



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**PERFORMANCE ANALYSIS OF OIL SKIMMER FOR GREASE  
TRAP SYSTEM TO SHORTEN THE RETENTION TIME**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

by

**NURUL SHAFIQAH BINTI OMAR**

**B071410072**

**920325105890**

FACULTY OF ENGINEERING TECHNOLOGY

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

**TAJUK: PERFORMANCE ANALYSIS OF OIL SKIMMER FOR GREASE TRAP SYSTEM TO SHORTEN THE RETENTION TIME**

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## **APPROVAL**

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

.....

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## ABSTRAK

*Peningkatan pencemaran air sisa dan sebahagian besar penyumbatan air kumbahan menyebabkan penyekatan yang terhasil daripada lemak, minyak dan gris. Bilangan pepejal yang didepositkan dalam pembentungan akan meningkat dan menyebabkan peningkatan pepejal ke aliran air buangan domestik. Versi automatik perangkap gris yang berkesan akan mengurangkan masalah ini dan mengelakkan kontaminan lemak, minyak dan gris dalam sistem pembetung. Pengemulsi juga menjadi masalah kerana apabila terdapat kesan pengemulsi, proses pemisahan akan lebih perlahan dan masa pengekalan akan lebih lama. Kecekapan rendah kaedah penyingkiran yang direka untuk tangki penyingkiran dan perangkap gris dalam loji rawatan adalah kelemahan utama teknik konvensional yang digunakan untuk mengeluarkan lemak, minyak dan gris. Penyelidikan mengenai sifat minyak, lemak, menjadi inspirasi objektif yang merancang konsep skimmer untuk tujuan perangkap minyak yang aktif dan untuk membangunkan prototaip skimmer minyak untuk perangkap gris. Di samping itu, projek ini menganalisis prestasi skimmer dengan korelasi kepada masa pengekalan. Empat jenis bahan untuk menganalisis skimmer, iaitu polipropilena, polietilena, aluminium, dan besi. Bahan ini dipilih dengan menggunakan metodologi perancangan projek menggunakan House of Quality, carta Morfologi dan kaedah Pugh dan sifat bahan yang sesuai. Perangkap gris aktif yang direka bentuk dengan empat jenis bahan untuk skimmer telah dibuat dan dianalisis. Dari analisis, hasilnya menunjukkan prestasi terbaik bahan skimmer yang digunakan untuk memerangkap minyak adalah polytherafluoroethylene, yang dikenali melalui masa yang singkat untuk mengumpul minyak. Projek ini telah menyediakan hasil yang lebih baik untuk memendekkan masa untuk memerangkap lemak, minyak dan gris sebagai keberkesanan prestasi bahan skimmer minyak dalam sistem perangkap gris*

## **ABSTRACT**

The increasing of wastewater pollution and the most of the sewage water blockage caused blocking resulting from the presence of fat, oil, and grease (FOG). Numbers of solids deposited in sewers would increase as introducing of additional solids to the domestic wastewater stream. An effective automated version of grease trap will reduce this problem and avoid the FOG contaminant in the sewer system. The emulsifier is also a problem because when there is an emulsifier effect in the FOG, separation process will be slower and retention time will be longer. Low efficiency of removal methods designed for skimming tank and grease trap in treatment plants is the main disadvantage of conventional techniques used to remove FOG. The research on the nature of oil, fat, was leading as the inspiration of the objective which, designing the concept of the skimmer for an active grease trap purpose and to develop the prototype of oil skimmer for the grease trap. In addition, the project analyzes the skimmer performance with correlation to retention time. Four types of material were analyzed for the skimmer, which are polypropylene, polytetrafluoroethylene, aluminum, and iron. The material was selected by using the methodology of designing the project which by House of Quality, Morphological chart and Pugh method with the material properties. An active grease trap with designed of four type materials for the skimmer was fabricated and analysis was conducted. From the analysis, the result showed the best performance of skimmer material used for skimming the oil were polytetrafluoroethylene, which identified by the shorten time taken to skimming the oil. This project provided a better result in order to shorten the retention time as effectiveness performance of the oil skimmer material in grease trap system.

