Development of Automatic Tube Oil Skimmer

Vignesh. T1, Bhuvaneswari M2, S.Manojkumar3, S.Kishore4, N.Bommuraj5

Department of Mechatronics Engineering
Sri Krishna College of Engineering and technology, Coimbatore – 641008
vignesh@skcet.ac.in , bhuvaneswarim@skcet.ac.in, 16eumt046@skcet.ac.in, 16eumt054@skcet.ac.in, 17eumt502@skcet.ac.in

Abstract. The paper work represent the removing oil from the water which is wasted from the machines. The machines get more heated while running, oil and water is used to cool the machine. This investigations is removing oil from water surface is done by skimmer. The oil skimmer is having tube under different operation condition (thickness of oil film, temperature of oil, rotational speed of tube, water PH, oil tube and tube material tube). The oil skimmer has floating tube with fixed length, flexible and discrete segmented model. The design of the wheel according to the tube size and tube length is fixed according to the tank size. Wheel is connected with the belt which is immersed in the oil and water mixer tank. While running the pulley wheel belt is coming upper, the wiper is attached in the frame. Wiper removes the oil coming from the belt. This method is most efficient method to solve the human fatigue and cost effective method.

1. INTRODUCTION

Now a day’s industry running in the whole day and year. So the machine will get heated while running. To remove the heat in the machine the coolant is used. Most the industry used oil and water mixer as the coolant. The expansion of new technology and importance of oil skimmer is evolved [1]. Skimmer medium as ‘belt and metal disc’ it is run above the water surface it is brought [2]. Belt is used under different working condition like thickness of oil film, temperature of oil, speed of the belt, type of oil used etc, oil recovery rate is based on this operating [3]. The recovery vessels is used to oil recovery vessels are available on the open sea but unworkable in narrow sea and it is developed a handy oil recovery system which is portable and used for supplementing the weak point of the oil recovery vessel [4]. There is difficult to recover the spilled oil on the water in dangerous areas, so this method is clean the surface using unmanned vehicle and also dynamic inclined plane (DIPS) place in front of USV, it is run very high speed and accuracy to the destination [5]. This system explain the recovery oil from the coastline which is very long by using truck. The barge crane makes to recuperate oil at the quay and loads the system on its floor. The two equipment is used one is skimmer operated by crane and another is buoy system for stretching oil boom automatically [6]. During transportation crude oil it requires the safety measure is port terminals and necessary to develop oil separate system belt skimmer is developed and it consist of floating disc and belt. Which is operate using Bluetooth [7]. The monitoring system used the IOT platform to get the data and is monitored continuously it is controlled by the mobile phones. The many open source hard ware kit is used to develop the prototype model. The oil skimmer is dragged by two connecting vehicles it is mostly used in oil skimming, it drawn from the oil from water surface [8]. It requires the vacuum blower with high power capacity acquire a gas liquid in the medium. This method is used in the well and also wavy sea it has a wide range of viscosity.

2. METHOD AND MATERIAL
Before get in to the costly process like chemical and other treatment this oil skimmer is used to do pre-process of removing the oil from the water. This skimming mechanism need the basic three properties like specific gravity, affinity and surface tension. There are many constrains taken while selecting the skimmer. The major property is the viscosity and the adhesiveness of the oil is skimmed. In this the tank is made of aluminium plates and plastic tube is used. The metal pulley wheels is used to connect the belt.

3. CAD MODELING

To visualise the idea many cad tool are used. In this skimming dive the creo software used to create the model. The various design considerations are followed while designing the model. The figure 1 shows the 3d model of the oil skimmer

![Figure 1. 3D model of tube oil skimmer](image)

The manufacturing the model, drafting is majorly used. The drafted model of the oil skimmer is shown in the Figure 2, and various views also showed.

