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Design, Analysis and Manufacturing of Disc Type Oil Skimmer

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Abstract: *Oil spills in sea occur frequently because of crude oil pipeline breakage, sinking of ship, release of crude oil from drilling rigs, etc. Oil spills are a type of pollution which has adverse effect on marine life. It also possesses a high risk of fire hazards. Oil skimmers are devices which separate oil from water-oil mixture. The efficiency with regard to oil skimmer is the quantity of oil recovered in comparison water traditionally used oil skimmers have lower efficiency. Another method used for removing the oil is by using special chemical absorbing pads which when placed over the surface, absorbs the oil. The proposed project aims at increasing the efficiency of the mechanical method of separating oil which uses oil skimmer. This will be done using a disc type oil skimmer and changing the material of the disc. Oleophilic material will be used for the disc and the results will be compared with traditionally used material of mild steel.*

Keywords: *Oil skimmer, oleophilic, efficiency, disc.*

I. Introduction

Oil is one of the most important energy and raw material source for synthetic polymer and chemical worldwide. As long as oil is explored, transported, stored and used there will be the risk of spillage. Oil pollution particularly of sea and navigable water, has excited more public concern than other water and split materials. Oil pollution has steadily increased with the increase in oil consumption. In 2017, oil spill occurred at Kamarajar port in Ennore near Chennai. This oil spill occurred because of collision of two ships of which one ship had containers of crude oil. Nearly 9.9 million gallons of oil was spilt. The oil was cleaned by using large buckets which employed human workforce.

An Oil skimmer is a mechanical device specifically designed for removal of oil from water-oil mixture Oil skimming is a low-tech but reliable and efficient technique. The skimming principle, upon which the technique relies, is dependent on three physical properties of oils, namely specific gravity, surface tension and affinity. Most oils have a lower specific gravity than water, which allows it to separate from water and float to the surface unless agitated. These oils are possible to collect using an oil skimmer. Most oils have little or no affinity for water, which prevents mixing of oil and water. As the skimming medium enters the water, the oil wets the surface preventing water from doing the same. Any water on the surface is pushed away as more oil attaches to the surface because of the surface tension of the oil. However, it is important that the skimming medium is not submerged too deep into the water, as it may cause the oil to be washed off the skimming medium and thereby lowering the efficiency.

The oil skimmer uses a rotating medium which is submerged inside the water. This rotating medium may be drum, belt or disc. The oil floating on water sticks to the rotating element due to adhesion. This adhered oil is then separated from the element using a separating strip. This separating strip collects the oil in a tank. The disc type oil skimmers have higher efficiency than the other types of oil skimmers. The rotating medium is made to run at lower speeds. Higher speeds will increase the mass flow rate but it will increase the quantity of water recovered thereby reducing efficiency.

In this paper, we intend to show that by changing the material of the disc of disc type oil skimmer, the efficiency of the operation in terms of quality of oil recovered can be increased. Mostly, disc made of mild steel is used in oil skimmers. We have used a disc made of Acrylic. Acrylic is a low cost oleophilic material which is also light in weight. Our aim is to find the efficiency of disc made of Acrylic and compare it with the efficiency obtained by disc made of mild steel. In oil spills, mostly crude oil is spilt. We are conducting the experiment on the device which we have manufactured. SAE 20W-50 oil is used as a replacement of crude oil.

II. Disc Type Oil Skimmer

2.1 Design:

Parts:

- Disc
- Motor
- Separating Strip
- Hub
- Screw
- Container
- Frame

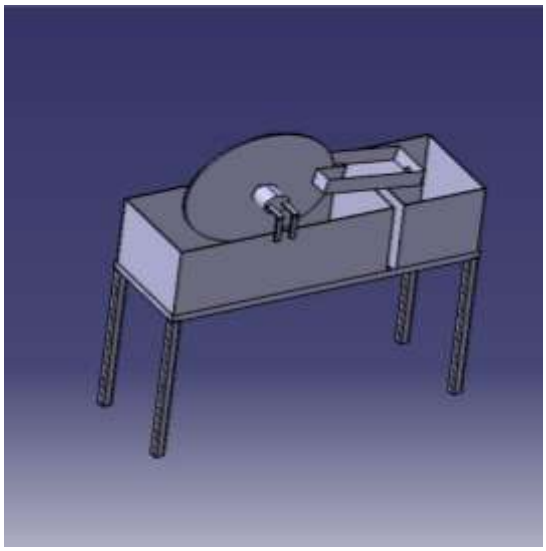

Fig 2.1 CAD model of Disc type Oil skimmer

The design of the disc type oil skimmer is application dependent. The main goal of the project is to skim the oil to calculate its efficiency. The efficiency varies according to the depth of disc inserted and not the size of the disc. Thus, disc of any size can be taken. We have used the disc of 200mm diameter.

