Experimental Investigation of Roller Type Oil Skimmer

Patel Harikrushanbhai Ashokbhai[1], Patel Punitkumar Jayantibhai [2]
[1, 2]Dept of mechanical engineering
[3]Asst. Prof., Dept of mechanical engineering
[1, 2, 3]Bits edu campus, Vadodara – Mumbai NH # 8, Varnama, Vadodara -391 240, India.

Abstract- *During the recent decade's world has witnessed big oil spillage accidents into ocean and made huge impact to the environment and marine life. Oil spills is enter from the many sources like ship accidents, Oil spills into rivers, bays, and the ocean most often are caused by accidents involving tankers, barges, pipelines, refineries, drilling rigs, and storage facilities. Oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution. The term is usually applied to marine oil spills, where oil is released into the ocean or coastal waters, but spills may also occur on land. Every year approximately 706 million gallons oil waste is enter the oceans. Herewith, the objective of this project is to design and conduct efficiency studies of roller type oil skimmer by using various roller materials. The roller absorb the oil from water which can be collected by using of the aluminum stripe and store into a vessels. The collected oil can be use for many purposes.*

Keywords: Roller type oil skimmer, Material of roller, function of oil skimmer, roller bloomer.

I. INTRODUCTION

Oil is one of the precious crude and being used in many routine application of human life. Since most of the oil are toxic so quite dangerous for alive when it comes to direct contact with them. Generally, Industries prefer density difference method for separation of oil from water. In this process oil-water mixture is kept in a large barrel for obtaining density difference. This process would take around 7-8 months. After that the separated oil is taken out from the barrel. During the period of 7-8 months, the company cannot use oil for other purpose. Hence this method is time consuming.

Our project is a Roller type of Oil Water Separator which works on the principle of adhesion of the oil to the roller materials. The water drops out from roller and which is falls back into the tank or vessel. The roller is attached on the shaft and shaft is rotated by using of motor, and oil is collected by the L-shape aluminum strip. L-strip collected oil is stored in vessel or tank with the help of piping or valve arrangement.

II. DESIGN CALCULATION

The main important calculation is shaft, in our project we use simply supported shaft both the end and is design calculation is below. We use 220 mm length boat is use so shaft is also use 220 mm.

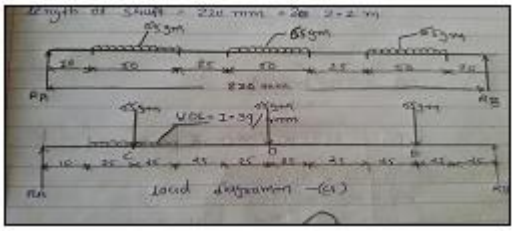


Fig (01) Shaft schematic diagram

Given data Power (P) = 12V
Length of shaft = 220 mm = 2.2 m
Speed (N) = 150 RPM
D=?
Torque on shaft

$P = 2\pi NT/6012 \times 10^3$

$= 2 \times \pi \times 150 \times T / 60$

$=60 \times 12 \times 10^3 / 2 \times \pi \times 150$

$T= 763.95\ N/mm^2$

Shown loading diagram fig no 01

$$RA + RB = 195 \quad \text{..... (1)}$$

Taking moment about point A=0

$$0= (65 \times 35) + (65 \times 110) + (65 \times 185) – (RB \times 220)$$

$$= 21450 – (RB \times 220) \quad \text{..... (2)}$$

Put the RB value on equation no (1)

$$RA + RB = 195$$
$$RA + 97.5 = 195$$

RA = 195-97.5
RA = 97.5 gm

Bending moments at point C, D, E

MC = (RA x 35) – (32.5 X 12.5)
= (97.5 X 35) – (32.5 X 12.5)
MC = 3006.25 gm
MD = (9705 x 110) – (65 x 75) (32.5 x 12.5)
= 5443.75 gm
ME = (97.5 X 35)-(32.5X12.5)
= 3006.25 gm
Maximum bending moment is M = md 5443.75 gm
Or
5.443 x10^3 N/mm.

