

ANALYSIS OF BELT TYPE OIL SKIMMER

Thombare Babasaheb B.¹, Barse Babasaheb N.², Barhate Ganesh B.³, Kolhe Sani M.⁴, Jagtap Harshal B.⁵

1BE student Mechanical, SND COE & RC, YEOLA, Maharashtra, India

2BE student Mechanical, SND COE & RC, YEOLA, Maharashtra, India

3BE student Mechanical, SND COE & RC, YEOLA, Maharashtra, India

4BE student Mechanical, SND COE & RC, YEOLA, Maharashtra, India

5Asst.Prof. Mechanical SND COE & RC, YEOLA, Maharashtra, India

ABSTRACT

Nowadays there are lots of oil accidents happening in the ocean and it makes huge impact on environment. Due to Sea accidents can further cause oil pollution. So the oil separator systems are necessary in such cases. Various oil separator systems are available currently all over. In oil separator systems belt is one of the most important component. Different types of belts are been in use in these systems. Performance and efficiency of these systems mainly depends on the type of belt & belt material use in the system. So it is necessary to study and analyze the performance of various types of belts in order to select proper belt for better performance. In this paper we are taking a review of various types of belt materials used, research work done on oil skimmers and their belt materials.

Keyword - oil skimmer, polyurethane belt, pollution, crude oil etc.

1. INTRODUCTION

Oil is one of the most precious crude and being used in many everyday application of human life. Since most of the oils are poisonous so quite dangerous for alive when it comes to physical contact with them. Many countries have made strict safety norms for waste water disposal contained with oils mainly typically from petrochemical and process industries so that such industries are equipped with such kind of oil skimmer to separate oil from disposal water.

The continuous removal of oil from process fluids, increases the life of fluid; resulting of:

- a) Reduction in the machine fluid refilling cost
- b) Improves the disposal water quality.

What is oil skimmer?

It is the process of removing or separating the oil from the oil polluted coolant or oil from oil & water mixture. The oil and the coolant in the mixed form is collected in the containers. And one of the following classified methods are adopted to separate the oil from the coolant.

- a) By separating the oil from the coolant by aggressively pouring the upper layer of mixture in the another container
- b) By soaking the oil layer using oil soaking element.
- c) By skimming oil using flat belt arrangement.

The first two methods are not accurate also these are time consuming and it requires sort of skill for it's execution. The later one is simple and the oil can be separated without any fatigue and the process is accurate.

Types of oil skimmers:

1. Disc skimmers
2. Drum skimmers
3. Rope skimmers
4. Brush skimmers
5. Belt skimmers

Philip C. Lewan et al [1992] had studied apparatus for removing oil from the surface of a liquid using an endless belt partially submerged in the liquid, the belt passes over a primary roller having a vertical axis and pressure rollers squeeze the belt on the primary roller removing oil from the belt which allows by gravity to a collection receptacle mounted upon a frame supporting the primary roller and its drive structure. The belt twists whereby its lower portion submerged in the liquid denotes a reversing loop whose configurations maintained by a weight roller having a horizontal axis of rotation. Mamta Patel [2015] had studied the function of oil skimmer, its various design aspects and performance. All the results of experimental studies indicate that slight design improvement of typical oil skimmers towards to include additional belt shaft and use of belt with steel material instead of rope; significantly improve the oil recovery efficiency and also its structure became simpler. As practical overview of different oil spillage cleanup method, this paper has illustrated several limitations of these methods and current oil spill technology. Further extensive research & testing can improve the existing techniques and equipment to have better control for oil recovery exercise. A set of experiments had been conducted by using various oils and different materials of belt to understand the oil recovery performance and viscosity deviation of oils before and after separation. Prof. P.A. Patil et al [2017] had concluded that the separation of oil is based on surface tension, specific gravity and viscosity. He studied the operation of oil skimmer on various positions of the belt like inclined, vertical, horizontal.

As per prof.P.A.patil, the separation of oil is based on surface tension, specific gravity and viscosity. Y [4].

1.1 PROBLEM STATEMENT

During the recent decade, World has witnessed big oil spillage accidents into ocean and made huge impact to the environment. Apart this, sometimes Oil is getting spillage through being the results of chronic and careless habits in the use of oil industries and oil products. It is estimated that approximately 706 million gallons of waste oil enters the ocean every year; whereas more than half of that sourced from land drainage and waste disposal

2. METHODOLOGY

The general steps to be followed in designing the machine are as followed..

- i) Selection of groups of mechanism for the desire motion.
- ii) Calculation of the force and energy on each machine member.
- iii) Selection of material.
- iv) Determining the size of component drawing and sending for Manufacture.
- v) Preparation of component drawing and sending for manufacture.
- vi) Manufacturing and assembling the machine.
- vii) Testing of the machine and for functioning.

3. CONSTRUCTION

In this machine belt nylon-fiber plays important role the endless belt rolls over the roller smashing over the surface of the coolant picking up the oil at the upper layer. The belt is power driven using the gearbox and electric motor as the prime mover.

