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ANALYSIS ON OIL REMOVING MECHANISM FROM WATER

B. Shanmugasundaram[1] **R. Prathipa[2]**

[1]Associate Professor of Mechanical Engineering, Adithya Institute of Technology, Coimbatore, Tamilnadu, India

[2]Assistant Professor of Chemistry, Sri Ramakrishna Institute of Technology, Coimbatore, Tamilnadu, India

ABSTRACT

World-wide statistics on oil spills show that the incidence of major oil spills has significantly fallen over the last three decades. However, environmental awareness and sensitivity to the impact of oil spills have grown at an even quicker pace over the same period.The prime focus of oil spill response activities is in prevention and planning. This is achieved through well-designed equipment, good maintenance and operating procedures, sound training techniques and a high degree of awareness and concern at all levels by employees and management. Despite best prevention practices an incident may occur. In the event of an incident the objective of the oil spill response is to assure that actions are efficient and compatible with the balanced environmental, social, and economic needs of the community. The response strategy includes all viable techniques to reduce damage from a spill. No oil spill response option would be ruled out or limited in advance.There is no doubt, therefore, that continued investment in preventive measures and emergency response capabilities is justified. A number of advanced response mechanisms are available for controlling oil spills and minimizing their impacts on human health and the environment. The key to effectively combating spills is careful selection and proper use of the equipment and materials best suited to the type of oil and the conditions at the spill site. Most spill response equipment and materials are greatly affected by such factors as conditions at sea, water currents and wind. Gauging the performance of oil spill response equipment has long been of interest for government regulators, oil spill responders and the oil industry.

1. INDRODUCTION

The considerable increase of oil exploration and transport in Arctic waters will increase the risk of an oil spill occurring in cold and ice-infested waters. Currently, mechanical oil spill recovery in cold climates is inefficient largely due to the fact that the equipment available to oil spill responders was not designed to collect very viscous oils and oil-ice mixtures. The presence of ice crystals in oil emulsions affects the adhesion processes between an oil slick and the surface of an oleophilic skimmer and prevents oil from being efficiently recovered. Oil spill responders have used weir type skimmers and large vacuum hoses to suck in oil-ice mixture, resulting in a significant amount of free water in the recovered product, reducing oil spill recovery efficiency and creating a discharge problem. Oleophilic skimmers are based on the adhesion of oil to the rotating skimmer surface. The rotating surface lifts the oil out of the water to an oil removal device (e.g. cleaning blade, roller, etc.). The materials used to manufacture the surface of adhesion skimmers have not been adapted to the special conditions in cold climates. Steel, aluminium, and general-use plastics had been in use for more than 25 years.

Material selection has not been based on the adhesive properties, but rather on historical practice, price and availability. Very little effort has been made to study the affinity of new materials for oil and the recovery efficiency under cold climate conditions. Research conducted in our laboratory indicates that the recovery material on the skimmer surface can change the recovery efficiency up to 20%, and that tailoring the geometry of the skimmer surface can have much higher recovery efficiencies, even up to 200%. To date we have only studied oils and water-in-oil-emulsions at temperatures above 0±C. All the oils tested were above their Pour Point. No ice-in-oil emulsions were tested. To our knowledge, no scientific research has been done to study the effect of changes in oil properties at cold temperatures and/or in the presence of ice in oil emulsion on oil adhesion to the material of the recovery surface. Our research aims at studying this process in detail. Various shapes of the recovery unit, such as a mop, belt, brush, disc, and drum, have been developed to increase skimmer efficiency.

Our research has shown that the relatively low recovery rate of smooth drum, belt and disk skimmers can be explained by their relatively small surface area. Only a limited amount of oil adheres to the recovery surface in every rotation, requiring more time or more skimmers to increase the overall recovery. Brush and mop skimmers attempted to address this issue by increasing the surface area in contact with oil. Although these skimmers allow more oil to adhere to the recovery surface, not all the adhered oil can be removed from the bristles. Thus, a significant fraction of the oil remains on the bristles, reducing the overall recovery efficiency. The oil spill recovery process is composed of two equally important goals. The first one is to remove oil from the water surface and the second one is to remove oil adhered to the recovery surface and transfers it into to a collector. The recovery efficiency depends on the achievement of both of these goals. In case of a smooth surface (e.g. smooth drum, disk or belt), the amount of oil recovered from the water surface is relatively low, but close to 100% of it can be removed by a cleaning blade.

2. COMPONENT FUNCTION AND ITS SPECIFICATIONS

2.1. DC Motor:

Fig. 1: DC Motor

30 rpm Centre Shaft Economy Series DC Motor is high quality low cost DC geared motor is used. It has steel gears and pinions to ensure longer life and better wear and tear properties. The gears are fixed on hardened steel spindles polished to a mirror finish. The output shaft rotates in a plastic bushing. The whole assembly is covered with a plastic ring. Gearbox is sealed and lubricated with lithium grease and require no maintenance. Motor

gives 30 rpm at 12V but motor runs smoothly from 4V to 12V and gives wide range of rpm and torque.

2.2. Polymer Belt:

Fig. 2: Polymer Belt

It is made up of polymer material. It is endless type which has width of 150 mm. The material is so selected to stick oil to belt. It is mounted on the aluminum pulley. Length of open belt is 1060 mm. It is immersed in liquid up to 100 mm. Belt material has good oil removal rate and it can withstand high temperature up to 180 F hence we have selected polyurethane belt. Tension to the belt is given by lower pulley with dead weight.

