



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN OF WATER FILTER SYSTEM CONTAINING RICE
HUSK AND KAPOK FIBER FOR RIVER TRASH COLLECTOR
SYSTEM**

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

by

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FACULTY OF ENGINEERING TECHNOLOGY

2017

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

**TAJUK: DESIGN OF WATER FILTER SYSTEM CONTAINING RICE HUSK AND
KAPOK FIBER FOR RIVER TRASH COLLECTOR SYSTEM**

SESI PENGAJIAN: **2017/2018 Semester 1**

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APPROVAL

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

Dr. Abdul Munir Hidayat Syah Lubis

(Project Supervisor)

ABSTRAK

Pencemaran adalah kebimbangan alam sekitar global yang paling serius pada hari ini. Bahan cemar air di Malaysia sering merangkumi masalah yang berkaitan dengan pengurusan sisa yang tidak mencukupi. Ia bukan sahaja isu-isu alam sekitar tetapi juga kerugian ekonomi jika terdapat apa-apa tumpahan atau pengestrakan yang tidak cekap. Oleh kerana banyak ketoksikan sebatian dalam minyak, ia boleh menyebabkan masalah alam sekitar yang utama kepada organisma akuatik, burung, dan manusia. Di Sungai Melaka, jika hujan berlaku, air di Sungai Melaka akan meningkat dan semua sampah akan terapung di sungai. Oleh itu, River Trash Collector System (RTCS) telah direka dan dibangunkan untuk menangani masalah ini. Penapis diperlukan untuk dipasang pada akhir RTCS sebelum aliran air ke sungai untuk menapis air supaya minyak tercemar, zarah dibubarkan, zarah serta air bau dapat dikurangkan. Oleh itu dalam kajian ini tertakluk kepada (i) sistem penapisan minyak reka bentuk untuk River Trash Collector System (RTCS), (ii) mengarang sistem penapisan minyak untuk River Trash Collector System (RTCS) dan (iii) menganalisis kualiti air yang ditapis. Beberapa konsep penapis dibangunkan dan konsep terbaik dipilih dan direka menggunakan Catia V5. Terdapat 3 bahagian penapis iaitu bahagian atas, tengah dan bahagian bawah. Penapis akan dimasukkan ke dalam paip PVC. Bahan-bahan sorben semulajadi seperti abu sekam padi dan kekabu digunakan sebagai bahan penapis dan dipasang ke dalam penapis yang direka dalam beberapa lapisan. Susunan lapisan adalah kekabu kemudian abu sekam padi dan berakhir dengan kekabu. Terdapat 2 kategori sampel air iaitu: (i) air sungai, (ii) campuran air - minyak. Sampel air diambil dari Pokok Bakau Taman Rempah, The Pines Hotel, Kg Morten, Pokok Bakau Kg Morten, dan Jambatan The Shore. Empat parameter dianalisis iaitu jumlah pepejal, suhu, nilai pH dan kadar penapis yang dibubarkan. Hasil purata sebelum dan selepas penapisan adalah 299ppm dan 171ppm untuk TDS, 7.0 dan 7.5 untuk nilai pH, dan 0.421ml / s untuk kadar penapis. Sebagai kesimpulan, penapis air boleh menapis air dan meningkatkan kualiti air dan mengurangkan pencemaran minyak.

