water and can lethally contaminate Corals products (Paxes, 1996). Oil emulsions may adhere to the gills of fish; destroy algae or other plankton due to hydrofluoric acid, ammonium bifluoride (http://www.epa.state.il.us/small-business/car-wash). Deposition of oil in the bottom sediments can serve to inhibit normal benthic growths thus interrupting the aquatic food chain (Fominyen, 2010). It is vital to know that wastewater discharged to treatment plants is non-toxic to the biological phase of the process.

There are undoubtedly many solutions to this issue.

The literature survey reveals oil pollutant removal methods such as catalytic degradation with nano MgO (Zhu et al., 2013), inject hot liquid using free-pressure pump are directly aimed to oil layer for oil recovery (Wang, 2012). Strain of microorganisms can remove oil containing wastewater effectively when the pH value was 7.0, the temperature was 30 degree Celsius, the rotation speed was 140 rev/min and the inoculation amount was 10% (Xu et al., 2009). With the tilted oil tank (Xie et al., 2012) and different improved oil recovery strategies, ranging from water flooding to solvent injection.

Zouboulis and Avranas (2000) treated oil-in-water by coagulation and dissolved-air flotation, which is commonly used though it is costly. Combined microfiltration and biological processes was used by Campos et al. (2002) while Delin et al., (2007) and Su et al (2007) have used biological aerated filter for oil-field produced water treatment. Xin et al., (2006) have introduced biological aerated filter by immobilized microorganisms in oil field wastewater treatment. Ahmed et al., (2005) have compared chitosan to activated carbon and bentonite as a potential residual oil remover for palm oil wastewater. Though the chitosan showed better result, it is inapplicable for removal oil and grease from automobile wastewater.

Pablo et al., (2008) used coagulation and electrocoagulation of oil-in-water emulsions. Mueller et al., (2003) tested adsorption after chemical de-emulsification for removal of oil, grease and chemical oxygen demand from oily automotive wastewater. However, the proposed method highlights the importance of pre-treatment and specially the removal of oil from wastewater before commencing a secondary treatment process without using chemicals or any other complicated systems an ordinary worker cannot handle.

A remarkable visual pollution that experiences in most vehicle service stations in Sri Lanka is the oil pollution. Service stations are seen with large oil spills and stagnant water around the floor. On a careful examination it is realized that ultimate destination of the oil path is leading to inland waterways. On highlighting the matter the National Environment Act 47, 1980 clause 23 V, in addition to pollution of inland waters, specifically mention about the prohibition on discharge of oil in to inland waters.

This study was aimed to identify the present treatment systems adopted for disposal of wastewater from automobile service stations and response from CEA to such disposal. Based on the findings it was targeted to propose a suitable economical method of wastewater treatment system to automobile service stations and to implement the proposed method in order to improve the quality of wastewater disposal to be in par with CEA Standards.

## 2 METHODOLOGY

The methodology of this research project basically comprised of two facets; i.e.:, Field survey along with collecting testing and analysis of service station effluent samples and design, fabrication and field testing of oil remover.

## 3 AUTHORITATIVE BACKGROUND

The Government Authority (CEA), who has the legal power to control pollution of surface waterways, was consulted. The information such as registration, categorization of Automobile service stations and the methods of disposal of wastewater and the minimum requirements needed to allow the wastewater to be disposed to the environment were known from CEA database. Discussions were carried out with the relevant staff of the CEA regarding the most remarkable and visible pollutant seen frequently in many of the vehicle service stations in Sri Lanka.

## 4 THE STUDY AREA

The sample area selected for data collection was the divisional secretariat division of *Kalutara*. The data collected through interviews based on a structured questionnaire from vehicle service owners of *Kalutara* divisional secretariat division. There were a total of thirty vehicle service stations within the division and out of which there were eleven major and nineteen minor categories.

## 5 DATA COLLECTION

The records of the Central Environment Authority of Sri Lanka indicated that there are five thousand one hundred Automobile Service Stations. The records of service stations were found in the database on a district basis. In order to implement a vehicle service station it has to be registered at the divisional secretariat. There were two hundred and six vehicle service stations in *Kalutara* District. The distribution of the vehicle service stations within *Kalutara* district in each of the Divisional Secretariat is shown in the Table 1.

**Table 1Distribution of vehicle service stations within *Kalutara* District (As at Feb 2013)**

| No | D.S. Division | A70 | B32 | Total |
|---|---|---|---|---|
| 1 | Agalawatta | 2 | 7 | 9 |
| 2 | Bandaragama | 9 | 13 | 21 |
| 3 | Beruwala | 11 | 19 | 30 |
| 4 | Bulathsinhala | 5 | 7 | 12 |
| 5 | Dodangoda | 2 | 11 | 13 |
| 6 | Horana | 10 | 14 | 24 |
| 7 | Ingiriya | 0 | 5 | 5 |
| 8 | Kalutara | 11 | 19 | 30 |

**Table 1 (Cont.)**

| No | D.S.Division | A70 | B32 | Total |
|---|---|---|---|---|
| 9 | Madurawela | 2 | 5 | 7 |
| 10 | Mathugama | 5 | 11 | 16 |
| 11 | Millaniya | 2 | 1 | 3 |
| 12 | Palindanuwara | 1 | 7 | 8 |
| 13 | Panadura | 7 | 12 | 19 |
| 14 | Walallavita | 2 | 6 | 8 |
| | Total | 69 | 137 | 206 |

The categorization done by the CEA was according to the handling capacity of the service stations and it identifies major and minor categories. The major category included the service stations capable of servicing Lorries, buses, vans and cars. The minor category stations serviced three wheelers and motor cycles only. CEA coded Major category as A 70 and the minor category as B 32.