Equivalent twisting moment is given by

$$Teq = \sqrt{T^2 + M^2}$$
$$= \sqrt{(763.95)^2 + (5054\ X10)^3}$$
= 5592.42 N/mm

Teq = π x D^3x τ /16 (By strength critical for shaft design)

5592.42 = π/16 x D^3 x 60

D^3= 5592.42 x 16 / π x 60

D^3 = 474.69

D = 7.85 mm Or 8 mm shaft

III. COMPONENTS DESIGN

Galvanize sheet
Material: - Galvanize iron plate
Length: - 2000 mm
Width: - 2000 mm
Thickness: - 1 mm

Specification of roller
Material:-PVC
Outer Diameter:-65mm
Inner Diameter:-8 mm
Thickness:- 50 m

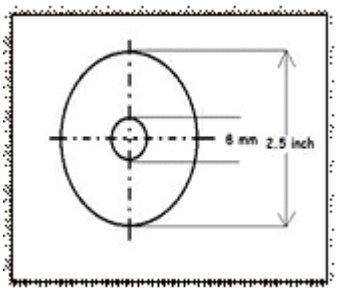


Figure no 02. Roller design

Shaft clamp

To support the shaft we use shaft clamps with 8 mm centre hole, both are welded back side of the boat body.

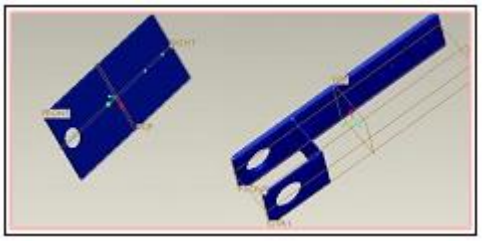


Figure no 3. Shaft clamp

Aluminum stripe

Three thin aluminum strips are attach at the top of rollers by which recovered oil is collect in to the storage tank by the help of aluminum strip. Strip size 40 mm X 20 mm X200mm.

IV. SELECTIONS OF ROLLER MATERIALS

Selection of roller material is based on polar non-polar properties of roller material, Water consists of polar molecules as H+ and OH- & the oil does not consist of any polar molecules, it is a non-polar element. Polar molecules attract each other and non-polar molecules attract each other and gets stacked with each other. Hence water and oil will form a separate layer in the reservoir. Hence we will be selecting such an appropriate material for the belt which will be non-polar in nature and oil while being attracted towards it gets stacked to it, and will permit easy lifting of it. So we are choosing poly belts (non-polar), asbestos rubber, PVC.

Fig no 4: Polar-non polar properties of oil and water

Adhesive property of oil is being greater than water. So we will select such a material for the belt having adhesive property greater than water and having close to oil, hence it will permit easy adsorbing of oil over the belt and easy separating from the water. Water having less adhesive

property will not easily stick to the belt and will remain in the reservoir.

V. MANUFACTURING AND ASSEMBLY

Fabrication of boat

We have perches galvanize metal sheet because of galvanize is corrosion resistance and start manufacturing boat body. First we have cut 490mm x 250 mm size sheet cut and top of the sheet body give semi spherical shape for base of boat body, and then cut 120 mm height and 490 mm sheet cut and use fly press bending, soldering and spot welding is use to joint ship body

Roller and shaft attachment

Roller is made by PVC pipe outer diameter 60mm and attached on shaft by using of favibond and hot glue gun. And fixe the roller buy using of the bolt.

Figure no 5 Roller and shaft attachment

Finally all parts like roller, shaft, are mounted on main ship body by using of the shaft C-clamp. After assemble all part and then testing it. Now the vessel is filled with mixture of oil and water. The oil that can be used for testing is castor oil or waste engine oil. The motor are connected to the shaft .The motor speed is adjusted low speed.

Figure no 6: Final attachment

VI. RESULT DISCUSSION

After working of oil water separator skimmer, we have observed how much spilled oil separated from mixture of oil-water in 10 minutes. Here we have taken tow oil sample that have different viscosity, and we observed result.