## **DEDICATION**

To my supervisor, my beloved parents, family and friends.

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I wish to thank God for giving me the opportunity to start on my Bachelor Degree and for completing this challenging journey successfully. My gratitude and thanks go to my supervisor, sir Mohamed Saiful Firdaus bin Hussin the support and guidance throughout the journey and the completion of this project.

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## **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE**

FOG	-	Fat, oil and grease
HOQ	-	House of quality
GTW	-	Grease trap waste
PTFE	-	Polytetrafluoroethylene
CA	-	Contact angle
PDS	-	Product design specification
CAD	-	Computer aided design
CATIA	-	Computer aided three dimensional interactive application

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

A fast development of a variety restaurants will influence a bad environment by the productivity of wastewater. Untreated restaurant wastewater and direct flow of food waste through the sewer pipe will cause environmental pollution. Besides it blockage in the presence of fats, oil, and grease by the increment of drainage capacity limit. The discharged of (FOG) directly into public sewers may causes an inefficient healthy community sewers performance and delayed the delivery capacity in a sewer, clogging in drain pipes also can be influenced, and producing a hard particles deposits due to chemical (reaction) and physical (aggregation) processes (Long et al., 2012) and unpleasant odours and corrosion of sewer lines due to anaerobic reactions.

FOG be able to be determined in three diverse forms, solids (fats), liquids (oils) and liquid-solid (grease) at room temperature conditions, the major purposes of grease trap is to trap and separated the FOG from water and collect the FOG for an appropriated disposal. This is because of the present of fat, oil, and grease in the sewer system or drainage not just influence the execution of the sewer system and wastewater treatment works yet, it may reduce asset life and increment maintenance costs. Moreover, FOG related blockages can bring out sewer floods and burst sewer pipes.



Oil trap or oil interceptors have been utilized since Victorian period (1837) and it is a pipe component proposed to skim or trap FOG before they enter a wastewater pipes system. Grease trap waste (GTW) from a grease trap often installed inside the food service premises has become a significant stream of organic waste in municipal areas. The direct drainage into the collection of sewer system is also illegal in most municipalities because it can contribute accumulate on pipe walls, and potentially form hardened deposits through a physical aggregation or a chemical reaction process (He et al., 2011).

The conventional techniques found by abstract oil and grease utilizing skimming tanks and oil and grease traps in treatment plants but the main disadvantage of these methods is their low efficiency of abstraction. Altogether sort of grease trap regularly uses the similar physics where densities show a vibrant character where the grease is lighter than water and drive rise to the upper once the mixture is allowable to settle for some time (also called retention time) (Nidzamuddin et al., 2015). However, a grease trap which designed to hold the grease within its separation chamber/compartment constantly reducing its working volume and hence its ability to allow separation required retention time will reduce (Aziz, 2010). This will decrease the productivity of the oil and more FOG will go through the oil trap then flow into the waste water sewer pipes system.

Grease Trap system used to separate water and FOG from wastewater produced from domestic, commercial and industrial waste water. By trapping the FOG using an automated active trapping system can easily separating FOG from the water. Typically, automated grease trap has hydrostatic pressure, skimmer device or automatic draw-off system to remove or suck the FOG. The reason for separating all these FOG is to avoid and reduce blockage and sewer overflows also improve both the environment and the efficiency of waste water treatment. Basically in waste water, on top layer contains floatable deposits (primarily FOG), the middle aqueous layer tends to be rich in organic matter and the bottom layer is generally a sludge consisting of food particles and other solids (Suto et al., 2006). Here are three kinds of well-known grease trap as recognized as weir type, bioremediation and automated grease type that is grouped into two clusters, passive and active of the grease trap. The passive grease is comparatively inexpensive in fabrication rate and simple in assembly and conception nevertheless this kind of grease

trap has slower period to progression then it frequently be influenced by the gravitational act to work and an active grease trap has littler progression to trap the FOG and fitted out with convinced tools that implicate the procedure of external power source (Nidzamuddin et al., 2015). The concept developed for this device is innovated from analysing various passive grease traps. The passive grease trap is relatively cheaper in production cost and simpler in construction and concept. Unfortunately, it has a longer time to process since it usually depends on the gravitational law to operate (Middleton et al., 1995). On the other hand, an active grease trap is more often than not is equipped with certain mechanisms that require the usage of the external alternating current power source. The mechanisms are usually employed to separate the FOG from the wastewater, and such examples are gravity, microorganism, heater, and skimmer or pump (Batten et al., 2009).

