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TAJUK: **DESIGN OF PORTABLE OIL SPILL SKIMMER**

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Faculty of Manufacturing Engineering

DESIGN OF PORTABLE OIL SPILL SKIMMER

Kamarulzaman bin Santuso

Master of Manufacturing Engineering (Industrial Engineering)

2019

DESIGN OF PORTABLE OIL SPILL SKIMMER

KAMARULZAMAN BIN SANTUSO

A thesis submitted
in fulfillment of the requirements for the degree of Master of Manufacturing Engineering (Industrial Engineering)

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

DECLARATION

I declare that this thesis entitled “Design of Portable Oil Spill Skimmer” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

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ABSTRACT

Oil Spill Response Action Plan is very important for preserving the ecosystem around the oil spillages area. During the emergency situation, the action taken must be quick and effective to prevent the spillages from spreading widely and causes more harm to sea and water creature. Currently, different equipment were used in the response plan such as using booms, skimmers, barriers, storage barges, tanks and also vessel depending on the condition of the spillages and the methods applied by the emergency response team. Standard Operating Procedure and Guideline has been developed to control the issue but as long as there is transportation involving oil, the issue cannot be solved completely. Realizing this factor this project is conducted, to help to provide alternative for oil spillages response plan. Part of this project is designing prototype of portable oil spill skimmer to collect oil spillages in a different scales and area such as in the middle of the ocean, sea shore, water treatment facilities and reservoir. Radio frequency control is used as a controller for location of the prototype, wireless camera for real-time video capturing.

ABSTRAK

Pelan Tindakan Respon Tumpahan Minyak adalah sangat penting untuk memelihara ekosistem di sekitar kawasan tumpahan minyak. Semasa keadaan kecemasan, tindakan yang diambil mestilah cepat dan berkesan untuk mengelakkan tumpahan daripada tersebar dengan lebih luas dan menyebabkan lebih banyak bahaya kepada hidupan laut dan air. Pada masa ini, peralatan yang berbeza telah digunakan dalam pelan tindak balas seperti menggunakan 'booms', 'skimmers', penghadang, tongkang simpanan, tangki dan juga kapal bergantung kepada keadaan tumpahan dan kaedah yang digunakan oleh pasukan tindak balas kecemasan. Prosedur Operasi Piawai dan Garis Panduan telah dibangunkan untuk mengawal isu ini tetapi selagi ada pengangkutan yang melibatkan minyak, isu ini tidak dapat diselesaikan sepenuhnya. Menyedari faktor ini, projek ini dilakukan, untuk membantu menyediakan alternatif bagi pelan tindak balas tumpahan minyak. Sebahagian daripada projek ini ialah merekabentuk prototaip 'skimmer' tumpahan minyak mudah alih untuk mengumpul tumpahan minyak dalam skala dan kawasan yang berbeza seperti di tengah lautan, pantai laut, loji rawatan air dan takungan. Kawalan frekuensi radio digunakan sebagai pengawal untuk lokasi prototaip, kamera tanpa wayar untuk menangkap video masa nyata.

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LIST OF SYMBOLS

B	-	Buoyancy
ρ	-	Density
g	-	Gravity acceleration = 9.81 m/s
V	-	Volume
s	-	Speed
d	-	Distance
t	-	Time

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Oils can be defined as any neutral, nonpolar chemical substance, which is found in form of viscous liquid at ambient temperatures and is both hydrophobic and lipophilic. Oils have a high carbon and hydrogen content and are usually flammable and slippery. Before oil is transported, reinjected or stored anywhere, it is gone through the field handling procedure, or oil processing on the production site (Anna Muizis, 2013).

Guidelines for oil or chemical handling procedures has been establish. To ensure the wastes are safely handled, suitable containers are also needed to be used by the waste generators. It is the responsibility of the waste generators to ensure that scheduled wastes are packed based on the composition in a manner suitable for handling, storage and transportation (DOE, 2014). According to (DOSH, 2006) The supplier or owner of the chemicals should ensure that the warehouse keeper formally acknowledges receipt of information on hazards of the materials, recommendations for safe handling and instructions to be followed should spillage occur; Seek confirmation that the implications of the information including those relating to first aid and emergency situations are understood. Seek confirmation that emergency arrangements are adequate and carry out the necessary inspections; be prepared to supply an emergency telephone number through which specialist advice may be obtained. All of the guidelines if were not followed and ignored will cause issues such as oil spillage that will bring negative impact to the environment and ecosystem.

