

Solar Based Disc Type Oil Spill Recovery System

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Abstract- The purpose of work is recovering oil from the water surface when it is spilled in a water bodies due to accidents or leakage. The basic principle used in this method is that oil has greater affinity towards some materials rather than water. Hence, when came in to the contact with such material, oil sticks to its surface and hence can be removed off from the surface of water. In this proposed work disk skimmer is used which consist of a metal disc coated with PVC material which has capability to attract oil, & is mounted on the shaft which is rotating with the adequate low speed.

Keywords- skimmer, disc, shaft, optimum, rotational.

I. INTRODUCTION

In this modern era various machines and the equipment's are being manufactured rapidly. Now Small-scale industries are contributing in a big way to the growth of our country. The engineer is constantly confronted with the challenges of bringing ideas and design into reality. Because of tanker accidents, vessel collisions, industrial and urban discharges, or offshore exploration and production, oil spill has become a major issue in the protection of the marine environment over the past decades [1][2][3].

Clean up and recovery from an oil spill is difficult [4] and depends upon many factors, including the type of oil spilled, the temperature of the water (affecting evaporation and biodegradation), and the types of shorelines and beaches involved. Spills may take weeks, months or even years to clean up. Many oil spill incidents happened [5][6].It will affect the environment[7].

Mechanical recovery is the most commonly used oil spill response technology which can recover floating oil from the water surface using mechanized equipment known as skimmer.

A. Basic science and engineering concepts used in development of project:

a. Specific gravity: Most hydrocarbons have a lower specific gravity than water. Without agitation, oil separates from the water and floats to the surface.

b. Surface Tension and Affinity: Normally, oil bonds more tightly to itself and other materials than to water. This affinity, and differences in surface tension between oil and water, cause oils to adhere to a skimming medium.

c. Adhesive forces: Adhesion is the tendency of dissimilar particles or surfaces to cling to one another.

B. Method of Filtration:

Gravitational settings is one of the easiest method of filtrations. It is widely used in turning, milling and grinding operations. The main disadvantages of this are that the degree of filtration achieved is very poor and it requires frequent cleaning of the tank. Depending upon the type of fluid and degree of filtration required, the following filtration devices are used for fine filtration.

a. Magnetic Separators: These are primarily used to remove magnetic solid particles to the extent of 70 to 75%. They are useful for removing fine dwarf particles of grinding operations. For fine filtration, the liquid after passing through magnetic separators is passed through other filtration vices, such as centrifuges of hydrocyclones. The initial cost of magnetic separators is also high.

The disadvantages of this system are:

Paper gets clogged quickly and requires frequent replacements.

This system is only useful for viscous fluids precautions in Handling of Cutting Fluids.

b. Centrifuges:

Centrifuges are used for fine cleaning coolants up to 1mm. They work on the principle of cleaning by centrifugal force. It is a rapid method, but requires frequent cleaning of the bowl. The use of pre-roughing devices extends the cleaning period to some extent. The cost of centrifuges is high.

c. Hydro cyclones:

This is a recently developed process. In it the liquid enters tangentially into the spinning spiral. The centrifugal force near the bottom of the cone is about 5000 to 7500 times greater than

the force of gravity. The high centrifugal force throws the solid particles to the wall of the cone. The spiral pushes it downwards through an opening at the lower end of the cone. The high speed of motion of the fluid develops rising column of air pushes the pure liquid upwards. The liquid is taken out by the outlet provided at the top of the cyclone.

iv. Paper Filtration:

In paper filtration, the dirty coolant is passed through paper filters. The clean liquid passes through the filter, whereas dust particles are trapped in it. This is the cheapest method of filtration and can be used for very fine.

C. Oil Skimming

Oil skimming is basically sticking of oil to some material which is inserted in it. This action can be effectively used as oil can stick to the material but not the other impurities in it. Hence by this principle, Oil can be separated from its containments as well as it can be separated when it is containment.

D. Disk Skimmers

These skimmers rotate a disk shaped medium through the liquid. Oil is wiped off and discharged into a collection container.

II. OIL SPILL RECOVERY SYSTEM

The proposed oil spill recovery system consists of Disc skimmers. A disk skimmer consist of a metal disc coated with PVC (polymer of vinyl chloride) material which has capability to attract oil, & is mounted on the shaft which is rotating with the adequate low speed. The wheel is dipped in oil water mixture with the depth of 1/4th to 1/3rd of diameter (which should be slightly greater than that of the oil thickness above water). Now when the wheel is rotated, the oil sticks to the coated material and is carried upwards. Here care is taken that centrifugal force generated is less than the adhesive force acting on the oil. The oil lifted by wheel is removed by the oil removing mechanism provided at the other end which is collected in the collector.

It consists of the rotating wheels and driving mechanism mounted on the small floater which is equipped with the blades for guiding motion of the small setup. Now those setups can be programmed so as to guide themselves or they can be controlled via remote control. The necessary power required to run the whole setup is been obtained by the solar energy. The oil which is been removed is collected in an oil

collector. Those containers can be equipped with level sensor, and hence when oil is been collected to its maximum capacity, the system can be called back for recovering collected oil and evacuating the collectors. As an experimental setup, we can analyze the system with one wheel. However, for practical purpose, number of wheels can be mounted on the shaft so that larger area will be covered in one go resulting faster and effective oil removing. And that also in minimum operating cost. Also, Because of wide scope for automation in it, the same task of removing oil from the surface requires much less human efforts.