## **1.2 Problem Statement**

Recent change in waste water pollution increase and the most of the sewage water blockage caused blocking resulting from the present of FOG. FOG comes from cooking oil, animal fats, and cools and solidifies at normal temperatures in pipes and blockages can form in the sewer pipes, eventually causing backups in the collection system. A spillage of big oil accidents into water cause a huge impact to the environment. Apart of this, sometimes in the use of oil industries and oil products getting spillage through caused by the results of chronic and careless habits (Patel, 2015).

These scenarios of blockage happen usually on peak hours and festive season when wastewater from the restaurant sink of washing process coming rapidly and consistently into the sink outlet. Besides, a form of blockages in sewer pipes as appeared in Figure 1 below, depicted a high thickness fats solidify when cooled, and combined with other solids waste (Shaifuddin, 2014). Numbers of solids deposited in sewers would increase as introducing of additional solids to the domestic wastewater stream. The overflow of waste water will produce excessive discharges of oil and grease to sewer systems, and the

problems may not just occur with the clogging of sewers but also the pumping plants and the interference of biological treatment processes. An effective automated version of grease trap will reduce this problem and avoid the FOG contaminant in the sewer system. In addition, the emulsifier is also a problem because when there is an emulsifier effect in the FOG, separation process will be slower and retention time will be longer (Aziz, 2010). Low efficiency of removal methods designed for skimming tank and grease trap in treatment plants is the main disadvantage of conventional techniques used to remove FOG.



Figure 1.1 the formation of solid waste

The clogging of sewer system caused by the remaining FOG needs to be clean and sometimes replaces because these may lead the increasing of maintenance and inspection cost.

Thus, it is important to design a smart and effective oil skimmer for grease trap system to skim and collect the oil for reused purposes, so that it can decrease the pollution and save the environment. Wide various type of oil skimmers are getting used to separate the mixed oil from the water in industries but typically the skimmers which were used are less effective because of the several factors such as skimmer's material and the shape

and design of the skimmer. Consequently, there is a need to abbreviate the retention time by developing a best material oil skimmer.

### **1.3 Objectives**

The objectives of this study are:

1. To design the concept of oil skimmer for grease trap
2. To develop prototype of oil skimmer for grease trap
3. To analyze the skimmer performance with correlation to retention time

### **1.4 Scope**

Based on the problem statements discussed above, this research project will be a focus on the design materials and shape and will achieve the following goal of design concept in the active grease trap system. From the design concept and material selection of the skimmer will be fabricate as a prototype design of the grease trap system. The available literature about using of material and analyzed the oils skimmer performance and the correlation of retention time. Data collected in this project would provide a better result in order to shorten the retention time as effectiveness performance of the oil skimmer material.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Grease trap**

Grease trap or called oil interceptor, oil recuperation gadget and oil converter is a pipes gadget intended to capture most oils and solids before they enter a wastewater transfer disposal system. Normal wastewater contains little measures of oils which go into septic tanks and treatment offices to frame a floating scum layer. This scum layer is very slowly digested and produced by microorganisms in the anaerobic digestion process. A lot of oil from nourishment planning amounts of oil from food preparation in restaurants can form a severe flood on a septic tank or treatment facility, causing the release of untreated sewage into the environment. High-thickness fats and cooking oil such as fat set when cooled, and can combine with other disposed solids to clog drain pipes.