## 5.1 Extent of Survey

The Questionnaire used for the survey had five main sub headings 1) Primary Information of the vehicle services, 2) Details of the Establishment, 3) Resources used at the time of inspection, 4) Use of chemicals and 5) Methods of Wastewater disposal adopted at the service station.

## 5.2 Questionnaire Survey

The questionnaire survey was carried out in thirty vehicle service stations throughout the Divisional Secretary's division in *Kalutara*. Visited eleven major service stations where heavy vehicles such as buses, Lorries and vans were serviced and nineteen minor service stations where only motorcycles or three wheelers were serviced. The owner or his representative of the vehicle service station was interviewed individually and the information was recorded as told by them without any amendments. Thus thirty vehicle service owners were interviewed and recorded.

## 5.3 Basic Amenities Available at Service Stations

During the survey it was noticed that a service station grouped under the category of major was located on the main street with hardly any space to manipulate vehicles. There were no cover to the service area and did not have the necessary hoists and other facilities. Only a concrete ramp served as a place to wash the under carriage of vehicles. Those stations that serviced buses and Lorries had 2 of 4 ton capacity hoists. There were three major service stations that serviced only vans and cars having hoists of less than 4 Ton capacity. The sanitary facilities were provided for workers as well as the clients and it was reported that the sewer lines were not connected to the waste water system.

Three of the service stations grouped under minor category had nicely arranged buildings and infrastructure facilities. These centers were guided by the respective three wheeler or the motor cycle dealers with the assistance of their importers. These had hoists of less than one Ton capacity capable of hoisting three wheelers. The waste water disposal system functioned as per the instructions given by the respective dealers. Details of basic amenities present at the respective service stations are shown in Table 2

**Table 2 Basic amenities/ Infrastructure availability in service stations**

| Facility | Major (11) | | Minor (19) | |
|---|---|---|---|---|
| | yes | No | Yes | No |
| Sufficient Land Area | 10 | 01 | 03 | 16 |
| Building for service | 10 | 01 | 19 | |
| compressors | 11 | - | 19 | |
| Water pumps | 10 | 01 | 19 | |
| Hoists | 10 | 01 | - | |
| Concrete ramp | 08 | 03 | 19 | |
| Wastewater disposal | 11 | - | 19 | |
| Treatment system | 11 | - | 19 | |
| Separate sewer disposal | 11 | - | 19 | |

## 5.4 Use of Resources

All major and minor service centre owners had their water for washing from either dug wells or tube wells. The electricity was from the mains supply. Average daily consumption of water in major service centers was around 8000 liters whereas in minor stations it was about 2500 liters. Major service stations facilitate about seven to ten vehicles per day at least whereas the minor stations service about ten three wheelers/motor cycles per day.

**Table 3 Use of oil and detergents and removal process in Vehicle service stations**

| Mode of oil removal | A70 | B 32 | Remarks |
|---|---|---|---|
| Pre-treatment system | No | No | |
| Manual | Yes (all) | Yes (all) | Sludge and oil remained at bottom of chamber |
| Oil separator with oil removing facility | No | No | |

## 5.5 Removal of Used Oil and Detergents

Manual oil removal processes has been adopted by all service stations. It was reported that the collected oil was removed to barrels and sold to those who needed the used oil. Only two major service stations had a separate bay for oil removal. However no attention was paid to the use of detergents that mixed with wastewater. The table 3 shows the details of oil and detergents used in service stations.

**Table 4 Analytical data for critical Determinants in Auto service stations (type A-70)**

| No | TSS (mg/l) | pH | Oil & Grease (mg/l) | BOD (mg/l) | COD (mg/l) |
|---|---|---|---|---|---|
| 1 | 64 | 7.5 | 14 | 80 | 360 |
| 2 | 109 | 4.4 | 15 | 140 | 12 |
| 3 | 99 | 8.7 | 265 | 50 | 858 |
| 4 | 65 | 7.5 | 9 | 40 | 443 |
| 5 | 114 | 7.5 | 47 | 260 | 198 |
| 6 | 92 | 8.1 | 95 | 83 | 693 |
| 7 | 153 | 8.6 | 21 | 200 | 378 |
| 8 | 71 | 7.4 | 8.5 | 250 | 1122 |
| 9 | 75 | 7.2 | 27 | 45 | 1108 |
| 10 | 53 | 6.1 | 59 | 150 | 235 |
| 11 | 40 | 7.46 | 20 | 20 | 357 |

## 5.6 Wastewater Sampling and Analysis

The samples of wastewater from eleven major service stations and nineteen minor service stations were collected and analyzed in the Laboratory. Only the analytical data with reference to the most important determinants were recorded. The determinants whose analytical data was recorded for TSS, pH, Oil & Grease, BOD and COD.

