

**FABRICATION AND TESTING
OF
“BELT TYPE OIL SKIMMER”**



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Submitted in the partial fulfilment of the requirements for the degree of Bachelor of Engineering in Mechanical.

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CERTIFICATE

This is to certify that “**Final year project report on, FABRICATION AND TESTING OF BELT TYPE OIL SKIMMER**” is submitted in partial fulfilment of the requirement for the degree of Bachelor of Mechanical Engineering and is entirely written by the following students under the supervision of Engr Farhan Haider Joyo:

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DEDICATION

We are delighted to dedicate this project to all those who love the nature and strive hard to preserve it!

“Protect and adore the pale blue dot, it’s the only home we’ve ever known.”

ACKNOWLEDGEMENT

First of all we would like to thank Almighty Allah for His countless blessings upon us, we could have never completed this project without His supreme authority.

After that, we would be thankful to our honourable Supervisor Sir Engr. Farhan Haider Joyo for his immense support and consistent motivation throughout this wonderful teamwork experience.

A special thanks to Prof. Dr Abdul Fatah Abbasi the Chairman, Mechanical Engineering Department, for his cooperation in granting us access to labs of department and using equipment for gathering necessary data to complete this project.

Last but not the least We are immensely thankful and grateful to our Parents, without their helping hands we could have never achieved this milestone!

ABSTRACT

One of the most valuable crudes, oil is employed in numerous aspects of daily life for humans. Since the majority of oils are hazardous, coming into physical touch with them poses a serious risk to human life and other animal life. Many governments have established stringent protection standards for the disposal of wastewater containing oils, frequently from petrochemical and system sectors, requiring that these firms use a range of oil skimmers to separate the oil from the wastewater, so that it may help in the reduction of pollution.

It helps in the Reduction of the machine fluid refilling cost. It improves the disposal water quality. This oil separation is done by using Belt Type Oil Skimmer It uses a non-polar material belt which carries oil from the wet sump of disposal water over its surface by rotational motion provided by a DC motor of low RPMs and is separated by scraper and collected in the container. This project aims to protect the sea life and reduces the oil refilling cost.

In the testing of this Oil Skimmer we have found that this skimmer works efficiently even on heavy viscous oils. From the different experiments and relations of different parameters we have observed that increasing speed increases oil flowrate. By increasing the rotation power consumption is increased from 104.47 watts to 110.70 watts. Also, the speed and torque relation shows that if the speed is increased the torque is decreased and vice versa.

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List of Abbreviations

3D	Three Dimensional
CAD	Computer Aided Design
DC	Direct Current
RPM	Rounds Per Minute
P	Power
T	Torque
V	Volume
v	Voltage
I	Current
Q	Flow rate
t	Time
N	Motor Speed

CHAPTER 01

INTRODUCTION

1.1 BACKGROUND

When WE contemplate oil spills, we typically think of oil ships dumping their cargo into oceans or seas. However, oil spilt on land frequently makes its way to marshes, lakes, and rivers, where it may also cause damage. Marine ecosystems include oceans and other saltwater bodies. Freshwater ecosystems are referred to as lakes, rivers, and other inland water bodies of water. Both freshwater and marine ecosystems are included under the umbrella term aquatic. When oil spills into an aquatic environment, it can harm both organisms that dwell below the water's surface and those that linger on or near the water's surface. Additionally, spilled oil can affect sources of human food and other components of the food chain. The intensity of an oil spill's effects relies on a variety of factors, containing qualities of the oil itself. The weather, water temperature, and other natural conditions all have an impact on how oil behaves in aquatic habitats. Different habitat types also respond differently to grease spills.

Oil spillage is not only due to some random incidents of cargo ships, but many industries also spill oils into the oceans which leaves harmful impact on the environment as mentioned above.

To coverup these oil spillages a term “Oil Skimming” is used, which is related with the separation of oil from water or any other fluid mixture.

Oil skimming is done by various methods like;

- **Weir skimming:** A dam or enclosure placed at the oil/water interface is used by weir skimmers. As little water as possible will be carried away by the oil that spills over the dam and is trapped in a well inside. The trapped oil and water mixture can then be pumped out through a pipe or hose and into a storage tank for recycling or disposal. These skimmers frequently become clogged and jammed by floating material.