2.3. Pulley:

It is made up of cast iron. Its length is 150 mm. It is coated with aluminum coating. Pulley is fixed into the bearing .The motion of the pulley is very good because the torque of the pulley is safe. Main function of the pulley to hold and support the belt and give rotary motion to the belt .At the bottom dead weight is supported by the pulley.

Fig. 3: Pulley

2.4. Supporting Frame:

It's made up of mild steel. Its length is 600 mm and width is 450 mm .Its supported to the pulley and belt assembles. And also motor is fixed on the frame. The frame is light weight so it's easy to transfer. It's main component in oil skimmer.

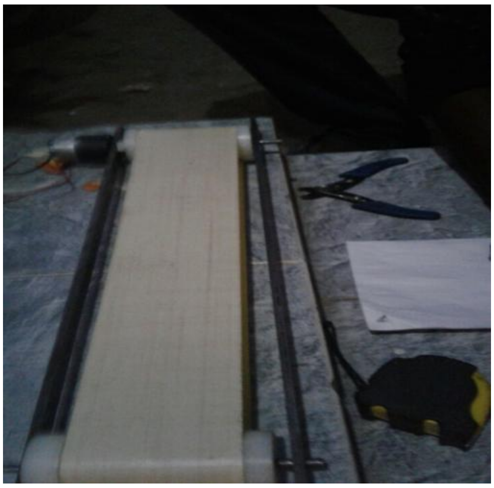

Fig. 4: Supporting Frame

3. DESIGN

d_1 = 470 mm;
d_2 = 45 mm
$X = d_1 + d_2 = 470+45 = 515$ mm = 0.515 m

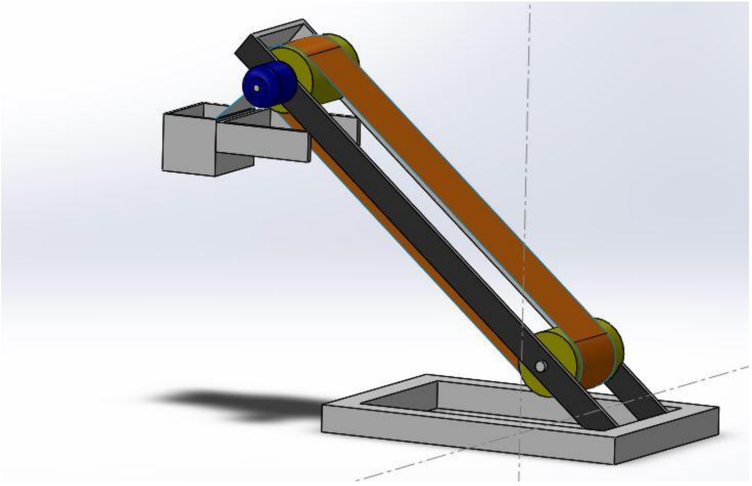

Fig. 5: 3D Model

Length of the Flat Belt:

Distance, $X_1 = 0.515$ m
Distance, $X_2 = 0.515$ m

Arc Length:

$S_1 = 0.06$ m
$S_2 = 0.06$ m

Angle of Contact:

$\theta = (180^c - 2\emptyset)$

$\emptyset_1 = (180^c - 2*0.06227)$

$\emptyset_1 = 180^c$

L = 0.515 + 0.515 + 2(0.022*3.14)

L = 1.168 mm

Angular Velocity of Belt:

For Driver:

d = 45 mm; N = 30 rpm

$V_1 = \pi d1N1/60$

$= \pi * 0.045 * 30/60$

= 0.070 m/s

For Driven:

$V_2 = \pi d2N2/60$

$= \pi * 0.045 * 30/60$

= 0.070 m/s

Velocity ratio = V_1/V_2

= 0.070/0.070 = 1

Torque:

Power, P = $2\pi NT/60$ (watt)

where,

N = Motor speed

T = Torque transmitted by motor

0.5 hp (Horse Power) = 0.3728 kw

372.8 =2*π*30*T/60

T =118.66 N-mm

Force is calculated by,

T = F*r

F = 118.66/22.5*10^-3; F = 5273.77 N

Let us assume,

T = thickness of the belt in mm

W= width of the belt in m

d =diameter of shaft in m

N= speed of rotation of shaft in rpm

Volume rate of oil recover per turn when shaft is rotating at 30 rpm

Assume 1mm for Thickness of oil film

Volume rate = Thickness of film x width of belt x circumferential area of shaft x Speed rotation of shaft

$V = t*w*\pi*d*N = 0.001*0.05*\pi*0.45*30 = 133.73$ ml/min

4. RESULTS

S. No.	Belt Speed (rpm)	Oil Spilled (ml)	Collection After Spilled (Oil ml)	Time (min)	Recovery Rate (ml/min)	Average Recovery Rate (ml/min)
1	30	300	280	2.06	135.92	131.94
2	30	400	385	3.10	124.19	
3	30	500	475	3.50	135.71	

Table 1: Recovery Rate

CONCLUSION

The investigation found to be very convenient for skimming the oil for the operator. It removes about 70 to 80 litre of oil per day. It is very much helpful to operators, as it avoids their tedious work of skimming the oil and grease from the wastage water. It also controls the water pollution.

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