ABSTRACT

Pollution is the most serious global environmental concerns these days. Water pollutants in Malaysia often cover problems associated with insufficient waste management. It is not only environmental issues but also an economic loss if there are any spillage or inefficient extraction implies. Due to the toxicity of many compounds in oil, its can cause major environmental problems to aquatic organisms, birds, and humans. In Sungai Melaka, if rain occur, the water in Sungai Melaka will increasing and all the rubbish will floating in the river. Thus a river trash collector system (RTCS) was designed and developed to handle this problem. A filter is needed to be installed at the end of the RTCS before water flow to the river to filter the water so oil contaminant, particles dissolved, particles as well as odour water can be reduced. Therefore in this study is subjected to (i) design oil filtration system for River Trash Collector System (RTCS), (ii) fabricate oil filtration system for River Trash Collector System (RTCS) and (iii) analyse quality of filtered water. Several strainer concept were develop and the best concept was selected and designed using Catia V5. There were 3 parts of strainer which are top, middle and bottom part. A strainer was put in the PVC pipe. Natural sorbent materials such as rice husk ash and kapok fiber were used as filter material and installed into the designed strainer in several layers. The arrangement of layers were kapok fiber then rice husk ash and end with kapok fiber. There were 2 categories of water sample which are: (i) river water, (ii) oil – water mixture. The water sample were taken from Pokok Bakau Taman Rempah, The Pines Hotel, Kg Morten, Pokok Bakau Kg Morten, and Jambatan The Shore. Four parameter were analysed which were total dissolved solid, temperature, pH value and filter rate. The average results before and after filtering were 299ppm and 171ppm for TDS, 7.0 and 7.5 for pH value, and 0.421ml/s for filter rate. As conclusion, the water filter can filtered the water and improve the water quality and reduce oil contaminant.

DEDICATION

To my beloved parents

Abdul Latef Bin Hashim

Fazilah Binti Ibrahim

Thank you for all supports, sacrifices, patient and willing to spend your time for me.

To my honoured supervisor and co supervisor,

Dr. Abdul Munir Hidayat Syah Lubis, Encik Mohd Idain Fahmy bin Rosley and all
UTeM lecturers

Thank you for always show me the guidance and persistence in helping to complete
this project thesis.

ACKNOWLEDGEMENT

I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to my supervisor, Dr. Abdul Munir Hidayat Syah Lubis of Faculty of Engineering Technology at University Technical Malaysia Melaka, whose contribution in stimulating suggestions and encouragement, helped me to coordinate my project especially in writing this report. I could not have imagined having a better advisor and mentor for my Bachelor study's final year project.

Furthermore I would also like to acknowledge with much appreciation the crucial role of the rest my thesis committee: Encik Mohd Idain Fahmy bin Rosley for his encouragement and support for me to finish my Bachelor study's final year project.

A special thanks goes to my friends: Haziq, Asyraaf, Abi, Munawir, Taufiq, Faiz and Muhammad that give their suggestion and comment for me to improve my thesis. I am gratefully indebted to their valuable comments on this thesis.

I have to appreciate the guidance given by other supervisor as well as the panels especially in our project presentation that has improved our presentation skills thanks to their comment and advices.

Finally, I express my very profound gratitude to my parents: Abdul Latef bin Hashim and Fazilah binti Ibrahim, for giving birth to me at the first place and providing me with unfailing support and continuous encouragement throughout my years of study and through the process of designing the product and writing the thesis. The accomplishment would not have been possible without them.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

BOD	-	Biochemical Oxygen Demand
NH ₃ -N	-	Ammoniacal Nitrogen
SS	-	Suspended Solids
UNESCO	-	United Nations Educational, Scientific And Cultural Organization
km ²	-	Square Kilometer
CAP	-	Consumers Association Of Penang
RTCS	-	River Trash Collector System
TOC	-	Total Organic Carbon
%	-	Percent
API	-	American Petroleum Institute
mm	-	Milimeter
\$/m ³	-	Dollar Per Cubic Meter
B.C	-	Before Century
RO	-	Reverse Osmosis
UF	-	Ultra-Filtration
UV	-	Ultra-Violet
Purolator	-	Pure Oil Later
OEM	-	Original Equipment Manufacturer
CEC	-	Cation Exchange Capacity
QACs	-	Quaternary Ammonium Compounds
m ² /g	-	Gram Square Meter
SiO ₂	-	Silicon Dioxide
CO ₂	-	Carbon Dioxide

ml/min	-	Milliliters Per Minute
°C	-	Degree Celcius
RHA	-	Rice Husk Ash
K ₂ O	-	Potassium Oxide
CaO	-	Calcium Oxide
P ₂ O ₅	-	Diphosphorus Pentoxide
PVC	-	Polyvinyl Chloride
cm	-	Centimeter
ml	-	Milliliters
TDS	-	Total Dissolved Solid
ppm	-	Parts Per Million
s	-	second
ml/s	-	Milliliters Per Second
CAD	-	Computer Aided Design