**Table 5 Analytical data for critical Determinants in Auto service stations (type B-32)**

| No | TSS (mg/l) | pH | Oil & Grease (mg/l) | BOD (mg/l) | COD (mg/l) |
|---|---|---|---|---|---|
| 1 | 34 | 7.9 | 20 | 60 | 10 |
| 2 | 55 | 6.9 | 12 | 100 | 267 |
| 3 | 50 | 5.9 | 52 | 70 | 353 |
| 4 | 65 | 7.5 | 14 | 80 | 360 |
| 5 | 64 | 8.5 | 15 | 50 | 198 |
| 6 | 71 | 7.4 | 21 | 40 | 235 |
| 7 | 53 | 6.1 | 27 | 45 | 357 |
| 8 | 40 | 7.4 | 20 | 20 | 378 |
| 9 | 40 | 7.46 | 20 | 20 | 357 |
| 10 | 75 | 7.2 | 27 | 45 | 1108 |
| 11 | 153 | 8.6 | 21 | 200 | 378 |
| 12 | 114 | 7.5 | 47 | 260 | 198 |
| 13 | 92 | 8.1 | 95 | 83 | 693 |

**Table 5 (Cont.)**

| No | TSS (mg/l) | pH | Oil & Grease (mg/l) | BOD (mg/l) | COD (mg/l) |
|---|---|---|---|---|---|
| 14 | 99 | 8.7 | 265 | 50 | 858 |
| 15 | 109 | 4.4 | 15 | 140 | 12 |
| 16 | 71 | 7.4 | 8.5 | 250 | 1122 |
| 17 | 64 | 7.5 | 14 | 80 | 360 |
| 18 | 53 | 6.1 | 59 | 150 | 235 |
| 19 | 65 | 7.5 | 9 | 40 | 443 |

## 6 DATA ANALYSIS

The assessment started with analyzing randomly collected raw wastewater effluent samples and the analytical data were compared with the recommended parameters of the CEA. Analytical data values of prominent pollutants present in the effluent samples are shown in Table 4 and Table 5.

The analytical data of the effluent samples taken from Major Auto Service Stations were compared with the tolerance limits for TSS and it was found that almost all the effluent from the major stations had exceeded the tolerance limit. Effluent from only one service station was within the tolerance limit. Figure 1 shows the comparison of the tolerance limit and the analytical value of the Total Suspended Solids (TSS) for the Type A 70. 20% of the minor type of service stations where only three wheelers or motor cycles were serviced had the Total Suspended Solids within the tolerance limits. Analytical data revealed that out of the samples analyzed from nineteen minor service stations, four minor service stations had the TSS indications below the tolerance limit.

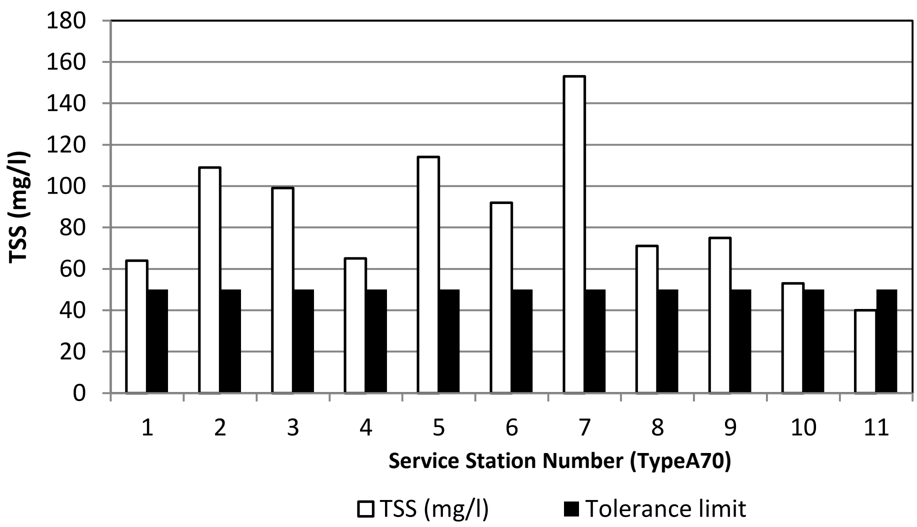


**Figure 1 Increase over the Limits of TSS in TypeA70**

The bigger vehicles may have higher amount of suspended solids as their tire sizes are bigger and the surface area of the under carriage is larger than that of a three wheeler. Therefore it may be advisable to introduce a suitable as well as affordable pre-treatment process before the waste water enters the actual treatment system. The comparison of analytical data of TSS from Type B32 is shown in Figure 2.