Oil traps have been utilized to diminish the measure of fats, oils, and oils (FOGs) that enter sewers. Usually boxes inside within the drain run that flows between the sinks in a kitchen sewer network. This trap can be situated over the ground, below ground, inside the kitchen or outside the building.



Figure 2.1 the example of grease trap under the sink

## 2.2 Type of grease trap

### 2.2.1 Passive Grease Trap

A passive grease trap is the pipe assembly containing a decomposition of waste. Fats, oils, and grease (FOG) is lighter than water and floats on the top surface of the water in the tank. A passive grease trap is often built on the ground outside a kitchen or under the sink. It usually made up of two or three sections of separation part and is filled with cold water.

The fats and oils in the water solidify and float because they are lighter than water. Any solid material enters into the grease trap sinks to the bottom, forming a deposit of sludge. The sections, called chambers, are separated by a barrier. This increases the amount of separation of the grease by dropping movement of liquid in the chambers. The amount of grease and oil change from the first chamber to the last it is decreasing and allowing more and more grease to separate. Inspection points on the outside of both sides of the grease trap allow sampling to measure how well it the FOG collected. Tight fitting cover avoids rainwater from getting into the grease trap. Raising the top of the grease trap above the surrounding ground or putting a raised lip around it also prevents rainwater from getting in. Passive Grease Traps are usually referred to trap isolated oil and

grease naturally by the gravitational trap. The oil trap innovation process of mixed water with FOG from inlet from sink flowing through divider section and FOG isolate itself from the water.

### **2.2.2 Active grease trap (remediation)**

An Active Grease Traps is an installed metal or plastic tank that is used in the food service offices to overcome the fat, oil and grease from entering sewer septic sterile or framework. Bioremediation grease trap is a use of a trap to deactivate microorganisms and digest fat trapped and converting it to soluble liquid, the liquid biodegradable safe to be drained into the sewage system. Grease trap is also accompanied by a full bioreactor with the enzyme such as *Candida rugosa* and *Pseudomonas cepacian* (Oya, 2007), (Ozama, 1999). Furthermore, the grease trap compartment and bioremediation require the addition of approximately (2-5 hours) to the digestive process occurs. In other words the bioremediation automatically and continuously pre-activates, grows and optimizes the physiological condition and digest grease and sludge to reduce causes of noxious/toxic odors, prior to injection into the wastewater.

### **2.2.3 Active grease trap (automatic device)**

An active grease trap for the automatic device is the automatic version grease traps. Usually, automatic grease trap has a hydrostatic pressure, skimmer device or system to automatically isolate the FOG and eliminate or suck it. In some, there is also temperature-controlled grease traps where oil is trapped and turned into oil heated fluid then becomes pumped out into a separate tank (Holloway, 1995). This type of grease trap is usually smaller than the others because it does not need larger plots since entering the grease trap is usually a processed upon

arrival. In another word, this type of grease trap used (grease recovery devices) to removes the grease automatically when trapped.

Passive grease trap (compartment)	Active grease trap (Bioremediation)	Active grease trap (automated)
<ul style="list-style-type: none"><li>• Builded in two or more compartments and close to the FOG source.</li></ul>	<ul style="list-style-type: none"><li>• Utilizes microorganism.</li><li>• Require an extra compartment and time.</li></ul>	<ul style="list-style-type: none"><li>• Mechanism used to trap or suck the FOG powered by external supplies.</li></ul>

Figure 2.2 Types of Grease trap

### 2.3 Wastewater Characterization

Human activity of production waste is unavoidable and part of this waste will end up significantly as a wastewater. Wastewater quantity and quality can be determined by many factors. The producing amount of waste for all human and industries are not the same, this amount and type of wastewater usually influence the behavior, lifestyle, and standard of living of the inhabitants by people surrounded (Henze et al., 2008). In restaurant and households, mostly produce by solid and liquid waste and it can be possible to change the amount of the waste quantity. There's no exception for industry to produce a large amount of wastewater.

#### 2.3.1 FOG in wastewater

Wastewater produced from in commercial food service facilities are different with residential wastewater and it will increase the volume during busy