- **Oleophilic skimming:** Oleophilic (oil-attracting) skimmers wipe the oil from the water's surface using discs, belts, or continuous mop chains made of oleophilic materials. In a recovery tank, the oil is then scraped off or squeezed out. The flexibility of oleophilic skimmers makes it possible for them to be employed successfully on spills of any thickness. On water that is clogged with debris or rough ice, some varieties, like chain or "rope-mop" skimmers, perform effectively.
- **Suction skimming:** A suction skimmer functions similarly to a regular vacuum. Wide floating heads are used to collect oil, which is then pumped into storage tanks. Suction skimmers are typically quite effective, although they can get clogged with junk and need continuous, expert supervision. On calm water when oil has accumulated against a boom or barrier, suction skimmers perform best.

This project is based on the **oleophilic skimming** and furthermore its **Belt type oil skimmer**, to coverup the oil spillage from industries.

1.2 PROBLEM STATEMENT

During the latest decades, World has witnessed large oil spillage accidents into ocean and made massive have an effect on to the environment. Oil leakage from ships and submarines causes the big loss of money. Oil spills can occur both in water as nicely as on land, such as spills from oil companies, industries and factories. The oil used in chemical facilities, utility plants, and meeting traces are often prone to spilling due to the fact of a variety of safety breaches and mishaps.

During the specific strategies the oil is wasted, and it results the large oil refilling costs. Oil can be poisonous, it's presence at some point of water waste disposal from industries results the extreme water air pollution which influences the sea lifestyles and in the end our lives

Following are the few dangerous impacts of oil spills:

Sensitivity of Birds and Mammals

There are many ways that an oil spill can harm birds and mammals, including direct physical contact, toxic contamination, habitat destruction, reproductive issues, and disruption of food sources.

- **Physical contact** –Fur and feathers become matted down when they encounter oil. Animals are at risk of freezing to death because of the matting, which causes fur and feathers to lose their insulating qualities. When the intricate feather structure that allows birds to fly or flow with the environment is broken, the risk of drowning increases.
- **Toxic contamination** –Inhaled oil vapours can be harmful to some animals, so be careful. Oil vapours have the potential to harm an animal's lungs, liver, and nervous system. Consuming oil puts animals at risk since it can interfere with their capacity to ingest or digest food by employing unfriendly intestinal cells.
- **Destruction of food resources and habitats** –A spill can endanger species that are not currently in direct touch with oil. The consumption of polluted prey by predators can expose them to oil. Predators can refuse to eat their prey and start starving because oil contamination gives fish and other animals unpleasant tastes and odours. Sometimes a population of surrounding prey organisms is wiped out, depriving predators of food sources. Depending on the surrounding conditions, the oil spill may potentially remain in the area for extended periods of time, causing additional harm. Oil that interacts with rocks or sands might remain in the area for a very long time in calm water conditions.
 - **Reproductive problems** –Oil can be carried from the feathers of birds to the eggs they are hatching. Eggs can become suffocated by oil if the pores in the eggs are sealed, limiting gas exchange. Embryos of birds exposed to oil showed developmental consequences, as well, according to scientists. The spill may also decrease the quantity of breeding animals and nesting

places. Animals exposed to oil have also demonstrated long-term reproductive issues in other studies.



Fig: 1.1 Oil affected dead fish



Fig: 1.2 Oil affected Bird



Fig: 1.3 Oil Refilling.

So, to avoid this oil spill from industries we have fabricated this “**Belt Type Oil Skimmer**” for industrial wastewater. It will reduce the oil refilling cost of machines or oil used in any other industrial activity and it will reduce the water pollution and it will improve the wastewater disposal technique.

1.3 OBJECTIVES

Following are the objectives which are aimed to be achieved;

- Developing the 3D CAD model on solid works.
- Fabrication of the prototype of Belt Type Oil Skimmer.
- Testing of the prototype.

1.4 SCOPE OF PROJECT

This **Belt Type Oil Skimmer** has a wide scope. It can be used in various process industries like; petrochemical industries, food industries and many other industries which spill oils.

This type of skimmer can be used in wastewater sumps, coolants and cutting fluids, Heat Treating activities, food processing facilities, steel mills/scale pits, parking lots/garages and service facilities and recovery wells etc.