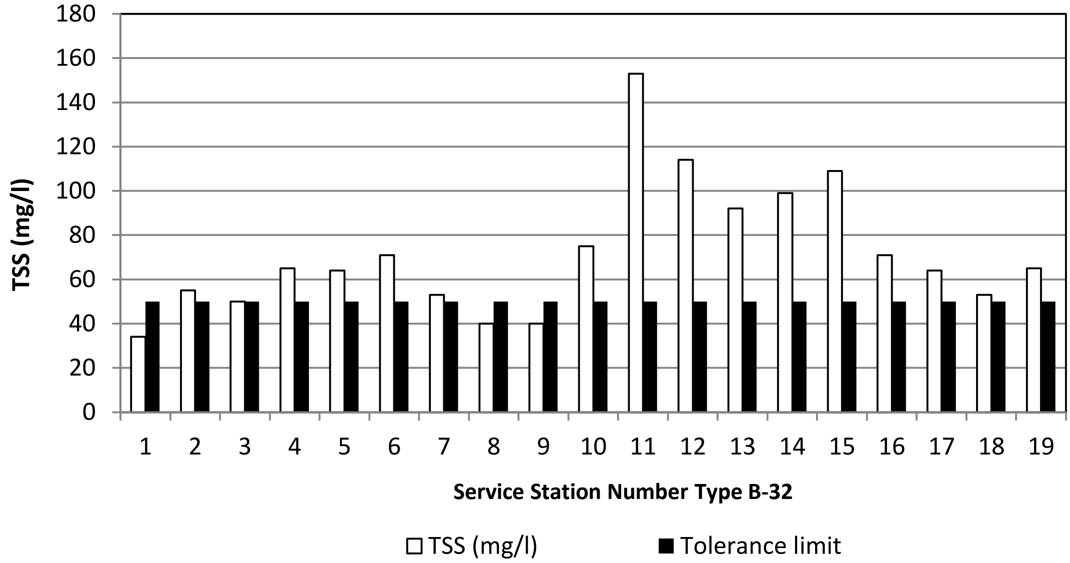


**Figure 2 Increases over the Tolerance Limit of TSS in Type B-32**

A prominent high percentage of Oil & Grease was seen from analytical reports of effluent samples when compared with the tolerance limit. It was about 200% increase over the limit of tolerance. Presence of oil spills at vehicle service stations is a common sight in Sri Lanka. During the survey it was observed that no suitable oil separation process was adopted in any of the service stations. Therefore it is necessary to draw much attention to the matter to restrict oil disposal to inland surface waters. Figures 3 & 4 show the difference of oil & Grease amount with the tolerance limit in vehicle service stations of Type A 70 and Type B32 Categories respectively.

