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Design and Fabrication of Oil Skimmer

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Abstract

Nowadays there are so many imports and export business going on through in the world. In this business the shipping by sea is supposed to be cheapest mode. But with this shipping business there are so many cases of oil spill in the sea. Due to these oil spills, there are so many deaths of marine life and it also contributes in pollution. After an oil spill, it creates a slick that ensures the sunlight and oxygen pass through the water. It affects the life below the water due to lack of oxygen and sunlight. As some of oil are dangerous and poisonous, they are also harmful for humans too.[1]
As a solution to these oil spills, there are types of oil skimmers such as belt type, rope type, drum type, disk type, etc. are used. Basically, oil skimmer is a device which helps to separate/ remove oil from water. This allows skimming media in the shape of a belt, disk, drum, etc. to pass through a fluid surface to pick up floating oil and grease with very little water. This oily material is subsequently removed from the media with wiper blades or pinch rollers. In these topics we are going to see different type of oil skimmers and their working.

Keywords :- Skimmer, oil slick

I. INTRODUCTION

As we see, nowadays water pollution due to marine litter is a global environmental problem. Domestic waste disposal into rivers and lakes leads to drop in water quality and will have ultimately more impact on water pollution. The largest proportion of all marine litter is plastics; it is nearly about 95% of all debris in some areas. Frequently oil spills accidents and oily water discharge from industries have also caused major environmental and health issues.
For transportation of oil through sea, large ships are used. This process is supposed to be complex process. During transportation of oil, the accidents of oil spills can occur that will lead to rapid increase in water pollution which is harmful for both marine and human life. Apart from pollution there is also economical loss due to wastage of oil in the sea. When this oil spill in water it forms an oil slick on surface of water. Due to this oil slick, there is difficulty in passing pure oxygen and sunlight through water which affects the life under water. The time for effective removal of oil from the water surface is limited to five days. If this period is exceeded, only chemical acceleration of oil decomposition in nature is possible.
Elimination of an oil slick is a complex process that can be achieved by three different methods: mechanical containment (booms & skimmers), chemical and biological methods (dispersants, seeding of microorganisms), and physical methods (manual labor). Therefore, the development of an environmentally friendly, cost-effective, and efficient oil–water separation (OWS) technology is highly urgent.[2]
Among these technologies oil skimmer is one of the effective ways to remove oil efficiently. Oil skimmer is a device used for separation of oil from water. There are different types of oil skimmers like belt type, disc type, drum type, etc. In these we will further see this type different type of oil skimmer and detailed study of belt type oil skimmer, its working, construction and its different features.

II. OBJECTIVES

The following are the objectives of our project -

- To study various skimmers used in waste management.
- To model the skimmer using suitable software.
- To carry out an analysis of the designed skimmer for its performance.
- To carry out the fabrication of the prototype of the skimmer.

III. RELATED WORK

By reviewing different paperwork and techniques used for several oil skimmers, we've started acting on our design of "Design and Fabrication of Oil Skimmer". The papers surveyed for literature are as follows:

Aisyah et al. (2020) demonstrated a rapid and cost-effective tool for the characterization and quantification of floating macro-debris and quantification of floating macro-debris. This study aims to quantify the abundance of Inorganic Micro Debris (IMD), explore the spatiotemporal trends, and identify the composition of floating IMD in the downstream section of the Citarum River.

Helinski et al. (2021) proposed a framework for selecting a device to reduce plastic pollution in freshwater, synthesizing information of forty prevailing plastic pollution capture devices. We distinguish three major components of plastic pollution technology (booms, receptacles, and watercraft vehicles) and collect details on each technology including its features, limitations,

efficiency, reported costs, and maintenance.

Dr. Chavan et al. (2021) expressed how water sources are contaminated by garbage, weeds, and plastic waste. Effective waste removal in water sources such as lakes, ponds, and rivers are essential for waste management and control. It will collect the waste from the surface of the water and dump it into the tub placed behind it. With the use of motors, the bot and collectors will have to & for movement. This project can be used for effective waste removal from the surface of the water.