A. Selection of Materials

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors:

- Reliabilities of properties.
- Reliability of applied load.
- The certainty as to exact mode of failure.
- The extent of simplifying assumptions.
- The extent of localized.
- The extent of initial stresses set up during manufacturing.
- The extent loss of life if failure occurs.

Materials selected in machine of Base plate, motor support, sleeve and shaft is mild steel for the following reasons:

- Mild steel is readily available in market.
- It is economical to use.
- It is available in standard sizes.
- It has good mechanical properties i.e. it is easily machinable.
- It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure.
- It has high tensile strength.
- Low co-efficient of thermal expansion.

Mild steel has carbon content from 0.15% to 0.30%. They are easily weldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases.

B. List of Components

- Dc gear motor 12 v dc 17 watt worm gear type.
- Chain drive for power transmission.
- 12 watt solar panel for battery charging.
- 12 v 9 Ah battery to store and supply power to motor.
- Shaft of 20mm diameter on which oil skimmer disc is mounted.
- Oil skimming disc of PVC material.
- Pedestal Bearing.
- Floating tube.

Solar panel specification:

- Max power - 12 watt
- Max power voltage- 17 volts
- Max power current- 0.59 amp
- Short circuit current- 0.61 amp
- Total charging current- 0.6 amp

III. WORKING OF MACHINE

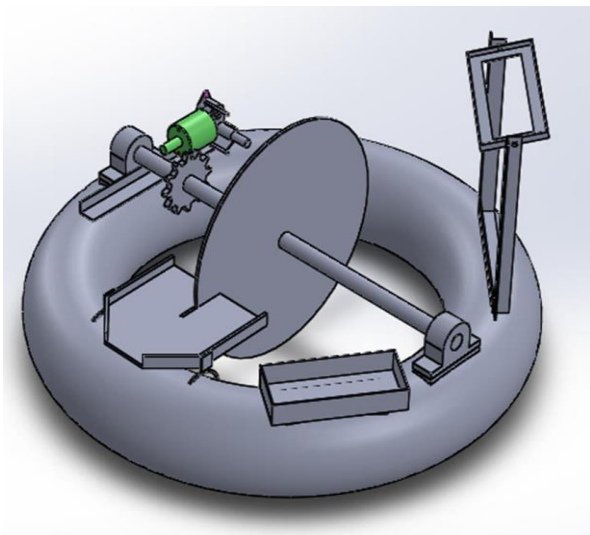


Fig -1: CAD model of oil spill separator

Rotating discs are used to attract oil. The collected oil is scraped off and the oil pumped to a collection tank. These units generally float on the surface of the water but larger installations may use fixed units.

In this project all the parts or assembly is mounted on floating tube. The motor is used to drive oil skimming disc which is practically deep in water to make contact with oil in water.

The disc rotates and collects oil from water due to its skimming properties. The solar panel is used to charge battery and ultimately run motor and make system portable and wire free.

The rubber scraper is attached with disc and collect oil in storage container.

Advantages of current system over existing system

- Low capital cost.
- Very easy to service and maintenance.
- Very low ownership cost.
- Self-adjusting - more labour required for adjustments to optimize performance.
- Very easy to deployed.
- Very high oil removal rates 95 % of pure oil is collected.
- It reduced oil pollution of sea.
- No external power is needed of skimming when used with solar power

Table-1. Raw Materials

PART NAME	MATERIAL	QTY
TUBE	PLASTIC	1
SPROCKET	MS	2
CHAIN	MS	1
PEDESTAL BEARING P-204	(STD)	2
ROUND SHAFT	C-45	1
DC MOTOR	STD	1
SKIMMING DISC	PVC	1
SOLAR PANNEL	STD	1

BATTERY 6 V	STD	2
ANGLE	MS	10
WATER TANK	PLASTIC	1
NUT BOLT WASHER (STD)	MS	6
WELDING ROD	STD	2
COLOUR	STD	0.75 lit

IV. CONCLUSIONS

The proposed work is easy, effective, economical and environ friendly system to tackle the global crisis of the oil spill. The system can be automated and run on solar system making it greatly capable to survive on its own.

Efficiency of a conventional disk oil skimmer could be nearly doubled by careful optimization of the angle between the plane of the disk and the vertical plane. Therefore, this parameter is particularly significant as it requires only a minimum effort to modify existing disk skimmers. Results revealed the presence of a minimum immersed area required for the offset angle to be effective.

An optimum rotational speed of around 80 rpm was found, regardless of the design or operating parameters applied. For each disk diameter studied, an optimum offset angle was found. These optimum values were independent of the oil film thickness and oil type. A maximum improvement was obtained for the largest disk diameter studied and oil film thickness of 20 mm.

In future concept of grid of multiple discs can be introduced for better result.

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