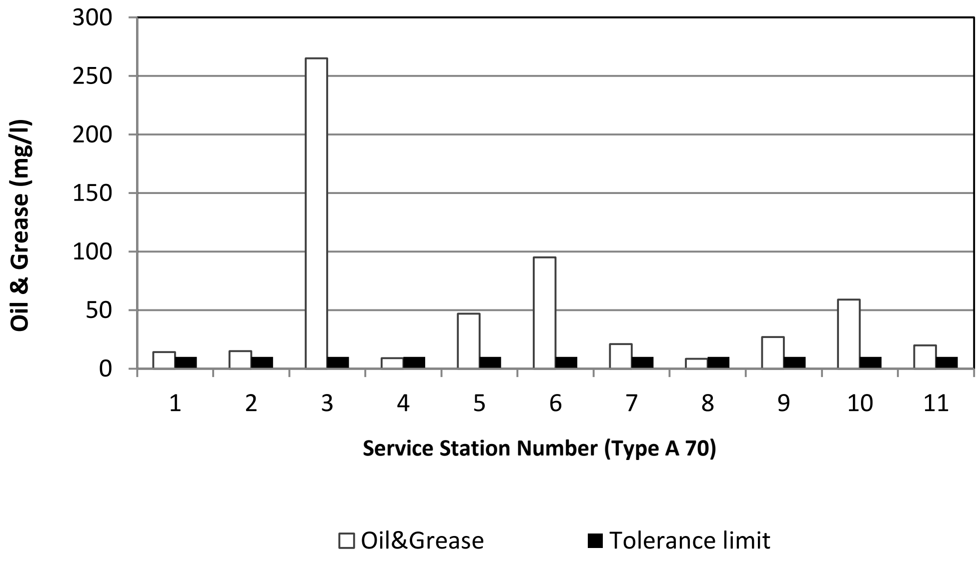


**Figure 3 Increases over the Tolerance Limit of Oil & Grease in Type A 70**

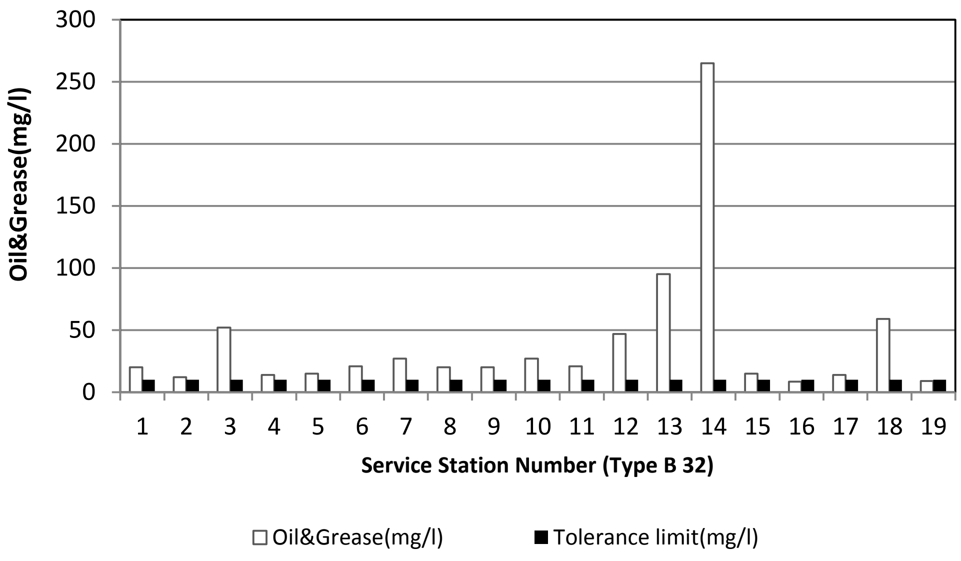


**Figure 4 Increases over the Tolerance Limit of Oil & Grease in Type B 32**

High values of BOD were observed from the analytical data from effluent samples of type A.70 service stations and it was as high as almost ten times the tolerance limit. Comparatively lesser values of BOD were shown from the effluents analysis in minor service stations (B 32). Figures 5 and 6 indicate the BOD differences compared with the tolerance limits in vehicle service station Type A 70 and Type B 32 categories respectively.

The analytical data from the effluent samples from type A 70 service stations as well as B32 indicated high values of COD. Figures 7 and 8 shows the difference of COD compared with the relevant tolerance limits in major and minor service station categories respectively.

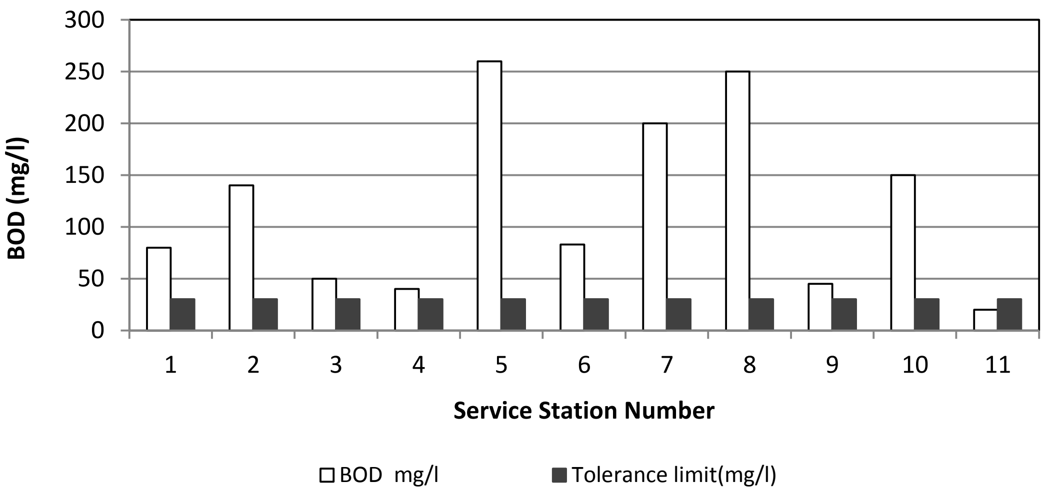


**Figure 5 Increases over the Tolerance Limit of BOD in Type A 70**

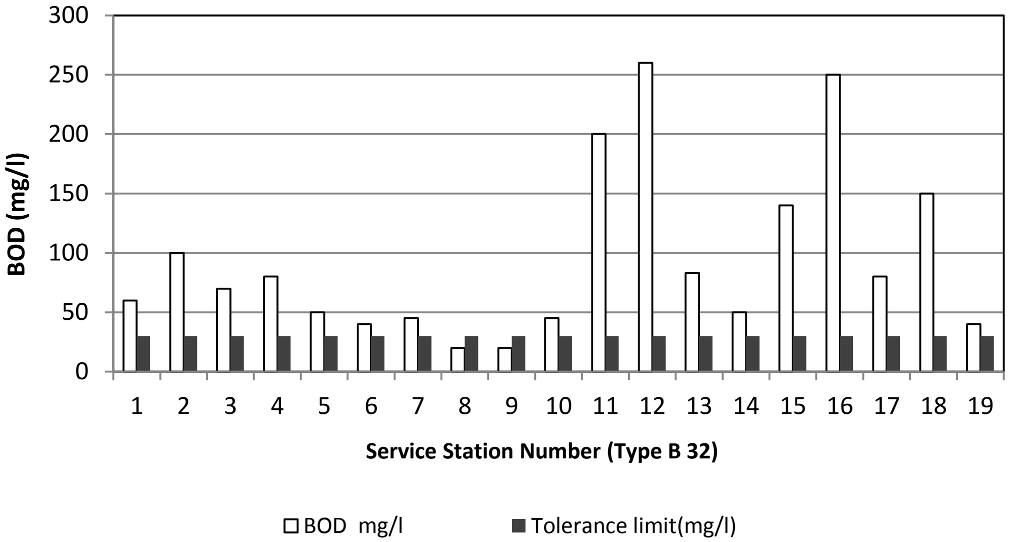


**Figure 6 Increases over the Tolerance Limit of BOD in Type B 32**

High percentages of contaminants were detected on analysing the wastewater samples from vehicle service stations. There were four such major pollutants. They were TSS, Oil &Grease, BOD and COD. Many methods have been developed to reduce BOD and COD. Therefore a suitable solution was selected from the reviewed literature survey to control the disposal of wastewater containing high amounts of TSS, Oil & Grease.