- Waste garage oil
- Castor oil

Results obtained for waste garage oil:

- PVC roller separated 100ml oil in 10 minutes when the motor was run at 60 revolutions per minute.
- Asbestos rubber roller separated 90ml oil in 10 minutes when the motor was run at 60 revolutions per minute.
- Poly belt rubber roller separated 110ml oil in 10 minutes when the motor was run at 60 revolutions per minute.

Results obtained for Castor oil:

- PVC roller separated 80ml oil in 10 minutes when the motor was run at 60 revolutions per minute.
- Asbestos rubber roller separated 70ml oil in 10 minutes when the motor was run at 60 revolutions per minute.
- Poly belt rubber roller separated 90ml oil in 10 minutes when the motor was run at 60 revolutions per minute.

Observation table:

We have experiment for waste engine oil and collect oil, collected oil measure density for 10 mm and also find the viscosity of oil by using Oswald viscometer. And find the efficiency of collected oil, observation table is shown is below.

Table 1:- Observation table

Sr. no	Oil type	Roller material	Quantity of oil is ml	Density (kg/m^3)	Time taken in viscometer
1	Waste engine oil	PVC	10	0.939	800 sec
2	Waste engine oil	Asbestos	10	1.018	870 sec
3	Waste engine oil	Poly belt	10	1.003	860 sec

Oil viscosity & efficiency measurement

By using Oswald viscometer, we have measured the resultant oil viscosity of before and after separation.

Oil viscosity can be determined through poiseuilles law. The expression which governs the flow of liquid the capillary is given as:

$$\eta = \frac{P \pi r^4 t}{8 L v} \quad \text{.....(3)}$$

Where,

V =Liquid volume flowing through capillary in time
P = Pressure head
L = Length of pipe
T = time taken by liquid to flow
Let t1 and t2 be the time of the flow of a fixed volume(V) of the tube liquid thrown the same capillary and viscosity of liquid can be determined as follow:

$$\eta \text{ oil} / \eta \text{ water} = p1\ t1 / p2\ t2$$

Since the pressure head is proportional to density by liquid:

$$\eta 1 / \eta 2 = \frac{d1\ t1}{d2\ t2} \quad \text{..... (4)}$$

VII. PROCEDURE

1. Weight accurately of empty pyknometer.
2. Add 10ml water in pyknometer.
3. Calculate the density of water.
4. Calculate the density of separation oil.
5. Calculate the density of pure oil.
6. Determine the time of flow for different oil with the help of Oswald viscometer.
7. Calculate the viscosity of oils.

Calculation

Time for flow of water (twater) = 6.40 sec
Density of water = 0.99 kg/m^3
Viscosity of water = 0.01 poise

- **Before use**

Weight of empty bottle (W1) = 28.69gm
Weight of oil filled bottle (W2) =38.72gm
So, weight of oil = W2 – W1
= 38.72 – 28.69
= 10.03 gm.

Density of this oil = weight / Volume
= 10.03 / 10
= 1.003 kg/m^3
Oil takes a time for flow in viscometer = 1000 sec (16.40 min).

$$\eta oil = \frac{d(oil) \times t(oil) \times \eta(water)}{d(water) \times t(water)}$$

$$= \frac{(1.003) \times (1000) \times (0.01)}{(0.99) \times (6.40)}$$

= 1.5869 poise
Or
158.69 centipoises

- **After separation**

Weight of empty bottle (W1)= 28.69 gm.
Weight of oil filled bottle (W2) = 38.87 gm.
So, weight of oil = W2 – W1
= 28.69 – 38.87
= 10.18 gm.

Density of this oil = weight / Volume
= 10.18 / 10
= 1.018 kg/m^3
Oil takes a time for flow in viscometer = 870 sec (14.30 min).

$$\eta oil = \frac{d(oil) \times t(oil) \times \eta(water)}{d(water) \times t(water)}$$

$$= \frac{(1.018) \times (870) \times (0.01)}{(0.99) \times (6.40)}$$

= 1.390 poise
Or
139.061 centipoises
And same process for all roller materials.

