

Floating Oil Skimmer with Garbage Collector

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Abstract— During recent years there are lots of oil accidents happening in the ocean and it makes huge impact on the environment. Sea accidents can further cause oil pouring and causes pollution. During the transportation of crude oil it requires the safety measures in port terminals. So it becomes necessary to develop the oil separator system. In this paper we have implemented oil skimmer system which separates oil from the water. It is operated by using Bluetooth. Belt skimmer system is developed in which it consists of floating disk and belt. System is tested and it regains most of the oil in the water.

Key words: Belt Type Oil Skimmer, Chain, DC Motor, Arduino, Bearing

I. INTRODUCTION

Oil is the precious crude and it is being used in many day to day applications of human life. Most of the oils are toxic and are dangerous when there is direct contact with them. Many countries has made stringent safety norms for wastewater disposal contained with oils mainly typically from petrochemical and process industries so that such industries are equipped with such kind of oil skimmers to separate the oils from disposal water. The continuous removal of oil from process fluid reduces the machine fluid refilling cost, Improves the disposal water quality and increases the life of the fluid.

An oil skimmer is a device that separates oil floating on a liquid surface. 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 removing oil from aqueous parts washers

A. Skimming Technologies

There are two mechanisms for removing oil from the water surface

- Oleophilic techniques
- Non-oleophilic techniques

Oleophilic technique is based on the adhesion of oil to a moving surface. Non-oleophilic techniques include weir skimmers relying on gravity, suction systems, and mechanical skimmers, which physically lift the oil with scoops, or grabs.

Oleophilic Skimmers Oleophilic skimmers recover oil based on the properties of specific materials, which have greater affinity for oil than for water. There exist numerous types of oleophilic skimmers and they are therefore divided into subgroups such as disc skimmers, drum skimmers, rope mop skimmers, belt skimmers, and brush skimmers. Oleophilic skimmers usually achieve the highest ratio of recovered oil in relation to entrained water, also referred to as the recovery efficiency, compared to other skimmer types. Oleophilic skimmers reach their highest efficiency when handling medium viscosity oils.

II. WORKING OF THE OIL SKIMMER

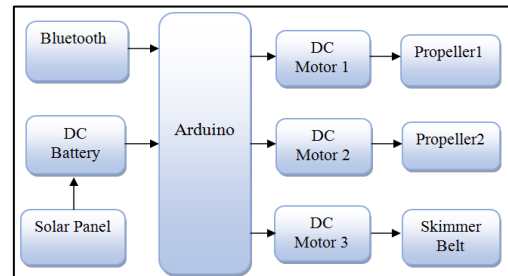


Fig. 1: Components of the Oil Skimmer

Oil skimmer system consists of Solar panel, DC battery, Bluetooth, three dc motors, arduino board two propellers and the skimmer assembly. Solar panels charge the battery and supply power to the arduino and runs the DC motors. Bluetooth is connected to the arduino board. We can move and control oil skimmer assembly in water through Bluetooth. Two dc motors are connected to two propellers. When propeller rotate in clockwise direction oil skimmer moves in right direction. When propeller moves in anticlockwise direction oil skimmer moves in left direction. Rotation of the propeller is controlled by dc motors. Third dc motor is connected to rod of the skimmer belt. Rotating Disc and Belt attracts oil which is dumped into collecting tank. Skimmer is partially dipped in water for more contact. Disc is floating and rubber scraper is attached to the disc and belt it collects oil in storage container. It also consists of garbage collector which collects any garbage material found in the water.