## 6.1 Necessity of an Appropriate Complete Oil Removal Device

On understanding the severity of the presence of oil in analytical samples, a need of a simple mechanism to get rid of the menace was highlighted. Hence designing and fabricating an oil separator capable of handling the situation was considered.

Thus an experimental set up to address the physical removal of oil and grease and TSS from wastewater was introduced.

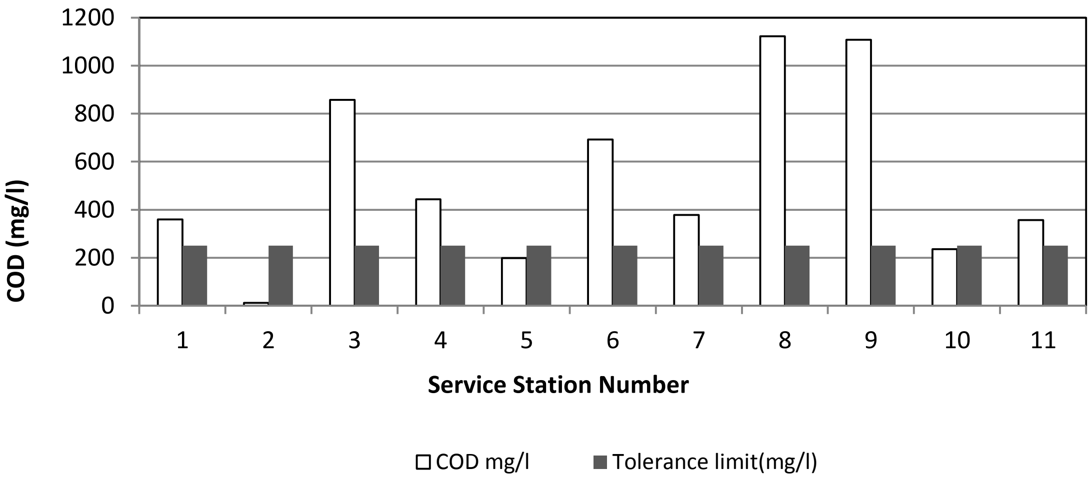


**Figure 7 Increases over the Tolerance Limit of COD in Type A 70**

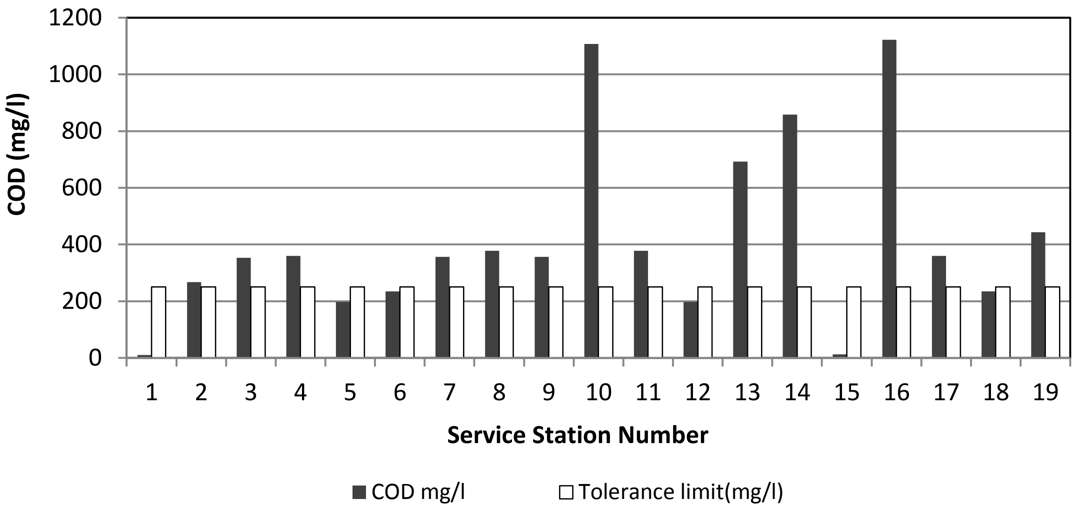


**Figure 8 Increases over the Tolerance Limit of COD in Type B- 32**

# 7 DESIGN OF AN OIL SEPARATOR

## 7.1 Oil/Water Separator-Theory of Design

The oil/water separators are devices that remove oil from wastewater by allowing the oil droplets to rise due to the hydraulic flow path of the separator, thereby extracting them from the wastewater flow.

In theory the flow through velocity (V) of a vessel is a function of the vessel size and flow rate (l/sec).The velocity is then compared to the rate of the rise of the oil droplet and the length of the vessel. If the resulting calculated trajectory (T) of a given droplet allows it to rise out of the effluent flow path to the surface before it reached the vessel's exit, it can be removed. This is purely an application of Stokes Law and terminal velocity to the rate of rise of a particle in a liquid medium.