![Figure 2. Assembly view of tube oil skimmer](image)

4. CALCULATIONS

4.1 Friction on wiper:
\[ f = \mu \times N \]

F - Friction force
\( \mu = 0.8 \) Mild steel & Rubber Coefficient
N - Normal force
P = F.V
F - Force
P - Power
V - Velocity
F = 8/0.3327N
\( f = \mu \times N = 0.8 \times 20 = 22N = 22 \)

4.2 Pulley Calculation:
Recommended series of pulley diameter = 150mm
Mild Steel = 7.85g/[cm]^3
Volume of pulley = \( \pi r^2 h \)
r - radius of pulley
h - Thickness of pulley (DDB - 7.55)
\[ V = \pi \times (0.075 \times 0.075) \times 0.020 \]
\[ V = 0.00035m^3 \]
e = m/v
m = e \times v
m = 785 \times "0.00035" = 0.27kg

4.3 Velocity:
\[ V = \frac{D}{T} \]  
D - Distance, T - Time D = 3m (Tube distance)
= 3/10
\[ V = 0.3m/s \]
\( \omega = \frac{v}{r} \)  
\( \omega \) - Angular Velocity
\( \omega = 0.3/0.075 = 4 \text{ rad} \)
P = T \times \omega  
P - Power
P = 1.9 \times 4 = 8w
\( \omega = \frac{2\pi}{60} \)  
N = ("4" \times 60) / (2\times\pi) = 38rpm

4.4 Volume of tank:
\[ V = \text{length} \times \text{width} \times \text{height} \]
\[ V = 0.60 \times 0.50 \times 0.15 \]  
Golden Ratio = (L) / (D) = 1.6
\[ V = 0.045m^3 \]
Volume rate:
V = t × D × π × d × N

- **V** = Volume
- **t** = Thickness
- **D** = Diameter of tubed
- **d** = Diameter wiper
- **N** = rpm

\[ V = 0.001 \times 0.012 \times \pi \times 0.012 \times 38 \]

\[ V = 0.28 \text{ml/min} \]

5. **HARDWARE IMPLEMENTATION**

The micro controller is the chip which used to program and control the hardware setup. It has own ram and Rom memory’s for storing the program and execution. It has a various input and output pin for getting and sending the information to the other devices. Serial ports is used to send the data to the output devices in serially. It has parallel ports also. Timer and counters are used to maintain the clock timing to the device. This connect to the real time world timing. Analog and digital converter are used to convert the signal to one form to another form. This all features are intergrade in the single chips. When the data sent via serial or parallel ports the baud rate is the major parameter to consider. Both input and output device need a same baud rate then only the data is send without delay and losses. Microcontroller AT89C51 is used in this project, it has a high performance and low power. It has 8 bit of C MOS and 4k Programmable flash memory. It having a read only memory for the erasable data’s. It is manufactured by Atmel high density non-volatile memory technology. The flash memory used to reprogram the controller. To combine 8 bit CPU with flash memory it’s become more power full microcomputer.

![Figure 3. PIC 16F877A Microcontroller](image)

5.1 **DC Motor**

The DC motor used is 12V motor which is used to run the motor in this project. Dc motor is used to convert the one form of energy to another form like electrical to mechanical. It has 5 principal’s field system, armature core, armature winding, Brushes and commutator. Figure 4 shows the DC motor used in the oil skimmer.
5.2 Relay

A relay is a type of switch. It is an electromagnetic switch. It operates by using less electric current but it turns on or off the larger current. This relay is used to convert high voltage into 5V for the microcontroller. Figure 5 shows the relay used in the oil skimmer.