A. Design Calculations

1) Angle of Lap

The Angle of Lap is calculated by the equation

$$\Phi = \sin^{-1}(r1 - r2) / X = \sin^{-1}(10 - 10) / 625.5 \text{ mm} = 0^\circ$$

Where,

r1 = Radius of shaft '1'

r2 = Radius of shaft '2'

X = Distance between the shaft centers

2) Angle of Contact

The Angle of Contact is calculated by the equation

$$\theta = (180 - 2 \Phi) = (180 - 2 \times 0^\circ) = 180^\circ$$

Where,

Φ = Angle of Lap

3) Linear velocity of belt

The individual linear velocities of the driver (motor shaft) and driven (bottom shaft).

a) For Driver

$$V_1 = (\pi \times d \times N_1) / 60 = (3.14 \times 0.020 \times 60) / 60 = 0.628 \text{ m/s}$$

b) For Driven

$$V_2 = (\pi \times d_2 \times N_2) / 60 = (3.14 \times 0.020 \times 60) / 60 = 0.628 \text{ m/s}$$

c) Velocity Ratio = $V_1/V_2 = 1$

4) Torque & Tension in Belt

Power is calculating through $P = (2\pi NT) / 60$

Where,

N= Motor Speed

T = Torque transmitted by Motor

a) Tension

$$T = (T_1 + T_2) \times r$$

$$T_1 / T_2 = e^{\mu\theta}$$

5) *Effective Pull in Belt*

Effective Pull is calculating through

$$P_e = T_1 - T_2$$

Where, T_1 and T_2 are tensions.

6) *Power Transmitted by Belt*

Transmitted Power by belt is calculating through

$$P = P_e \times V_1$$

III. MANUFACTURING AND ASSEMBLING COMPONENTS

A. List of Components

- Dc gear motor
- Chain drive for power transmission
- Solar panel for battery charging
- Battery to store and supply power to motor
- Shaft on which oil skimmer Disc and belt is mounted
- Oil Skimming Disc and Belt
- Bearing
- Floating tube

1) Belt

It is made up of polymer material. It is endless type which has width of 90 mm. The material is so selected to stick oil to belt. It is mounted on the aluminum pulley. Length of open belt is 1280 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) DC Motor

These standard gearmotors are incredibly tough and feature full metal gears to help you drive wheels, gears, or almost anything else that needs to turn. They have a gear ratio of 300:1 and operate up to 12 volts and deliver a stall torque of 368 oz-in. and a max speed of 10 RPM. Each standard gearmotor sports a 6mm diameter D-shaft.



Fig. 2: DC Motor

3) 20MM Pillow Block Bearings UCP204-20MM

UCP204-20MM has a combination of a cast iron pillow block housing with an anti-rotation device with self-alignment and a set screw locking chrome steel insert bearing with a slinger seal design. This specific unit is a standard duty pillow block bearing with a wide inner ring and two set screws and a cast iron unit with the standard base to center height with a grease fitting. UCP200 Series Pillow Block Bearing is equipped with two specifically designed set screws that are positioned in the inner ring of the ball bearing to lock and attach to the shaft.

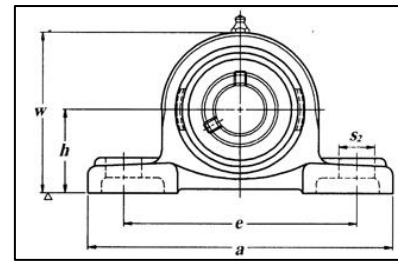


Fig. 3: Bearing

4) 20mm Circular Rod

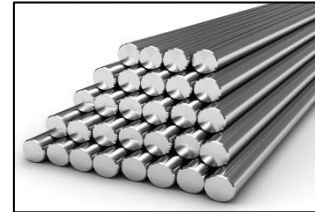


Fig. 4: Circular Rod

5) PVC Pipe



Fig. 5: PVC Pipe

6) Propeller Blade



Fig. 6: Propeller Blade

B. Selection of Components

1) Selection of Material

The main objective in the fabrication of machine is the proper selection of material for the different part of a machine. Design engineer must have to be familiar with the effect of the manufacturing process and heat treatments have on the properties of material. The choice of material for engineering purposes depends upon the following factors:

- 1) Availability of the material.
- 2) Suitability of materials for the working condition in service.
- 3) The cost of materials.
- 4) Physical and chemical properties of materials.
- 5) Mechanical property of material. The mechanical properties of the metals are associated with the ability of material to oppose mechanical forces and load.
 - Strength: It may be defined as the capacity of material to withstand load.
 - Stress: The internal resistance set up per unit cross sectional area is called as stress.
 - Stiffness: The ability of a material to resist elastic deformation is called stiffness.
 - Elasticity: It is the property of a material by virtue of which it regains its original size shape after deformation the load causing deformation are removed.