The rise rate of oil droplets is also governed by Stokes Law. If the droplet size, specific gravity and viscosity of the continuous liquid are known, the rise rate can be calculated.

## 7.2 Operation of the Oil Separator

The main objective is to design and test a small scale oil separator to separate oil from wastewater. In general the effectiveness of an oil separator is increased by adopting slower flow rates into the separator and allowing a longer detention time. When wastewater enters the receiving chambers the velocity and turbulence of the fluid is reduced to allow the heavier solids to settle while the larger oil droplets to rise to the water surface. Further separation continues in the middle chamber where smaller droplets rise slowly to the surface joining the larger droplets. The resulting accumulated oil layer is then taken out by centrifugal action. The remaining wastewater is passed under the second baffle board to the outlet chamber where it is discharged to the secondary treatment system.

## 7.3 Operational and Flow Condition of Oil separator

A vehicle service station with three servicing bays was considered and assumed that the maximum work load took place when all the three servicing bays were in operation and the minimum work load took place when only one service bay was used.

An average raw water flow of 12000 liters per day was considered and the surface area of the proposed separator as 2m x 0.4m and thus the surface area of the separator is 0.8 m2 and the surface loading is 15000 $l/d/m^2$.

Average flow considered as 0.5 l/s by considering the 8hrs of a working day and the retention period of the tank is considered as 30 minutes if one bay is in operation. If one bay is at work then the volume required for average flow is 0.9 $m^3$.

When all three bays are at work the volume required for peak flow and therefore required separator must have a minimum volume of 1.35 $m^3$.

The design of the separator is subjected to the following constraints

Horizontal velocity (vh ) through the separator should be less than or equal to 1.5 cm/s (0.015 m/s) or equal to 15 times the rate of the oil globule (vt), whichever is smaller. (American Petroleum Institute design guide)

$(v_t) = 0.0123(s_w - s_o)/\eta$ (Stokes equation)

$s_w$ =Specific gravity of waste water

$s_o$ =Specific gravity of oil

$\eta$ = Kinematic viscosity of waste water at design temperature ($v_t$) = 0.108

Based on the design calculation, it is estimated that the separator dimensions are: D = 0.6 m, W=1.25 m and L = 1.8 m.

## 7.4 Fabrication of the Oil Separator

An experimental oil separator having a capacity of 90 litres was turned out with G.I plain sheets having a length about three times the width and the depth was kept at one meter maximum. Inlet pipe was fixed at depth of about 150mm from the bottom of the separator fixed with a 900 bend so that the inlet flow will not support horizontal flow of fluid thus minimizing the turbulence of the oil layers at the surface. Mild steel Grating was turned out and fixed at a 450 angle to the vertical behind the inlet pipe to arrest grits etc. Vertical mild steel rods having 12mm diameter was fixed at 100mm intervals across the separator to increase the separation of oil from water. Two adjustable baffle boards were fixed following the vertical rods. These baffle boards were turned out of 3mm thick G.I plates and allowed to move freely up down through the groove, slides on either sides across the separator. Slots having diameter of 6mm drilled in the grove and was provided with a 6 mm pin so as to adjust the baffle board suitably. Similar type of a baffle board was fixed at the outlet position. They control the inlet of effluent and the out let of separated oil and water. The dust particles settled at the bottom of the separator was allowed to get collected to a small ditch to which a wash out was fixed to takeout the sludge when necessary. The collected oil at the rear baffle board was taken out using a centrifugal mechanism. A perforated PVC pipe was fixed to a 16mm mild steel rod coaxially with a handle. The perforations were done only on the top side of the PVC pipe so that the oil entered the pipe through the perforations was force by the centrifugal action to lead out of the separator. By turning the handle the oil flow can be accelerated. The water at the bottom layers pass under the baffle board through the outlet and enter the secondary treatment system. Details are shown in figure 9 and fabricated oil separator is shown in figure 10.