The drum & belt assembly rotates along with shaft. The shaft is placed in the bearing housing with the bearing. These bearings are bolted to the main body. There is a slot provided in the bearing housing for true alignment of drum. Drums are placed close to each other at some considerable distance inclined with each other at an angle of 180° to increase oil contact surface. Catching power of the belt and its capacity depends on the circumferential distance at the roller or the drum shell, with this the belt is able to attract the oil only towards it and thus separation of oil layer is possible. The tray with flow mouth is placed beneath the drum scribing plate provided in front of drum shell & is fixed by fixing knobs. The roller is placed as shown in assembly drawing.

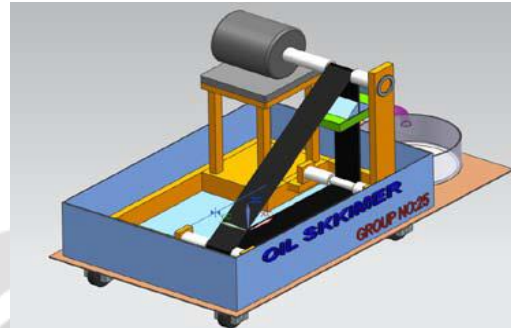


Fig.3.1 3D CAD model of oil skimmer conceptual model [3]

4. WORKING PRINCIPLE OF OIL SKIMMER

The coolant fluid mixed with oil that loose from the lubricated components such as guide ways or reciprocating components is required to be separated. Most of the machine tools such as all types of grinding machine, automates milling machine etc. the coolant after flowing over the cutting edges, loses its quality due to the mixing of oil. Also it spoils the pump or conveying pipe lines. The coolant is made to flow in to the collecting tank. From there it is attracted towards drum-belt surface when it flows over the surface with the roller. The upper rollers are actuated with the help of setscrew to raise or lower down to tighten or loosen the belt. Oil in the coolant container tank floats at the upper layer is separated and sticks up to the belt due to adhesion between the belt material and the sticky property of the oil. It is then collected in the tray and another tank (container) and pure coolant is again re-circulated for its use in machine tool.

5. CALCULATIONS

Linear Velocity of Belt

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

For Driver: $V_1 = \pi dN/60$

For Driven: $V_2 = \pi dN/60$

b) **Velocity Ratio** = V_1/V_2

Torque & Tension in Belt

Power is calculated through
 $2\pi NT/60$

where, N = Motor Speed

T = Torque transmitted by Motor

Whereas, Force is calculated by,

$$T = F \cdot R$$

Tension in the tight and slack sides to be calculated by,

$$T = (T_1 + T_2) \cdot R$$

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

5.1 Analytical calculation

Let us assume,

T=Thickness of film on belt in mm.

W=Width of 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 40 rpm.

Here we assume 1mm. thickness of oil film

Volume rate = Thickness of film \times Width of belt \times circumferential area of shaft \times speed rotation of shaft

$$V=t \times w \times \pi \times d \times N$$



Fig5.1.-Actual construction of oil skimmer.

Table no. 5.1 selection of material

SR NO	COMPONENT	MATERIAL	STEEL CODE
1	Angle for stand	Mild steel	C-45
2	Roller shaft	Bright steel	C-45
3	Frame	Mild steel	C-25
4	Shaft	Bright steel	C-45
5	Rests	mild steel	C-25
6	Holding block	Mild steel	C-25
7	Container sheet	Mild steel	C-25
8	Sheet	Mild steel	C-40
9	Nut bolt & washer	Mild steel	C-45

10	Belt	polyurethane	
11	Plummer block	Cast iron	
12	Nut bolts and washer	M.S	
13	Single row ball bearing	Chromium steel	6204

6. APPLICATIONS: -

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

7. ADVANTAGES:-

- 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.
- Increase in the life of coolant pump.

8. LIMITATION




- Oil skimmer can separate only adhesive oil fluid particles.
- It can separate the oil which can float on the coolant.

9. CONCLUSIONS

From above observations the polyurethane belt is having better oil skimming capacity. It removes about 60 to 70 litre per day. Polyurethane belt is very convenient for skimming oil for operator. It is efficient and economical for removing the oil. It is more convenient to use where less noise operation is required.

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	<p>Thombare Babasaheb B. SNDCOE &RC, Yeola, Pune University, Department of Mechanical Engineering.</p>
	<p>Barse Babasaheb N. SNDCOE &RC, Yeola, Pune University, Department of Mechanical Engineering.</p>
	<p>Barhate Ganesh B. SNDCOE &RC, Yeola, Pune University, Department of Mechanical Engineering.</p>
	<p>Kolhe Sunny M. SNDCOE &RC, Yeola, Pune University, Department of Mechanical Engineering.</p>
	<p>Mr. Harshal Balasaheb Jagtap, Asst. Professor, Mech. Engg. Dept, SNDCOE & RC, Yeola M. Tech. (Heat Power Engg.)</p>