Another important design parameter is the selection of motor. As the quality of mixture gets affected by higher speeds, a low speed motor is required. Also, as the weight and size of disc is not very large, a 12V DC motor can be used.

2.2 Material:

1. Acrylic:

Acrylic is artificial fiber made from a special group of vinyl compounds, primarily acrylonitrile. Acrylic fibers are thermoplastic (i.e., soften when heated, re-harden upon cooling), have low moisture regain, are low in density, and can be made into bulky fabrics. They wash and dry easily and are dimensionally stable. They are resistant to bleaches, dilute acids, and alkalis, and to weathering and microbiological attack.

2. Mild Steel:

Mild steel is the most widely used steel. Mild steel isn't promptly tempered or solidified however it has enough quality. It contains 0.16 to 0.18 % Carbon (greatest 0.25% is allowable), 0.70 to 0.90 % Manganese, 0.40% Silicon, Sulphur most extreme 0.04%, Phosphorous up to 0.04%.

2.3 FEA:

FEA is carried out to check for the stresses in the disc and the separator strip. The rotation of the disc causes frictional stress between the disc and the separator. The CAD model of disc and separating strip is brought into Ansys. Both of them are meshed such that disc rotates and the separating strip is stationary.

(Note: FEA is done primarily to check the areas of stress concentration.)

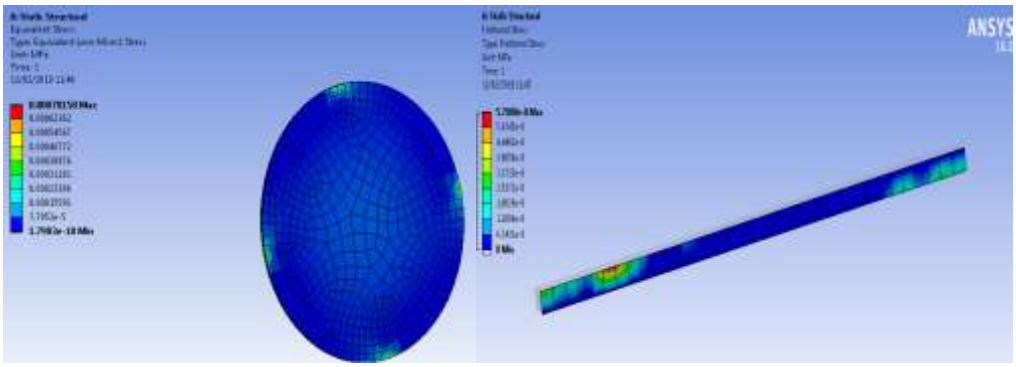

Fig 2.2 FEA of Acrylic disc and separating strip

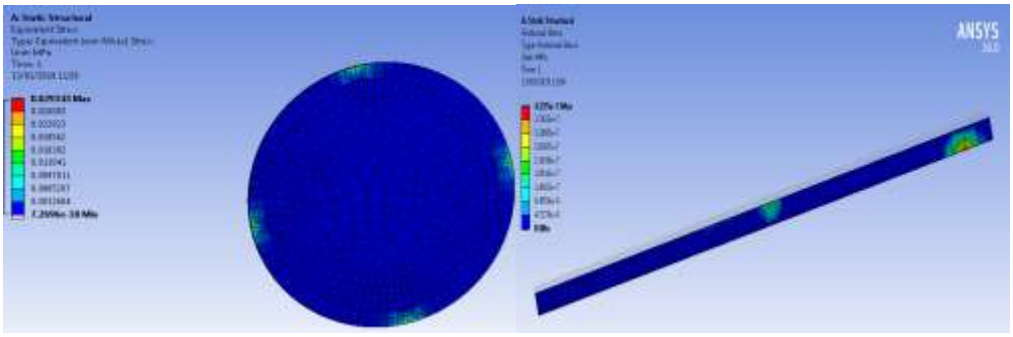

Fig 2.3 FEA of Mild Steel disc and seperating strip

2.4 Manufacturing:

The model was manufactured according to standard design parameters discussed in 2.1. The manufacturing of disc, tanks, supporting frame was done. The standard parts bought were DC motor, bus, bolts and rectifier. The various manufacturing processes carried out were as follows:

- Cutting
- Welding
- Drilling
- Sheet metal bending
- Finishing

III. Methodology

III.1 Data Gathering:

Our main aim is to find efficiency. Efficiency is calculated based on working of device for a time of 60 seconds. The oil content in the collected water-oil mixture is used to calculate the efficiency. The oil used is engine lubricant oil SAE 20W-50. The disc used is made of Acrylic. After testing Acrylic, Mild Steel will be tested.