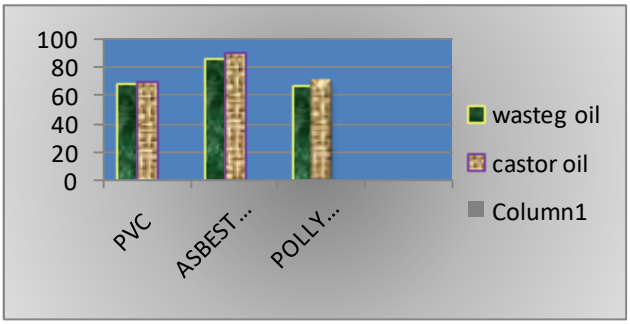
Result table:-

Table 2:- Result table

Sr. no	Material	Density (kg/m^3)	Time taken in viscometer	Viscosity in centipoises		η(%)
				BEFOR	AFTER	
1	Pvc	0.939	800 sec	158.30	106.70	67.40
2	Asbestos	1.018	870 sec	158.30	139.06	86.70
3	Poly belt	1.003	660 sec	158.30	104.47	66

As per above result table we made below graph, is the experimental result of oil recovery of oil skimmer by using

of deferent type of oil and roller materials. And all data in graph are in percentage of the efficiency.



VIII. CONCLUSION

In this project, we enforced to highlight the function of oil skimmer, its various design aspects and performance. As per over project modal oil recovery rate is high on poly belt but poly belt collected oil water contain is more as compare to PVC and Asbestos roller. So oil refinery cost is increase in poly belt. But In asbestos roller is give very small amount of water practical after the oil separation , as compare to other roller materials, and give 86.70% oil recover from this asbestos roller materials. As practical overview of different oil spillage cleanup method, this paper has illustrated several limitation of this method and current oil spill technology, further extensive research and testing can improve the existing techniques .

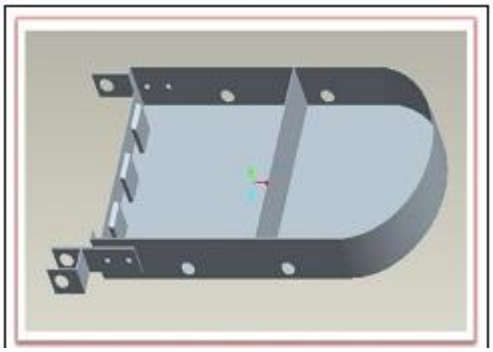
REFERENCE

[1] M.Husseien; A.Amer, A.Ei Maghoraby, N.A. Toha," Availability of barley straw application on oil spill cleanup" Int. J.Environ, Sci.Tech, 6(1), 123-130, winter 2009
[2] K Subramanian, Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill
[3] M.Patel, "Design and efficiency of various belt type oil skimmers, "International Journal of Science and Research. 2319-7036
[4] National Research Council", "Understanding oil spill dispersant and its effects", National Academic press, Washington, 2005.
[5] P.Grills, F.Linde, "oil skimming" Business potential and Strategic options facing a marginalized Bossiness segments at Sandvik process systems.
[6] "A Free Floating Endless Belt type oil skimmer", Journal of United States Environmental Protection Agency Aug-1972
[7] R.S. Khurmi and J.K.Gupta, Machine Design-I, S chand
[8] V.B.Bhandari, "Design of Machine Elements".
[9] Abanaki oil water skimmer for belt selection guide.
[10] Study of different type of oil skimmer for site www.oil skimmer .com

OTHER PHOTO GRAPH


Wastage oil separation


Castor oil separation


3D Modal of boat


Viscometer snap

AUTHOR PROFILE

Harikrushanbhai Patel received the B.E degree in mechanical engineering from BITS EDU CAMPUS, Vadodara in 2017 & receive diploma in mechanical engineering from N.M.Gopani polytechnics institute Ranpur in 2014.

Punit Patel received the B.E degree in mechanical engineering from BITS EDU CAMPUS, Vadodara in 2017.