Most of the oils float on the water surface only few heavier oils settle in the bottom.

So, this **Belt Type Oil Skimmer** will separate only those oils which will float on the water surface.



Fig:1.4 Floating Oil.

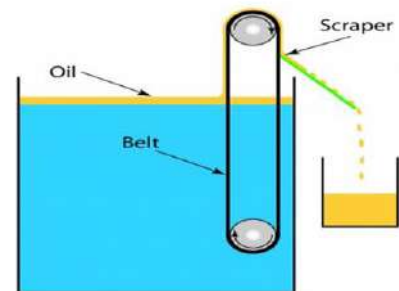


Fig: 1.5 Simple Diagram of Belt Type Oil Skimmer.

CHAPTER 02

LITERATUREREVIEW

2.1 Overview

Oil spills are very dangerous to environment so to coverup these oil spills many new ideas are being discussed and much research is ongoing about these oil recovering systems.

As this technology is not old enough so, few of the following are some analytical and experimental research.

Their summaries.

- I. **Thombare Babasaheb B, Barse Babasaheb N, Barhate Ganesh B, Kolhe Sani M and Jagtap Harshal B**, analyse the working of belt type oil skimmer using polyurethane belt and conclude that polyurethane is the most suitable choice for belt material because of its cost effectiveness to working efficiency. Furthermore, they have concluded that polyurethane belt is more efficient material for removing oil and it is very much suitable for noiseless operation of oil skimmers. They have practically found that this oil skimmer is separating oil from water about 60 to 70 litres per day.[1]
- II. **S. Siva and P. Praveen**, analyse the working of oil skimmer and its different design parameters. They have used garage waste oil, SAE40 oil and the mixture of both for oil skimming process and they have found that the skimmer is proved to be 86% efficient on garage waste oil, 92% efficient on SAE40 oil and 88% efficient on mixed oil of garage waste oil and SAE40 oil. They conclude that by using steel belt shaft instead of using rope improves the oil recovery efficiency and they recommend that there should be furthermore extensive research and analysis is required over the small changes of parameters of oil skimmer to check the efficiency of oil skimmer.[2]
- III. **Prof. Kamble S. P., Mr. Salunke Aniket Audumbar, Mr. Rajurkar Saurabh Anil, Mr. Mendake Dhiraj Pradip and Mr. Shinde Prathmesh Prakash**, have fabricated a oil skimmer for the experimental

analysis and they review the different design parameters and the limitations of belt type oil skimmer in different applications, they suggest the different applications of oil skimmer in garages, parking lots, food processing facilities and other activities which are supposed to spill the oil during the continue operation. They have suggested that there should be proper wet sump system to recover these wasted oils before they are drained into the rivers, lakes or ultimately into the oceans.[3]

IV. **Mamta Patel**, carried experimental research on oil skimmer by fabricating a prototype of oil skimmer of belt type. She has used a triangular shaped oil skimmer which provides a relatively longer belt to oil skimmer and it provides good oil recovery. She is using different materials of belts and different types of oils i.e. garage waste oil, SAE40 oil and the mixture of both to carry an experimental research and she compares the oil recovery efficiency of the oil skimmer. She has found that the oil skimmer's efficiency on garage waste oil, SAE40 oil and mixed oil is about 86%,92% and 88% respectively.[4]

V. **Peter Grill and Fredrik Linde**, work on different business and strategic aspects of oil skimming systems in different applications. They have suggested different business potential in the manufacturing of oil skimmers. they develop the business model of selling oil skimmers for different applications i.e., offshore, and industrial applications. They have worked on this business analysis with the contribution of Sandvik company of oil skimmers which manufactures these oil skimmers. Peter Grill and Fredrik Linde have thoroughly described the need of oil skimmers in the under developing water management agencies of different oil spilling industries and other workstations.[5]

Chapter 03

METHODOLOGY

3.1 INTRODUCTION

This chapter contains all the methods which are followed in the fabrication and testing of this “Belt Type Oil Skimmer”. Before fabrication of this “Belt Type Oil Skimmer” a brief 3D model is developed by using the SolidWorks software. And a tachometer is used to find out the speed of pulley shaft in (RPMs).