Thombare Babasaheb B.1 (2018), has studied in their paper named "A Review on Analysis of Belt Type Skimmer "that according to polar and non-polar properties of oil and water, water consists of H+ and OH- having polar nature while oil acts as a non-polar substance. Therefore, they do not get mixed with each other, and the oil floats on water instead of sinking in. The belt material they selected was a non-polar material due to which the oil gets attracted to the belt. They took the belt material like (cotton, rubber, steel, oleophilic, etc.) They took the material that had higher adhesive properties than water. Due to this, the belt absorbs the oil more easily than the water. This is what they concluded in their paper.
Rakesh Pund1 (2018), Studied in their paper as named "Review on Analysis of Oil Skimmer" that the polyurethane belt is having better oil skimming limit. They found out that the skimmer can evacuate around 60-70 liters of oil each day. They even stated that the polyurethane belt is more advantageous to utilize where less clamor activity is required. They performed a practical in which they tried numerous belts (with different materials of belts) and concluded that the polyurethane belt has more oil recovery capacity.

Vishal G. Naphade1 (2018), has studied in their paper named "Design of Disc Type Oil Separator" that the material of the disc in the disc type oil skimmer can change the oil recovery capacity of the skimmer due to the weight of the material. Due to heavy disc the oil recovery capacity changes drastically. Instead of the mild steel disc, they used acrylic disc which is light in weight and does not soak oil. They resulted that the acrylic disc skimmer has a better oil recovery capacity than the mild steel disc skimmer.

Mamta Patel (2015), has studied in her paper named "Design and Efficiency Comparison of Various Belt Type Oil Skimmers" that the slight difference in design and material can give a large impact on the oil recovery capacity of the skimmer. She concluded that the improvement of the oil skimmer towards including an additional belt shaft and the use steel belt with steel material instead of rope significantly improves the oil recovery efficiency of the skimmer. Even by making changes in the use of the materials well as slight changes in the design.

Rafi Jamal Algawi1 (2014), has studied in their paper named "Study of operating conditions for oil skimmer apparatus from water" that the oil recovery rate increases with the increase in belt rotational speed. The oil recovery efficiency decreases with the increase in belt rotational speed. They even resulted that the oil recovery rate increases with the decrease in the oil temperature, but a decrease in oil temperature decreases the oil efficiency rate. They studied that the oil viscosity plays an important role in oil recovery using an oil skimmer. A lower temperature increases the oil recovery rate and the oil recovery efficiency by increasing the viscosity.

IV. METHODOLOGY

The methodology to achieve the above objectives is as follows

a). To study various skimmers used in waste management -
The study of various types of skimmers will be carried out. The applications of skimmers will be studied. The different watercraft vehicles will be studied.

b). To model the skimmer using suitable software -
The pilot study in respect of different models will be carried out. The identified skimmer for a particular application will be modeled using suitable software.

c). To carry out the fabrication of the prototype of the skimmer -
The whole body of the skimmer (Watercraft Vehicle) contains four crucial parts including the body, garbage collection storage, conveyor, and power system consumption. Every fabrication process for each element is customized based on the specific function.

V. DESIGN

For design of components, gadgets used in our project is referred from data available in various textbooks & reference books. Design is the most important step in our project. The dimensions were compared with the data provided in reference books and the components available in market.
For designing our skimmer model and its components we have used CATIA software. After assembling all components together this is how our final model looks