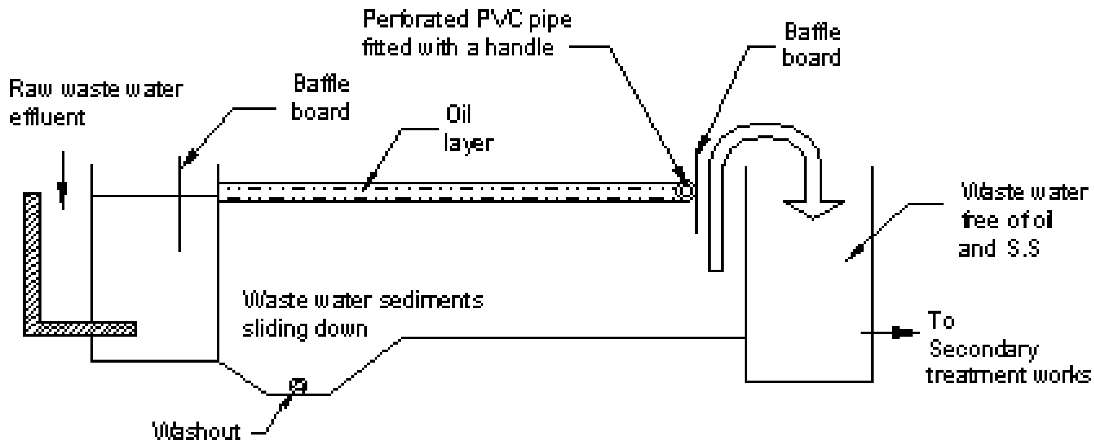


**Figure 9 Longitudinal Section of Oil Separator**

In designing the separator the inlet horizontal velocity of the incoming effluent was kept below 1.5 cm/s so as not to disturb the oil globules collected at the surface. The flow of effluent to the separator was controlled by the necessary adjustment to baffle board fixed near the inlet pipe. The depth of separator was kept at one meter and the length to width ratio kept at 3:1.

## 7.5 Proposed Oil Separator as an Economical Treatment Method

Separating oil by skimming is not an effective process as it does not separate oil completely.

Difficulty in removing sludge collected at the bottom of the chamber. Advantages of using the proposed oil separator

The proposed oil separator is portable and occupies less space. Free oil could be separated completely from wastewater effluent. Sludge that is collected at the bottom of the separator could be taken out from the washout. The effluent free of oil and sediments eases the work on secondary treatment system and thus a simple aeration method could be adopted using the existing compressed air at the vehicle service station.

The proposed method also suggests removing used oil from vehicles in an isolated location or in a bay that uses only for oil changing without allowing the oil to be disposed into effluent collecting tanks. The removed oil then could be taken into containers and carefully stacked in store. The used oil thus collected could be sold to those who need used oil for various purposes.


**Figure 10 Fabricated Oil Separator**

The oil spills that remain along with wastewater could be separated using the oil separator so that no oil is disposed along with wastewater to the secondary treatment system. The TSS present in the effluent could also be removed from the washout of the separator. The method also suggests minimizing the use of detergents and discourages mixing oil with detergents.

The proposed oil separator helps to reduce the load on the secondary treatment works by completely removing oil and the sediments. Separating detergents from oil and allowing oil and sediment free effluent into the secondary treatment system reduces the cost for using powerful aerators and pumping equipment to pump wastewater to elevated tanks.

Thus the method proposed is an economical method compared with the existing treatment system used in many of the vehicle service stations throughout Sri Lanka.

## 7.6 Testing of the Device

The pollutants of waste water effluents could be controlled by introducing suitable methods of treatment. However the proposed methods should be affordable to the owners of small scale service stations too. Thus an oil separator was designed and fabricated on an experimental basis to remove free oil completely from wastewater in vehicle service stations. The fabricated oil separator was tested for oil separation. The analytical data of effluent after passing through the oil separator is given in Table 6.

**Table 6 Lab Test results of TSS and Oil before and after passing Oil Separator**

| Parameter | Raw value (mg/l) | Value After passing through oil separator | CEA Tolerance Limit (mg/l ) |
|---|---|---|---|
| Oil& grease | 164.6 ± 4.6 | 0 | 10 |
| TSS | 338.2 ± 5.1 | 53 ± 4.3 | 50 |

Oil and grease were tested in a laboratory according to the Standard methods for the examination of water and wastewater (APHA, 2005).

## 8 CONCLUSIONS AND RECOMMENDATIONS

Analytical data very clearly indicated that almost all the vehicle service stations dispose oil along with wastewater effluents. The negligence and the ignorance of the service station management had resulted in such a menace. Most of the service station owners were not aware of the dangers of disposing oil to the environment freely. Had they realized that having such simple mechanisms of arresting oil wastewater could be dispersed with minimum harm to environment, they would have definitely adopted same.

Following recommendations are made to safeguard surface waterways as well as to have a clean environment around vehicle service stations in Sri Lanka.

- CEA should approve the location of vehicle service stations along with Pradeshiya Saba so as to avoid public protests regarding residential area, sensitive issues such as polluting water resources.
- The vehicle service station owners and the workers attached to those stations should be educated of the consequences of oil seeping to surface waterways by distributing leaflets or having short seminars at site or a group meeting at one site for an hour at least. This can be arranged through regional offices of the CEA. The important points to discus at the seminar may include:
    - The importance of preparation prior to the service and impart them what pre-treatment is all about and introduce an innovative oil separator capable of arresting TSS as well as completely removing oil from wastewater.
    - The use of detergents - wash water mixed with detergents and soap should not allow to be disposed to oil collecting chambers.
    - Introduce management practices such as how to maintain the service station and preventing oil spills and cleaning floor wherever oil spread as it happens. Good operating practices and habit changes to care for the environment.
    - Vehicle tires to be clean first at a separate bay along with cleaning the under carriage for dust particles and wash water thus collected be directed to a separate chamber.
    - Oil changing to be done at a specific bay and the oil thus removed are collected to oil collecting chamber with no other wash water or wastewater in it.
    - The used oil filters and other used materials that contaminated with oil need to be stacked in specific collecting bins and disposed suitably.
    - Only wastewater without having suspended solids and oil may be allowed to be disposed to secondary treatment system.

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