3.2 METHODOLOGY

This is divided into following major sections.

3.2.1 Design Parameters and development of 3D model:

So, let us divide this section into two parts described as under:

a) **Design Parameters:** The design parameters are inspired from a research paper [3], written on this Oil Skimmer which is mentioned in the **Chapter02 LITERATURE REVIEW** and the design is not completely the same as we have designed in the Solid works.

Following design parameters are taken to develop the 3D model of our prototype;

- i. Total height of the Belt Type Oil Skimmer is **3ft.**
- ii. Width of the Belt Type Oil Skimmer is **1.25ft.**
- iii. Base length of the Belt Type Oil Skimmer is **2.5ft.**
- iv. Top Length of the Belt Type Oil Skimmer is **1.83ft.**
- v. Diameter of pulley’s shaft is **1.5inches.**
- vi. Inner diameter of the bearing block is **1.5inches.**
- vii. Diameter of the pulley is **3inches.**
- viii. Width of the Polyurethane belt is **4inches.**
- ix. Length of the polyurethane belt is **5ft.**
- x. Thickness of the belt is **3mm.**
- xi. Width of the scraper is **5inches.**

b) Development of 3D model: Using the above design parameters the 3d model of the Belt Type Oil Skimmer is developed in solid works.

Its detailed model is given as below in the picture:

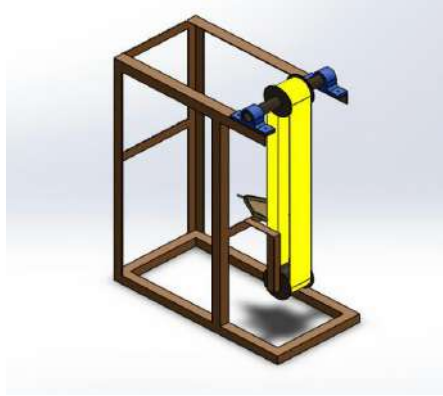


Fig: 3.1 Isometric view of 3D CAD model

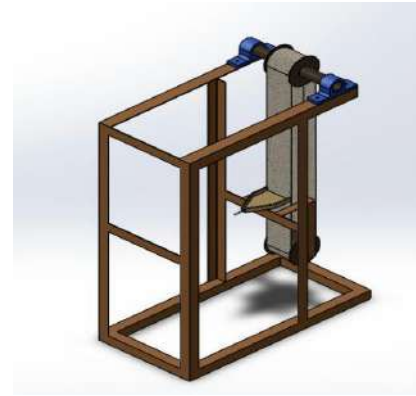


Fig:3.2 Isometric view from Back.

3.2.2 Selection of material and components for fabrication:

There are different components used in the fabrication of this Belt Type Oil Skimmer. Its detail and material selection is described as under;

a. Structure: Structure is one of the main and founding part of the fabrication of any prototype or any project. In fabrication of this Oil Skimmer the structure is made up of “**Structural Steel**” which gives sufficient support and strength in bearing the different forces and pressures. It also provides the support to the other components of Oil Skimmer. Structure is made up of **Angle** shaped Structural steel and these Angle shapes are joined by **arc welding**.



Fig: 3.3 Structure.

b. Belt: Belt of this Oil Skimmer is the main component which is responsible for the separation of **oil** and other **oleophilic** toxic fluids from the wastewater being disposed from industries. It is made up of the **non-polar** material called **Polyurethane** which attracts the oleophilic fluids and these fluids are

deposited over the belts surface because of basic chemical principle of **non-polar material attracts non-polar material**.

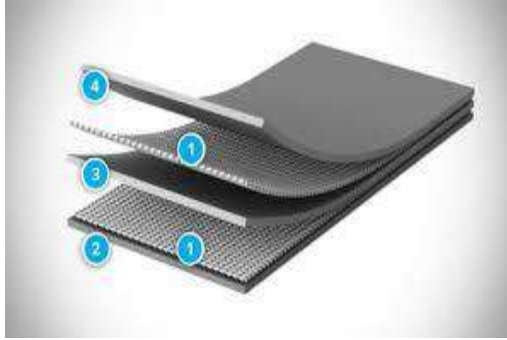


Fig:3.4 Polyurethane Belt



Fig: 3.5 Belt and Pulley assembly

- c. Pulley:** Pulley is used to support the cable or rope or any elastic material long wires and belts. It also transfers the power from one point to another. In this Oil Skimmer we have used two pulleys to support the polyurethane belt and transfer the power obtained from DC motor to the belt via shaft in the rotation of belt. It is made up of steel.