CHAPTER 1

INTRODUCTION

1.1 Introduction

Oil pollution is the most serious global environmental concerns these days. In industries, oil is the main global sources of energy and raw material. It is not only environmental issues but also an economic loss if there are any spillage or inefficient extraction implies (Dong, Cao, & Xu, 2017). One of the largest offshore oil spill in US history was Deepwater Horizon (BP) oil spill that occur in the Gulf of Mexico in April 2010. US government and public urges the parties involves in problem regarding oil spill to search for effective oil spill management and remediation strategies (Ali *et al.*, 2012).

Water pollutants in Malaysia often cover problems associated with insufficient waste management. The federal and government are in their research about how to handle wastes that will not exceed their budget and not leave an impact to the public's health (Hamid *et al.*, 2010). The main pollutants in Malaysian's rivers and lakes are Biochemical Oxygen Demand (BOD), Ammoniacal Nitrogen (NH₃-N) and Suspended Solids (SS). A largest source for high BOD is from untreated or partially treated sewage from manufacturing and agro-based industries. Domestic sewage, livestock farming and other liquid organic waste products is the main sources of NH₃-N, while the sources for SS are mostly earthworks and land clearing activities which the removal is generally achieved through the use of sedimentation and/or water filters (Huang *et al.*, 2015). Current State of Water Environment in Malaysia, from 146 river basin monitored, 80 were considered clean, 59 slightly polluted and 7 polluted. This is an improvement from the year 2005, when 80 river basins were clean, 51 slightly

polluted and 15 polluted. The seven rivers that are polluted were located in the industrial zone which is Pinang and Juru River in Penang; Buloh in Selangor while Danga, Tebrau, Segget and Pasir Gudang in Johor (Khalit, 2015).

Melaka is famous due to its history that existed and becoming the starting point of the center of government and be recognized by UNESCO World Heritage Site at 7 July, 2008. Therefore, Melaka being famous and attract many tourist from worldwide and increase tourism activities because it can generate economic revenue. However, the government feel that tourism alone is not enough and desperately increase the development that led to extremely exploitative land use. During this rapid development, without knowing it, the environment becomes affected, which also causes water sources to be harmed. The environment being destroyed because of increasing of development and job creation (Hua & Marsuki, 2014).

Nowadays, several technologies were suggested for oily wastewater treatment such as absorption, filtration, membrane technology and physical, mechanical, biological and photochemical method. Absorption or filtration using porous sorbents is the most normally way to use (Dong *et al.*, 2017). Generally, to remove oil spills, the cost-effective sorbents are normally used. These sorbents either inorganic mineral, organic synthetic or organic vegetable products (Ali *et al.*, 2012). A few reviews recommend that extensive spills are first taken care of by attempting to limit the scattering of the oil with booms, followed by gathering of the oil with skimmers. The rest of the oil which washes onto shores is mechanically gathered either by suction or shovels. Sorbents are regularly applied for small-scale spills (Bazargan, Tan, Hui, & McKay, 2014).

From environmental engineering perspective, natural sorbent materials are the most efficient because of the possibility of sorbent collection, complete oil removal from the spill site, easy disposal with low environmental hazard, more economical the most synthetic sorbents, and possible co-application with other method such as the use of microbial consortium for oil spill remediation. One of the natural sorbent materials that can be use as sorbents materials is kapok fiber (Abdullah, Rahmah, & Man, 2010). Another natural sorbent materials is rice husk. By changing rice husk into petroleum

adsorbents, it can take care two environmental problems that are usage of a farming waste and remediation of contaminated aquatic situations (Kenes *et al.*, 2012).