Focusing on oil spills issue, this may be originate in natural or anthropogenic cause. The natural causes such as oil that seeps from the bottom of oceans which enters the marine environment. Crude oil is formed during long periods of time through natural processes involving organic matter from dead organisms and fossils. Thus, oil exists in many environments and may be naturally spilled due to various factors (including climatic conditions, disturbance, etc.). Such natural oil spills may occur in oceans, due to eroding of sedimentary rocks from the bottom of the ocean (the effect may be similar with that of an accidental oil spill from human drilling in oceans such as the recent BP oil spill from the Gulf of Mexico) (Oil Spill Pollution Causes, 2017). The anthropogenic causes including accidental oil spills (such as the recent BP oil spill in the Gulf of Mexico) as well as leaks and spills due to a large variety of human activities related to oil refining, handling and transport, storage and use of crude oil and any of its distilled products (Oil Spill Pollution Causes, 2017). Even though numerous climate factors and natural disturbances can generate oil spills, the main causes of oil spill pollution are usually of anthropogenic origin (accidental spills). Accidental spills may occur in various circumstances mostly during the storage, handling, transportation, offshore drilling, routine maintenance activities and road runoff (Oil Spill Pollution Causes, 2017).

There are ways to control oil spill pollution. Oil spill control measures aim to decrease and limit oil spills, as well as limit their spreading in the environment. This can be done in several ways, including the use of barriers and absorbent materials to mechanically recover the spilled oil is a commonly used method when the oil spill happens in a water environment, implying the use of physical barriers for the mechanical prevention of oil spreading. The main types of barriers used are booms, skimmers and natural and synthetic absorbing materials (Oil Spill Pollution Causes, 2017).

An oil skimmer is a device that is designed to remove oil floating on a liquid surface. Depending on the specific design they are used for a variety of applications such as oil spill response, as a part of oily water treatment systems, removing oil from machine tool coolant and aqueous parts washers, and collecting fats oils and greases in wastewater treatment in food manufacturing industries. The use of skimmers in industrial applications is often required to remove oils, grease and fats prior to further treatment for environmental discharge compliance. By removing the top layer of oils, water stagnation, smell and unsightly surface scum can be reduced. Placed before an oily water treatment system an oil skimmer may give greater overall oil separation efficiency for improved discharge wastewater quality. It should be noted that all oil skimmers will pick up a percentage of water with the oil which will need to be decanted to obtain concentrated oil.

1.2 Problem statement

Oil spills response and recovery plan is an action plan to control water pollution from oil spillages by preventing it from spreading and threatening the ecosystem. Currently, few available systems were used to clean up the spillages such as drum, skimmer, suction etc. Each systems have their own advantages on the methods of spillages clean up based on the system's design. But, few limitations regarding oil spillage control are the cost of operation for the system (US EPA, 2004), and the suitability of the system for used in variable space and radius of the spillages.

There are skimmers that are not suitable to be used in limited and small space due to its size, focusing on clean up large scale spills in area such as ocean surface that acquire large size of the skimmer system like vessel type. Also, controlling the skimmer location is also an issue as it only static at the location where it is released to clean up the spillages (Muizis, 2013).

All these limitations create an opportunities for some improvement as well as innovation can be made, plus it will provide another system option for oil spillage response and recovery plan.

1.3 Objective

Objectives of this project are:

i. To develop a portable oil spill skimmer for oil cleaning in water surface application.

ii. To control the maneuvering of the skimmer system using remote control in a radius of 45 meter for location monitoring.

iii. To gauge the capability of vision monitoring of portable oil skimmer system.

1.4 Scope

The scope of this project is to add some improvement oil spill skimmer system by using remote controlled system and vision system. This project will focus on designing the new improvised skimmer system by referring to the available skimmer system.

Few scopes and guidelines are listed to ensure that the project is conducted within its intended boundary and heading in the right direction to achieve its objectives.