- Plasticity: Lack of elasticity is called plasticity.
- 6) Ductility: It is the property of material to undergo a considerable deformation under tension before rupture
- Ductility: It is the property of material to undergo a considerable deformation under tension before rupture.
- Brittleness: It is the property of fracturing a material without warning or without appreciable deformation.
- Hardness: The ability of material to resist wear, abrasion, scratching or indentation by harder bodies is called hardness.

2) Selection of Belt Material

The belt should be made of such a material which can easily lift/carry the oil above head and pour it over the blade. The oil lifts through belt by having the its materials following inherent properties:

- Belt material is selected according to its polar & non-polar properties. Water consists of polar molecules as H⁺ and OH⁻ whereas oil doesn't have any polar molecules hence it reacts as non-polar element. Polar & non-polar molecules attract towards their respective elements and bond with it. Moreover to these, Oil is lighter in density as compare to water so always oil floats on it. Hence water and oil form a separate layer in the reservoir. Belt material has been selected in such a manner so it can react as a non-polar element and oil gets attract toward it and get stick on it which permits us to easily lift the oil through belt. Here we are selecting the belt materials of polymers (non-polar). Like Cotton, Steel, Rubber, Polyurethane, Oleophilic.
- Adhesive property of oil is greater than water so we select such a material for the belt having adhesive property greater than water and having close to oil, hence it can easily absorbs oil over the belt which ultimately gets separate from water. Since water having poor adhesive property, it doesn't stick much to belt and remains in the reservoir.
- During operation, belt is getting wear due to friction and subsequently reduction of its life. Oleophilic material offers less wearing property as compare to polyurethane so ultimately Oleophilic belt is choose to use in Oil skimmer.

C. Model

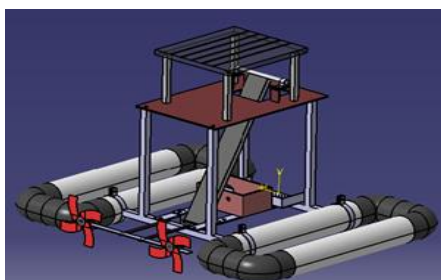


Fig. 7: 3D CAD model of oil skimmer

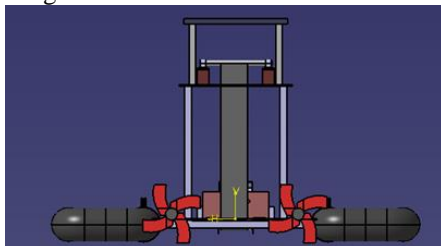


Fig. 8: Front view of Oil Skimmer



Fig. 9: Implemented Model

IV. ADVANTAGES

There are many advantages of this system as explained below:

- No external power is needed of skimming when used with solar power
- It reduced oil pollution of sea.
- Increase in tool life.
- Increase in coolant life.
- Better quality can be obtained.
- Increase in surface finish & accuracy.
- Increase in production rate.
- Increase in coolant supply.

V. APPLICATIONS

- Centre less grinding machine.
- Cylindrical Grinding machine.
- Surface Grinders.
- Automats Milling Machine & where coolant separation is necessary.

VI. CONCLUSION

In this paper we have implemented oil skimmer system which separates oil from the water. The main causes of oil spills are carelessness of transporting authority and changing weather conditions like storm will results spilling of large tones of oil in water. This spilled oil is waste oil it destroys the coastal life around it. Oil spillage results in loss of lives and money. So the recovery of spilled oil is very necessary. So we have implemented oil skimmer system which can be operated using Bluetooth. The system is designed and tested and it shows that it can regain most of the oil from the water.

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