1.2 Problem Statement

Nowadays, environmental pollutant including air, soil, and water has become one global environmental issues because of its major impact on public health. During last 30 years, one of the most serious global environmental issues is oil pollution that exists in different forms and is generated by many causes. The major causes of oil spillage or oil pollution in ocean and other waterways commonly occur during the production, transportation, refining, storage of crude oil (Kenes *et al.*, 2012), accidental spills from tankers, and oil drilling accidents (Kudaibergenov *et al.*, 2013). Due to the toxicity of many compounds in oil, its can cause major environmental problems to aquatic organisms, birds, and humans (Kudaibergenov *et al.*, 2013). The amounts estimated that petroleum is annually spilled on the surface of the ocean between 10,000,000 and 20,000,000 tons, whereby a ton of it may cover about 12 km² of the ocean's surface. Then, from petroleum spills, it has the toxic volatile constituents that can evaporate and as a consequences, cause atmospheric pollution (Kenes *et al.*, 2012). Therefore, clean-up of oil spill from the water surface is an important task (Kudaibergenov *et al.*, 2013).

There are many types of water treatment techniques have been used for oil spillage clean-up such as physical treatment methods, chemical/electrochemical treatment methods and biological treatment methods. Physical treatment methods are organoclays, copolymers and resins, sand/stone filters, organic evaporating methods, electro dialysis method and filtering through oil/water separating membranes. While for chemical/electrochemical treatment methods are coagulation and flocculation methods, advanced chemical oxidation methods, electrochemical methods, and photocatalytic treatments methods. For all of this method, it have major disadvantages that these methods are not economical as well as they cannot separate oil/water emulsions efficiently. Consequently, the researchers are trying to find out the material

and method that is cheap and efficient to remove oil spills from water (Gunatilake & Bandara, 2017).

On 23th April 2015, malaysiakini stated that Melaka River pollution has caused the death of thousands of fish due to poisoning in the river. Consumers Association of Penang (CAP) said that this problem will be more serious if immediate steps are not taken because it's not only affect river but also will spread to the nearby sea and threaten fishery resources and the livelihood of local fishermen. Besides, Melaka River has turned black due to dry spell and residents that living along riverside were affected by the stench from the polluted waters and many had complained of feeling dizzy due to the strong smell coming from the river (thestaronline, 2016).

To solve this problem, the usage of natural sorbent minerals as filter. The natural mineral are kapok fiber and rice husk. Rice husk are their ecological safeness, origin from a broad source of raw materials, floatability after petroleum sorption, high hydrophobicity, low expenses and permeable structure after warm treatment that gives a high sorption capability (Kenes *et al.*, 2012). While, kapok fiber was acknowledged as the regular sorbent for oil slick cleanup including inland oil spill remediation the hollow structure of kapok fiber is beneficial because of its extensive powerful pore volume, and the waxy surface can improve its adherence to oils (Dong *et al.*, 2017).

1.3 Objective

- To design oil filtration system for River Trash Collector System (RTCS)
- To fabricate oil filtration system for River Trash Collector System (RTCS)
- To analyse quality of filtered water

1.4 Scope

- Designing the oil filtration system by using natural absorbent materials
- Fabricating oil filtration system for RTCS
- Test and analyse the water content

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A filter is well-defined as a device, instrument or material, which removes something from whatever passes through it. (Erhuanga *et al.*, 2014) Filters are utilized to protect the process and the product. For example, at refineries and petroleum gas processing facilities that use alkanolamines in gas-sweetening systems, expelling contaminants from the recycling amine stream can be vital in limiting working issues, for example, from foaming inside gas/liquid contactors. Particles are known to stabilize foaming that can decrease gas contactor throughput. Another case is the advantage that carbon columns get from particulate filtration. Supposed "mechanical" filters upstream of the column protect the activated carbon granules from being plugged with debris that would hinder liquid access to the activated carbon surface. Downstream, another arrangement of particulate filters protects the liquid system from the fines created by mechanical abrasion of granules inside the carbon bed. Filters keep debris from proceeding with downstream to successive stages. At the point when such carryover happens, critical equipment, for example, heat exchangers, may end up plainly fouled or the final product might be forced out of specification.