III.2 Procedure:

The acrylic disc is attached to the motor. The motor rotates at the speed of 60 rpm. The motor works on direct current. It should be attached to DC source or AC source with the help of rectifying arrangement. The tank from which oil has to be skimmed is filled with water-oil ratio of 200:22. The disc is inserted inside the mixture at a depth of 20mm. The motor is started. The motor is switched off after 60 seconds. The skimmed oil is collected in a measuring jar. Allow the collected mixture to settle for 5 minutes. The total height column and water column is measured. The total volume of oil can be calculated by multiplying the measured column height with the area of the jar. The disc is then inserted at a depth of 30mm along with the oil in same ratio and procedure is repeated.

The same procedure is carried out on Mild Steel disc. Make sure to use gloves while handling the equipment. The oil needs to be handled and transported correctly for increasing the accuracy of the experiment.

IV. Observation and Calculations

4.1 Observation table:

Material	Depth	Total height(mm)	Height of water column(mm)
Acrylic	20	51	6
	30	58	10
Mild steel	20	56	12
	30	62	16

4.2 Calculations:

Efficiency is calculated on basis of content of oil in water- oil mixture.

□ =Volume of oil recovered/ Total volume of mixture recovered

The volume is calculated by multiplying area of measuring jar with height.
(Note: 220ml of oil fills the measuring jar by 50mm)

4.3 Result table and graph:

Material	Depth	Efficiency (%)
Acrylic	20	88.21
	30	82.75
Mild Steel	20	78.57
	30	74.19

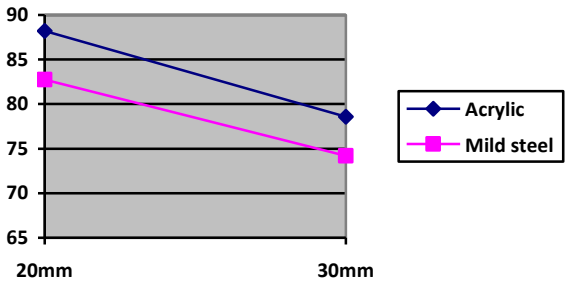

Fig 4.1 Graph of Efficiency Vs Depth

V. Conclusion

A disc type oil skimmer can be used to separate oil from water-oil mixture efficiently. The disc when made up of Acrylic gives higher efficiency when compared to the traditionally used disc made of Mild Steel. Efficiency obtained by using the Acrylic disc was 88% which is 10% more than the disc made of mild steel. The FEA analysis also shows that the Acrylic material has enough strength to withstand the forces that act on it. Also, when the disc is immersed deeper, the volume of the mixture recovered increases, but the quantity of water recovered also increases thereby decreasing the efficiency. Thus, disc should be immersed at an optimum depth to get higher efficiency.

References

[1]. Zuckerman, S. (1967). The Torrey Canyon. Report of the Committee of Scientists on the Scientific and Technological Aspects of the Torrey Canyon Disaster. Departments of State and Official Bodies. Cabinet Office, London, UK
[2]. Clark R B 1986 Marine Pollution United States: Oxford University Press New York
[3]. The International Tanker Owners Pollution Federation Limited 2012 Use of Skimmers in Oil Pollution Response Impact PR & Design Limited, Canterbury, UK
[4]. DESIGN AND FABRICATION OF OIL SKIMMER, International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 05 | May -2017
[5]. Analysis of effectiveness of oil spill recovery using disc-type oil skimmer at laboratory scale, 2nd international Tropical Renewable Energy Conference (i-TREC) 2017
[6]. Guzman, L. and Campodonico, I. (1981). Studies after the Metula oil spill in the Straits of Magellan, Chile. In Proceedings of the Petromar '80 Conference, Monaco, 363-376. Graham and Trotman Ltd., London, UK
[7]. Winslow, R. (1978). Hard aground: The story of the Argo Merchant oil spill. W.W. Norton & Company Inc, New York, USA
[8]. Marine Pollution Bulletin, Vol. 10. pp. 193-197. Pergamon Press, Ltd. 1979.
[9]. Butler, J.N. (1978). The largest oil spills. Inconsistencies, information gaps. Ocean Industry, October 1978, pp.101- 112 [6] National Research Council. Using Oil Spill Dispersants