5.3 LCD Display

Liquid Crystal Display (LCD) is a type of display that uses liquid crystal for primary operations. LED is also used in various smartphones and television systems, and other computers. It has various use cases for business and consumers. The LCD 16x2 used in this work. It is given in the figure 6.
5.4 Specification of electronics components

Table 1. Shows the Specifications of Electric Component

| Parameter     | Value               |
|---------------|---------------------|
| Frame         | Mild steel          |
| De Motor      | Torque: 10 kg-cm    |
| PIC16F877     | Micro controller    |
| Transformer   | 12v                 |
| Relay         | 5v                  |
| Float sensor  | 5v                  |

5.5 Microcontroller PIC 16F877A

The microcontroller having the EEPROM, it has flash memory and non-volatile ROM. To interface with the input and output device it having 40 pins in this 33 pins used for input and output. Other pins used conversions purpose like analog to digital. To generate the pulse the chip has PWM pin. This Chip having timer, receiver and transmitter circuits. The figure 3 shows the architecture of the pic microcontroller

Figure 7. Microcontroller PIC 16F877A
Figure 8. PIC controller connected with sensor and display

From fig.7 the +5V power supply given to controller, it is run by +5V power supply only. The micro controller consist of 4 ports and 40 pin configuration. The ports are port0, port1, port2, port3. Each ports is having 8 pins. From the port zero data line is taken for the LCD connection. The control line of LCD taken from the port 1, 0, 1 and 2 pins. To adjust the brightness of the LCD the small pot variable resister is used. To produce a clock pulse crystal oscillator is used. There are many oscillators used in the industry but they will produce the varying voltage and fluctuation in temperature. If the voltage and temperature fluctuation it is affect the accuracy. The ports two and three is used as input and output purpose

6. RESULT AND DISCUSSION

The oil skimmer model is fabricated and demonstrated in the industry. This proposed model is less and mist cost effective. It has very less weight compare to other models. Both wheels are designed in equal diameter based on the requirement and design calculations. All components in this model is designed based on the requirement and design calculations. In this wiper mechanism used it is most effective method to filter the oil. It has more accuracy. The figure 10 shows the fabricated image of oil skimmer
7. CONCLUSION

Oil skimmer system prototype is tested and evaluated in the industry circumference. The recovery test has done in the industry. The system gives the good performance result. The system works well in harsh surface. This method is more cost efficient and less material requirement. This system is designed and tested and it shows that it can regain most of the oil from water.

References

[1] S. Siva and P. Praveen, “Design and Fabrication of Belt Type Oil Skimmer,” vol. 5, no. 07, pp. 1–5, 2017.
[2] M. A. Dawood and R. J. Algawi, “Study of operating conditions for oil skimmer apparatus from water,” 2017 Int. Conf. Environ. Impacts Oil Gas Ind. Kurdistan Reg. Iraq as a Case Study, EIOGI 2017, vol. 2018-January, pp. 65–70, 2017, doi: 10.1109/EIOGI.2017.8267627.
[3] N. W. Skimmer, “Recovery Vessel Dr.Kaiyo,” pp. 5–9, 2008.
[4] J. Wang, F. Ren, Z. Li, Z. Liu, X. Zheng, and Y. Yang, “Unmanned surface vessel for monitoring and recovering of spilled oil on water,” Ocean. 2016 - Shanghai, no. 2, pp. 3–6, 2016, doi: 10.1109/OCEANSAP.2016.7485405.
[5] M. Yoshie, I. Fujita, and K. Takezaki, “Field simulation of oil skimming system package for crane barges in emergency,” Ocean. MTS/IEEE Kobe-Techno-Ocean’08 - Voyag. Towar. Futur. OTO’08, 2008, doi: 10.1109/OCEANSKOBE.2008.4530997.
[6] S. Sunil et al., “Floating Oil Skimmer with Garbage Collector,” vol. 5, no. 04, pp. 33–36, 2017.
[7] W. Choi, D. Yoon, T. Kim, J. Lee, and A. Background, “Won-Seok Choi 1, Dong-Geul Yoon 1, Tae-Eon Kim 2 and Jang-Myung Lee 3 *,” no. Mfi, pp. 458–463, 2017.
[8] I. Fujita, “An Air,” vol. 00, 2006.