- d. Bearing Block:** A bearing is used to provide the smooth rotation of the shafts. In this oil skimmer we have used two bearing blocks which provide the support to the both ends of the pulley shaft and these bearing blocks are joint with the nut and bolt to the structure. These bearing blocks are made up of grey cast iron while the bearing inside is made up of carbon steel.

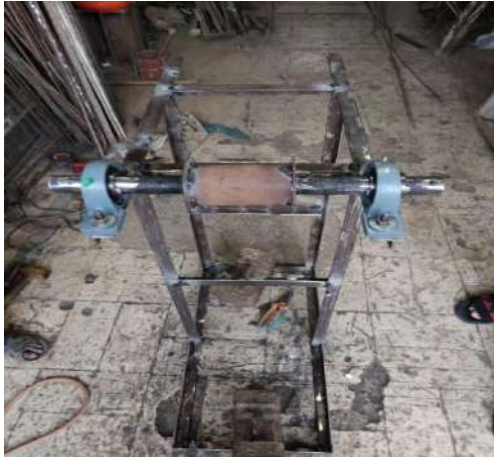


Fig: 3.6 Pulley assembling in structure



Fig:3.7 Bearing Block

- e. **DC Motor:** Motor is a work consuming device which provides us mechanical power/Rotation at the expense of electricity or any other energy source.

In this oil skimmer we have required the low RPMs so we have used a small 12v dc motor which is used in cars for windscreen wiper movement. We have used this motor to avoid the expenses of gearbox because usually motors available in the market are of high RPMs. This motor consumes about 50 to 120 watts power and around 5 amps current. Inside of this motor a worm gear is used to transmit the power to motor axil which is coupled with the pulley's shaft. Thus the shaft rotates and belt which is mounted over pulley also rotates.



Fig:3.8 DC motor.

- f. **Scraper:** Scraper is a thin sharp edged plate which is used to remove the oil from the polyurethane belt. It is made up of the steel and it is attached with the structure of oil skimmer by nut bolt joints. It is a v shaped and the wide end of the scraper is contacted with the belt which removes oil by using sharp edge and the other end converges and a pipe is attached with it to collect the removed oil.



Fig: 3.9 Scraper

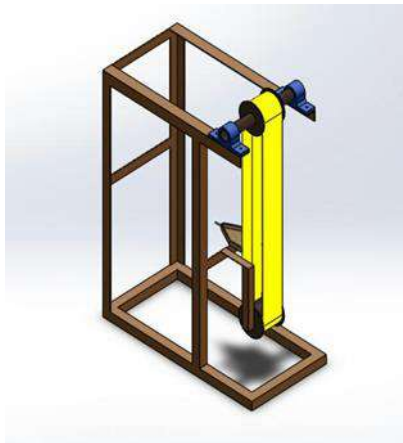


Fig:3.10 3D CAD model of Belt Type Oil Skimmer



Fig: 3.11 Fabricated Prototype

3.2.3 Testing Steps:

There are following steps which were followed in the testing of this “Belt Type Oil Skimmer”.