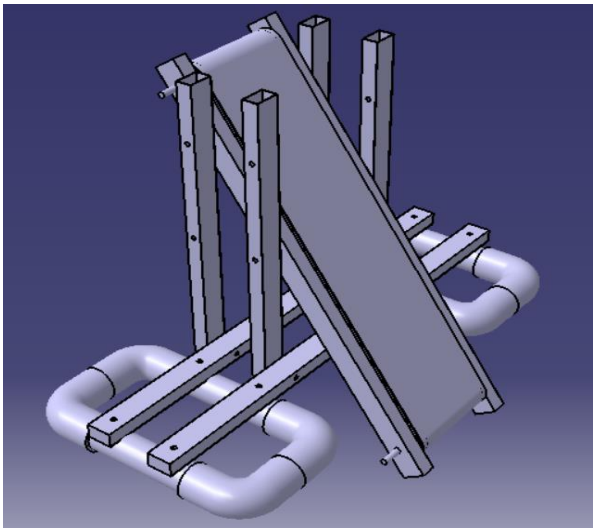

Fig. 1 : CAD Design

VI. COMPONENTS

Table no.1 : List of Components

Sr. No.	Component	Quantity	Specification
1.	Frame	1	To hold all the components & support the structure.
2.	Container	1	To aggrandize oil.
3.	Roller	2	To support the Belt and provide motion to belt.
4.	Pulley	1	Transmit energy and motion.
5.	Pipe	4	As a floater.
6.	Bearing	2	To support the rotating shaft.
7.	Belt	1	As an oil absorbent.
8.	Bolt	8	Assembling two components.
10.	Cap Pipe	4	To waterproof the connection.
12.	Washer	4	Distribute the load over a large area.
13.	Shaft	1	To transmit power from driving device i.e., motor.

1). Belt

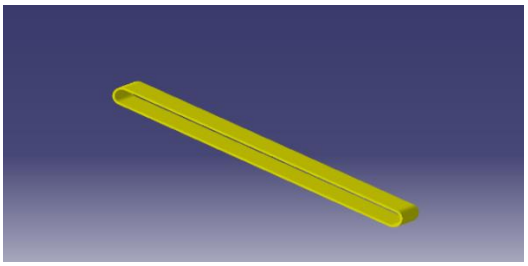

Fig. 2: Belt

In the design of the oil skimmer, we are using the belt for removing oil slick from oil spills. A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. But in the design skimmer, we are using the belt for removing oil from water surface.

Previously used belts were made of polyurethane but in our skimmer, we are using belt made of kapok fiber. Kapok fiber has large number of hydroxyl group in structure, waxy structure, porous structure and higher contact angle and higher interfacial energy barriers between Kapok fiber and oil which are reason behind limited oil sorption possibility. Kapok fiber shows higher affinity towards oil than water. Kapok fiber has almost 90% adsorption capacity it can absorb almost twenty-five times its own weight of oil from the environment So, this is the reason why we are using kapok fiber material for belt.[3]

2). Motor

The motor provides driving force for pulley, belt, and for operating the direction and movement of skimmer in water. There are different types of motors. They are DC Motors, AC Motors, Synchronous motors, Induction motors, etc. AC motors are driven by Alternating current (AC).

For our prototype we are using geared DC Motor. It is high torque geared motor with 60 rpm speed and 12V voltage. Geared motor is simple DC motor which is mechanically commutated electric motor powered from direct current.

3). Scrapper

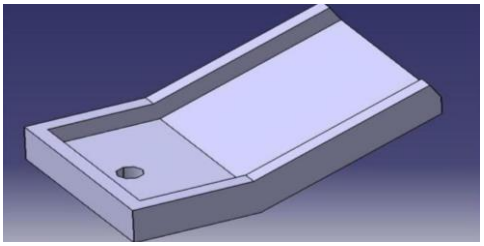

Fig. 3: Scrapper

Its function is to remove the oil that sticks or clings to the surface of belt. The contact between belt and scraper enables the removal of oil. It is made up of mild steel. An angle of 30 degrees is provided for inclination.