(a) Review current practice: Review the current practice of oil spill response and recovery plan through websites and journals. This is including the standard operation procedure practicing worldwide.

(b) Review existing equipment/system: Review current oil spill collecting tools and equipment that being used to study the design, method and operational work flow of the oil skimmer system.

(c) Design of portable oil skimmer system: Designing the new skimmer system with added features, remote control and vision system. This include with the selection of material to suit with its operating environment.

1.5 Significance of Study

This project could ease the job of oil spill response and recovery team to clean the oil spillages on liquid surface by using a portable system that is easy to handle. Furthermore, the system is equipped with vision system so the operator can monitor images on oil spillages around the skimmer.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Oil spill response and recovery system is a system to clean up oil spills and prevent it from spreading wider and further affecting the ecosystem. There are few types of oil spill recovery system and skimmers is one of them. The methods and processes of oil spills cleanup is different based on the types of the system's used.

2.2 Mechanical Methods of Oil Spills Cleanup

One of the most efficient and environmentally friendly methods of the oil spill cleanup, preferred in many countries, is mechanical recovery. It is also a largest class of the recovery techniques, which includes a broad variety of skimmers, booms and oil-collecting vessels. The mechanical methods do not involve chemicals and therefore do not require special permissions to be implemented, unlike dispersants, which use is limited or even forbidden in many regions. The mechanical oil recovery systems are provided to the oil spill location by the specially designed and equipped spill response vessels (Muizis, 2013).

2.2.1 The Booms

The booms serve in water areas mainly as a technology to contain the oil spill and prevent it from spreading, which facilitates the further cleaning steps. The main containment boom formula used for the planning equipment requirements for the response is:

B = 1.25 x H, where:

B is the amount of boom in meters required to contain the free floating oil;

H is the amount of oil spilled in m^3 (Muizis, 2013).

The majority of booms designs fall into two categories: curtain booms and fence booms. Curtain booms consist of a sub-surface skirt supported by an air or foam-filled flotation chamber (freeboard) usually of circular cross-section. Fence booms have flat cross-section, which has a vertical position in the water by means of integral or external buoyancy (Muizis, 2013).

Some booms types can be defined into a category of special purpose booms, such as ice booms for light ice conditions, sorbent booms, tidal seal booms and fire booms. Fire booms, for example, are specifically constructed to withstand very high temperatures generated by burning oil. The fire booms can be of either fence or curtain design (Muizis, 2013)

Figure 2.0: Inflatable Light Boom (ILB), a curtain boom type (Muizis, 2013)

2.2.1.1 Structure of the Boom

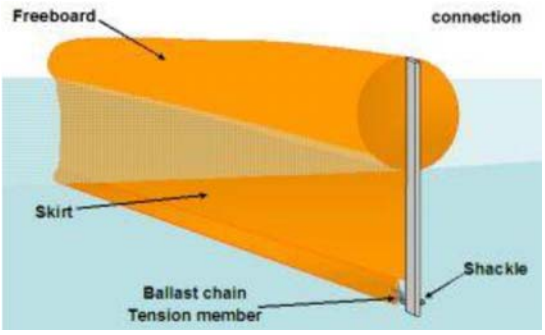

Figure 2.1: Structure of the most typical boom (Muizis, 2013)

A boom consists of several main component parts. Freeboard is the part of the boom which stays above the water surface. Its function is to prevent oil from being washed over the boom. Freeboard can be filled with air, or rigid. The skirt is the continuous portion below the water, which has the purpose of containing the oil. It is often considered that the skirt's effectiveness depends on its depth. However there is an optimum skirt depth for different applications. Ballast is the weight added to the skirt to maintain the barrier in a position perpendicular to the surface of the water. It can be water, or steel and lead weights. The connection is a device that links together the necessary amount of the booms. It can have many different shapes and can be made of various materials (Muizis, 2013).

2.2.2 The Skimmers

Usually, skimmers are used together with the booms. The skimmers remove oil from the water surface without causing changes in its physical or chemical properties and transfer it to the storage tanks onboard the vessel. In case of the winter conditions with presence of the ice on water, often there is no need to use the booms, because the ice serves as a barrier against oil spreading (Muizis, 2013).