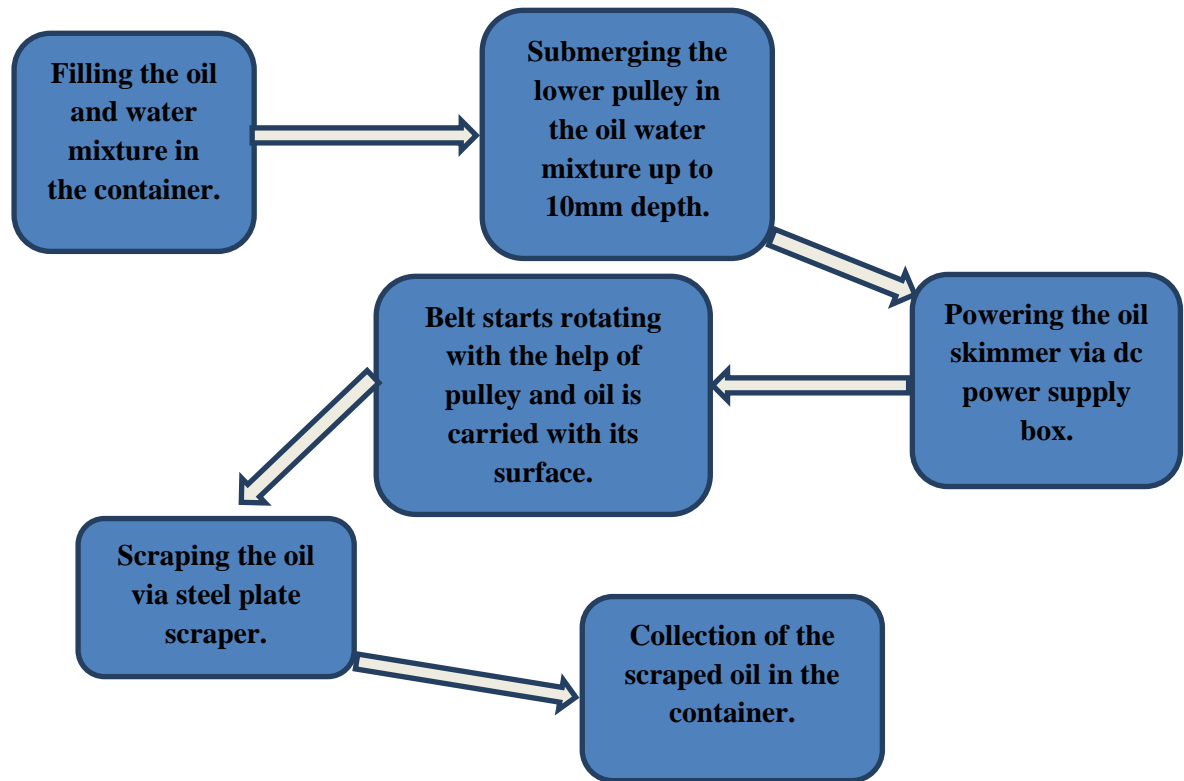


Fig: 3.12 Block Diagram of testing steps of Belt Type Oil Skimmer.

3.2.4 Equations and Calculations:

3.2.4.1 Equations: There are following equations which are used in the calculation of some unknown variables.

- I. Equation of flowrate: Flowrate is defined as the total volume per time taken to fill that volume with fluid. It is given by;

$$Q = \frac{V}{t}, \text{ where } V \text{ is the volume and } t \text{ is the time taken to fill this volume with fluid.}$$

And Q is the flowrate.

- II. Equation of Power of DC motor: Power is calculated by two equations as following;

$$P = VI, \text{ where } V \text{ is the voltage and } I \text{ is current.}$$

Also,

$$P = \frac{2\pi NT}{60}$$

III. Equation of Torque of DC motor: Torque is derived from the above equation of power as; $T = \frac{P60}{2\pi N}$.

3.2.4.2 Calculations: We have calculated two motor speeds as;

Speed 1 (N1)	23 RPM
Speed 2 (N2)	26 RPM

Table 3.1

All the calculations are based on these two speeds, N1 and N2.

- **For N1 23 RPM.**

I. Flow rate: $Q1 = \frac{V1}{t1}$

$$= \frac{240 \text{ ml}}{30.5 \text{ s}}$$

$$Q1 = 7.86 \text{ ml/s.}$$

II. Power: $P1 = VI1$

$$= 12 \text{ volts} \times 8.702 \text{ amp}$$

$$P1 = 104.42 \text{ W}$$

III. Torque: $T1 = \frac{P1 \times 60}{2\pi N1}$

$$= \frac{104.42 \times 60}{2\pi 23}$$

$$T1 = 43.37 \text{ N} - \text{m}$$

- **For N2 26 RPM.**

I. Flow rate: $Q2 = \frac{V2}{t2}$

$$= \frac{600 \text{ ml}}{47.46 \text{ s}}$$

$$Q2 = 12.64 \text{ ml/s}$$

II. Power: $P2 = VI2$

$$= 12 \text{ volts} \times 9.23 \text{ amps}$$

$$P_2 = 110.76W.$$

$$\text{III. Torque: } T_2 = \frac{P_2 \times 60}{2\pi N_2} = \frac{110.76 \times 60}{2\pi 26}$$