Filtration is rarely the main concern when building up another or improved process. Significantly more consideration is given to product yield, limiting undesirable side effects, maintaining a strategic distance from ecological issues and accomplishing ideal process financial aspects. Despite the fact that filtration once in a while is viewed as ahead of schedule, it regularly essentially influences prepare financial aspects - both through the direct cost of filtration and through its effect on

the adequacy of separated liquid (filtrate) for the following procedure stage or last application (Repetti, 2004).

2.2 Filtering Methodology

2.2.1 Media Filtration

Filtration innovation is widely utilized for the removal of oil and grease and TOC from produced water. Filtration can be refined by the utilization of different sorts of media, for example, sand, rock, anthracite, walnut shell and others. Walnut shell filters are ordinarily utilized for created water treatment. This procedure is not influenced by water saltiness and might be applied to any type of produced water. Media filtration innovation is very productive for the removal of oil and grease, and effectiveness of over 90% has been reported. Productivity can be additionally upgraded if coagulants are added to the feed water prior to filtration. Media recovery and strong waste transfer are setbacks to this procedure (Igunnu & Chen, 2014).

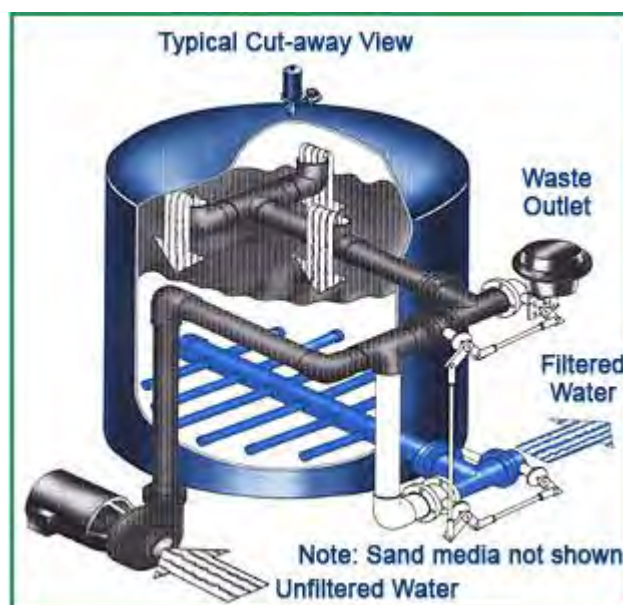


Figure 2. 1: Sand Media Filtration

2.2.2 Gravity Separation

A gravity separator is the most widely recognized sort of separator. In its most straightforward frame, this comprises of an expansive holding tank in which the oil and water mixture is held sufficiently long for the oil to separate by gravity alone. At the point when inflow volumes are large, it can be hard to discover sufficiently enough separator to give the long residence times required (Dhanak *et al.*, 2016). Water-treating equipment that makes use of gravity separation includes skim tanks, API separators, plate coalescers and skim piles. These devices are extremely basic and inexpensive; in any case, because of the large residence time's necessary for separation, they are heavy and require large footprints. These devices are ordinarily utilized on both land-based and offshore fixed-structure facilities; however, they are motion-sensitive and discover restricted use on floating facilities (Society of Petroleum Engineer, 2017).



Figure 2. 2: API Separator

2.2.3 Cyclone Separation

The cyclone has been utilized for the solid-liquid separation field to separate the dispersed phase from the persistent liquid at first. Because of higher proficiency, littler volume, and lower cost, cyclone have been generally utilized as a part of various fields, for example, liquid-liquid separation, gas-