4).Roller

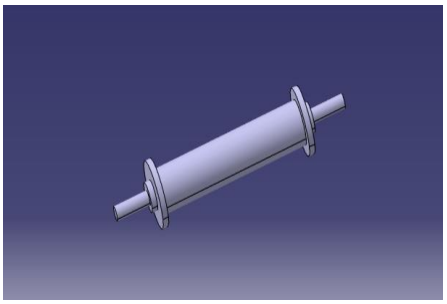

Fig. 4: Roller

Roller is used to support the belt and provide motion to belt.

5).Frame

Frame is used to hold all the components & support the structure. For our prototype we have fabricated aluminum frame. The reason behind using aluminum is that it is light in weight and it does not get corroded.

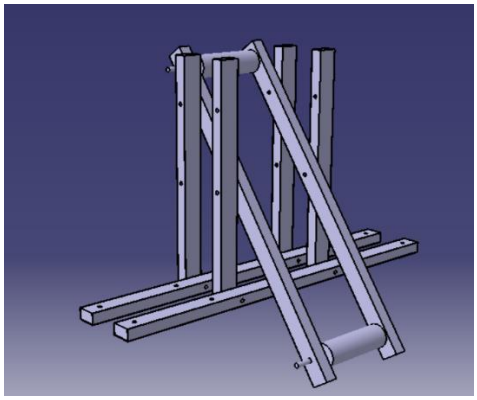

Fig.5 :Frame

6).Oil Container :

Oil container is used for storing collected oil. For our model we have used oil container made from plastic because plastic is light in weight, cheap and easily available.

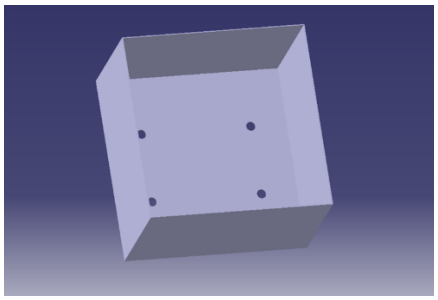

Fig.6 :Container

VII. FABRICATION AND WORKING OF OIL SKIMMER

7.1 Fabrication of Oil Skimmer

Fig. 7 : Fabricated skimmer

It is the main body frame on which the other parts of the device are mounted such as the belt, container, and scrapper. The material used is Aluminum so as to keep it lightweight. There are provisions given for the attachments of the tank, bearings, etc. as mentioned in Figure 1 CAD assembly design.

a). Floating Assembly

The materials that can be used as floating materials should have a density less than that of the density of water. The commonly used floating materials are foam, pipes which have a density less than water density such as PVC pipes.

Fig.8 : Floating Device

b). Belt Assembly

A Belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not to be parallel.

Fig. 9 : Belt Assembly

c). Roller Assembly

Plastic pulleys were chosen because they are lightweight and inexpensive. These came in standard sizes and were installed on the shaft.

Fig.10 : Roller Assembly

e). Skimmer Assembly

The frame was designed with a 45-degree angle as the standard because it provided the most strength for the load on the base and frame. The metallic strips were removed with the use of a cutter. The markings were created with chalk. These strips were fused together at the joints using a nut and bolts. The two sections were joined using an arc welding process. This is how the frame was created. Bearings were purchased on the open market.

The bearings were placed on the frame using a nut bolt system once the joints were created. It is the main body frame on which the other parts of the device are mounted such as the belt, tank, and scrapper.[6]

Fig.11 : Skimmer Assembly

7.2. Working of Oil Skimmer

Water has a higher density than oil, as we all know. Oil floats on the surface of the water because it has a lower density than water. Oil is easily visible on the surface as a result. It is impossible to overstate the importance of viscosity in equipment operation. Because of its higher viscosity, oil adheres fast to the surface of the oil Skimmer's belt. A motor propels the shaft forward. A pulley is attached to the shaft. The pulley is looped with the belt. Two pulleys may be seen in the photograph. The belt circles between the two pulleys while the motor rotates the shaft. A mixture of water and oil is used to draw the belt. The oil adheres to the moving belt's surface, sealing it off from the water. After that, the wiper (scraper) that comes with the device makes contact with the belt. The oil falls into the collecting tray or tank due to contact between the belt and the scraper blade and can be reused if necessary. This ensures that the oil is sufficiently removed and isolated from the water supply. As a result, the technique is simple and straightforward. The belt may become worn out after a long time of use. It's a simple task to replace it. [4]