$$T_2 = 40.70N - m.$$

CHAPTER 04

RESULTS AND DISCUSSIONS

4.1 RESULTS:

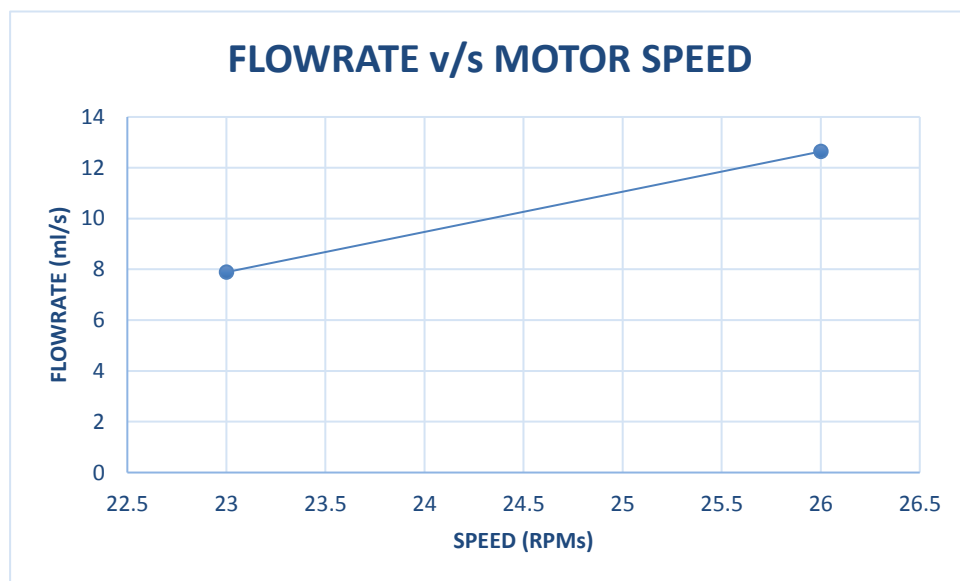
From the testing of the fabricated prototype of Belt Type Oil Skimmer we have obtained the following results.

As the DC motor which is used in this prototype has two fixed speeds and these results are based on these two fixed speeds, which are following;

GRAPH 1: Flowrate v/s Speed (RPMs).

S.NO	MOTOR SPEED (RPM)	OIL FLOWRATE (ML/S)
1	0	0
2	23	7.89
3	26	12.64

TABLE 4.1

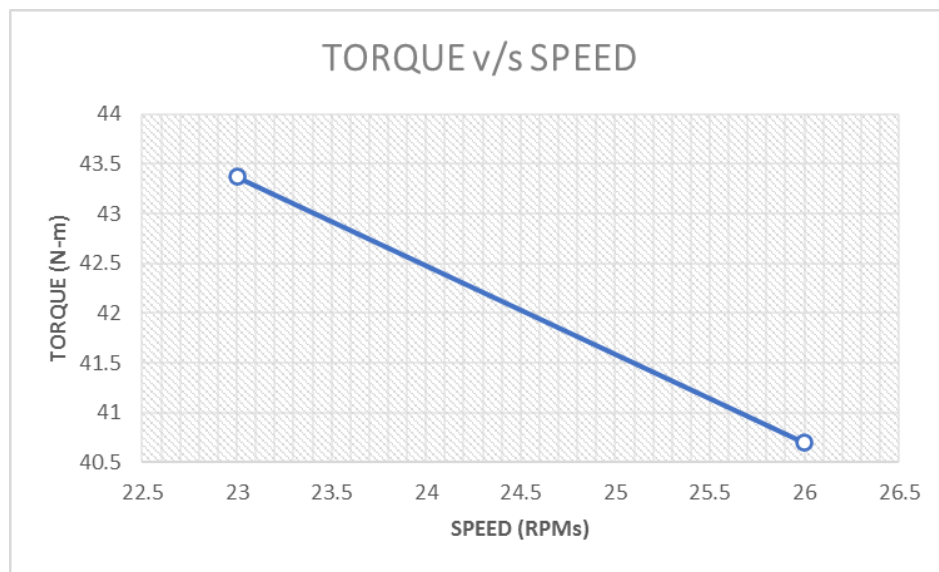


GRAPH: 4.1

Graph 2: Torque v/s Speed.

S.NO	SPEED (RPMs)	Torque (N-m)
1	0	0
2	23	43.37
3	26	40.70

TABLE 4.2

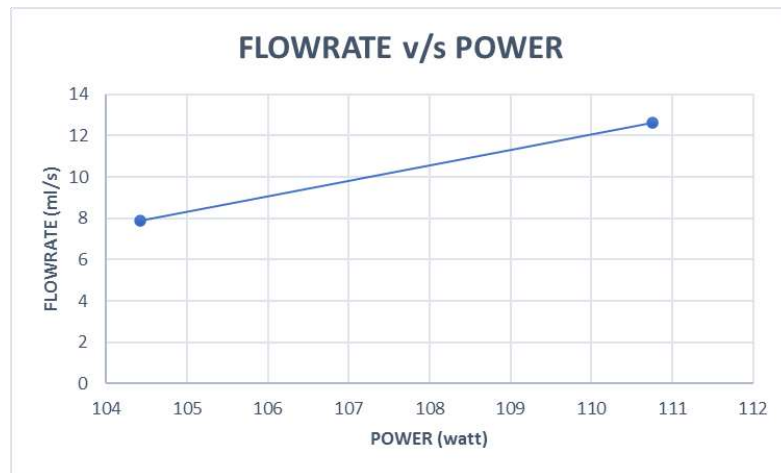


GRAPH 4.2

Graph 3: Flowrate v/s Power.

S.NO	POWER (WATT)	FLOWRATE (ML/S)
1	0	0
2	104.42	7.89
3	110.76	12.64

TABLE 4.3



GRAPH 4.3

4.2 DISCUSSIONS:

From the above obtained results we can see that with the increase in the motor speed the flowrate of oil is increasing continuously. In the graph 4.1 we can see that where speed is 23 RPM from this point the flowrate is rapidly increasing by increasing the motor speed (RPM) up to the 26 RPM. Also, in graph 4.2 we have observed that as the speed of the motor is increasing the torque is decreasing from 43.37 to 40.70 N-m and from the graph 4.3 we have observed that increasing power increases the flowrate. We can furthermore analyse this behaviour of flowrate against the motor speed, torque and power consumption to achieve the optimum parameters for the more efficient working of this **Belt Type Oil Skimmer**.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 CONCLUSION:

As we have discussed in detail that how does the oil spillage affect the environment and can cause serious dangers towards human kind, animal kind and other Sealife. The best way to avoid this danger is to get rid of oil spillage by using the skimmers which separate the oil from different fluid mixtures etc. The oil spillage is of many types like oil spillage from industries, oil tanker collisions/accidents and domestic waste of oil.

We have fabricated the Belt Type Oil Skimmer which is based on the oleophilic skimming process. It separates the oil from any other fluid mixture like water or any other coolant by using a non-polar material belt called polyurethane. It is mounted over two pulleys and lower pulley is dipped in the oil-water mixture about 10 cm. When the motor is started the pulley coupled with it starts rotating which also rotates the belt mounted over it. As the belt is dipped in the oil-water mixture so it deposits the oil over its surface and the oil is then scraped off from the other side of the skimmer by using a thin plate and sharp edged scraper then the oil is collected in the container.

From the results we have observed that it is an effective and efficient oil separation machine, and its maintenance and operation cost is very low. Its usage will reduce the pollution from environment, and it will reduce the oil refilling cost.

5.2 FUTURE WORK:

There is a wide space to work on this Belt Type Oil Skimmer.

There are following recommendations for the future work;

- Analysis of different belt materials to minimize the cost and maximize the oil recovery rate.
- Powering these oil skimmers from the renewable energy sources.

- Analysis of the different parameters of this oil skimmers like speed, torque, power and flowrate etc to increase its efficiency and decrease the O&M cost.
- Developing the business model to bring this Oil Skimmer in common use.
- Advertising this oil skimmer in the wastewater management agencies of the underdeveloped industrial markets.

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