Fig. 12 : Working

VIII. ADVANTAGES AND LIMITATIONS

8.1 Advantages of Oil Skimmer

- There are many advantages of this system as explained below
- No external power is needed for skimming when used with solar power.
- It reduced oil pollution in the sea.
- Minimum labor required.
- Belt is easily replaceable.
- Increase in production rate.

8.2 Limitations of Oil Skimmer

- Belt needs to be changed after some time.
- It’s needed an external power supply.
- Oil collected can contain some amount of water.

IX. RESULT AND CONCLUSION

9.1 Result

Observation No.	Amount of oil recovered (in ml)	Time Required (In minutes)
1	300	24
2	300	20
3	300	19
Average :	300 ml	21 minutes

After taking three observation we have observed that : Skimmer takes 21 minutes to recover 300 ml oil from water surface.

9.2 Conclusion

As we learned from all the research work that there are some important aspects and points that are essential to consider while designing an oil skimmer. The very first thing is the design aspects of the skimmer and rotational speed of the belt are very important as also the material which has been used. The slightest changes in the design aspect of the skimmer may cause a huge difference in the oil recovery efficiency of the skimmer. The other crucial thing is the placing of the component parts of the skimmer should be placed significantly. The working design of the skimmer should be accurate and significant for better performance of the skimmer. For better efficiency it is studied that the polyurethane belt is most efficient for the skimmer to recover oil from the surface of the water.[5]

X. FUTURE SCOPE

- The speed of the belt cannot vary so it is to be improved by providing a multispeed arrangement.
- Scrapper plate arrangement may be improved.
- Oil resisting belt can be fitted to improve the life and strength of the belt.
- Solar panels can be attached to run the DC motor so improving the energy efficiency.
- Water drops are collected simultaneously with oil and this is to be reduced for better performance.

- Skimmer cannot move in different directions on the water surface by using a microcontroller and motors it can travel in different on the sea surface to improve

XI. REFERENCES

1. Aisyah, S., Hidayat, H., Rahmadya, A., Husrin, S., Hurley, R. and Olsen, M., 2022. Observation of Floating Inorganic Macro-debris in The Downstream Citarum River using Manual Counting. In IOP Conference Series: Earth and Environmental Science (Vol. 950, No. 1, p. 012011). IOP Publishing
2. Helinski, O.K., Poor, C.J. and Wolfand, J.M., 2021. Ridding our rivers of plastic: A framework for plastic pollution capture device selection. Marine pollution bulletin, 165, p.112095.
3. Thombare Babasaheb B., Barse Babasaheb N., Barhate Ganesh B., Kolhe Sani M., & Jagtap Harshal B. (2018):" Analysis of belt type oil skimmer" IJARIIE-ISSN(O)- 2395-4396 Vol-4 Issue-2 2018
4. Rakesh Pund, Roshan Mhaske, Shivam Rahane & Shubham Rajput (2018): "Review on analysis of oil skimmer"International Research Journal ofEngineering and Technology (IRJET) Volume: 05 Issue: 10 |Oct 2018.
5. Mamta Patel(2013):"Design and Efficiency Comparison of Various Belt Type Oil Skimmers "International Journal of Science and Research (IJSR) ISSN (Online): 2319- 704.
6. Rafi Jamal Algawai & Maha adnan Dawood (2014): "Study of operating conditions for oil skimmer apparatus from water"ResearchGate Conferencepaper – April 2017.