

# Solar Oil Skimmer Mechanism Adopted to Extract the Oil During Any Oil Spillage on Sea

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## ABSTRACT

- Over the past few years there have been many oil accidents that have occurred on the sea. Oil spills will occur due to oil accidents, drill process on sea or due to any pipe line leakage. The oil on the sea water will float on top surface and if not removed, it will damage the surroundings of the ecosystem.
- So, in this paper we implement a floating oil skimmer mechanism system used for removal and separation of oil from the water surface. The solar oil skimmer system contains a rotary disc to grab oil on the surface of the water and two propellers to move the oil skimmer. The rotary disc and propeller were driven by DC motor which was connected to the motor driver and Arduino Mega as a controller.
- The solar oil skimmer is also equipped with a joystick that is used to adjust the rotation speed of the rotating disc and control the movement of the oil skimmer. Based on the result of testing the solar oil skimmer has been able to take and separate the oil on the top surface of the water with separation speed of 620.27 ml/min at a speed about 18.0 RPM. Imagine a floating oil skimmer as a sleek, metallic device gliding over a vast, dark expanse of water. Its surface, a shimmering mosaic of silver and black, contrasts sharply against the murky depths below. It moves with an almost sentient grace, its edges blurring into the surrounding water, like a mirage. The skimmer's mechanism, a series of concentric rings, spins gently, creating delicate ripples that spread across the oily surface.

**Keywords:** Oil spill control, removal equipment, with solar panel, and a battery.

## 1. INTRODUCTION:

- The oil and gas produced, has a potential to pollute the environment when an oil spill occurs. The oil spill occurs during the process of moving goods on board, drilling, and due to leakage of oil pipelines on under water. An example was the oil spill that occurred on Central Java. In the period 1989 to 2015, there are 20 cases of oil spills, of which 16 cases were

caused by ship accidents and 4 of them were caused by pipe leaks on sea. Oil spill can also occur because the Indonesia is the largest oil trade lanes in Southeast Asia. This condition was supported by high shipping activity of the Japanese ships around of 90% and Chinese ships were around 70%- 90%.

- Pollution from the oil spill on sea is the focus of attention at the wider community. The oil spill in the water is very easy to spread and move to other places, because of the influence of water waves, wind, and sea water flow. The impact will be very fast and threaten the survival of the organisms, damages to the ecosystem, and decrease in economic qualities due to the damaged environment. Therefore, up to now we need additional efforts to reduce, separate, and eliminate the oil spill on surface of the water are to be studied. There are several methods that have been developed including burning, sinking, dispersing, absorbing, bio-degradation, gelling, and skimming. On these methods, the skimming is the most widely using method because it is simple, easy, and does not require any additional chemicals, so it will be environmentally friendly.
- The 'working principle' of the oil skimmer is to utilize the rotating element to separate oil from water. The oil which floats on the surface of the water will stick to the rotating element due to force called adhesion force, this is enough to separate the oil from water. The adhered oil is then separated by using an element called scraper and it will flow directly into the storage tank. The rotating element which can be now developed in the form of drums, belts or discs.
- So, this paper constructs an 'Oil Skimmer' which was designed to float on top of the water surface. The oil skimmer is composed of a rotary disc that can rotate and functions to absorb and separate oil spills which are on the top of the water. Here the rotary disc is chosen because this type is the most suitable for sticking / taking oil with medium viscosity.

- Besides this type is also most likely to be used on other offshore operations. Furthermore, oil skimmer has equipped with two propellers that functions as a mechanism to drive the oil skimmer. The two propeller and rotary discs were rotated using a DC motor connected to the battery and Arduino board controller. Also, the rotating disc speed of the oil skimmer will be adjusted with the help of joystick which was connected to the Arduino Board.

## 2. COMPONENTS:

- DC motor
- Battery unit
- Solar Panel
- Arduino Nano
- Joystick controller
- Fabricated body frame
- Floating Tubes
- Pump
- Propeller
- Rotating Disk
- Scrubber
- Storage tank

## 3. INSTALLATION METHOD:

Oil skimmer mechanism consists of battery, rotary en-coder, a joystick, Arduino Mega board, three DC motor and driver, two propellers, rotary discs, and a LCD. The battery in this oil skimmer supplies power to the Arduino board to drive the three DC motors. The solar panel charges the battery alternatively. The two DC motors were connected onto the propeller. When propeller rotate in the clockwise direction oil skimmer moves in right direction also when propeller rotate in anticlockwise direction oil skimmer moves in left direction. At last the third DC motor was connected to the rotating discs that functions to absorb and separating the oil spilled. All the three DC motors were connected to a motor driver and the Arduino Mega board. Speed and direction of rotation of the motor can be controlled using a joystick. In this oil skimmer, the speed of the rotary disc can be determined using rotary encoder method and then displayed in an LCD on joystick controller.

## 4. BLOCK DIAGRAM OF OIL SKIMMER MECHANISM:

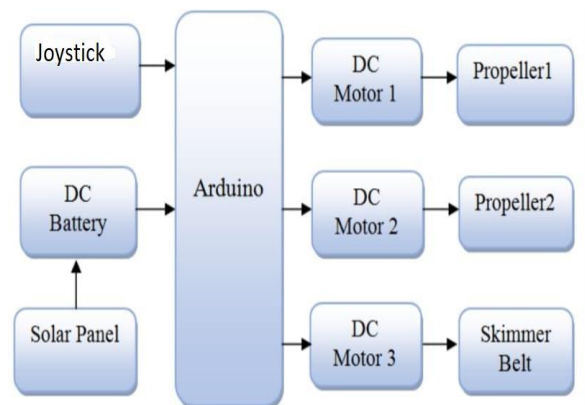


Chart -1: Flow chart

## 5. CONSTRUCTION:

- The solar oil skimmer mechanism consists of a Solar panel, a DC battery, Bluetooth, three dc motors, Arduino mega board, two propellers and the oil skimmer assembly. The solar panel charges the DC battery and supplies power to the Arduino mega board to run the DC motors. Bluetooth is connected to the Arduino board. We can move and control oil skimmer assembly in water through the joystick controller, which transmits a signal to the receives.
- Two dc motors are connected to two propellers. When propeller rotate in clockwise direction oil skimmer moves in right direction. When the propellers move in an anticlockwise direction then the oil skimmer moves towards left direction. Rotation of the propeller is controlled by dc motors. The third dc motor was connected to the rod of the skimmer's discs. Rotating Disc of Acrylic material attracts oil which is dumped into collecting tank. Skimmer is partially dipped in water for more contact. Disc is floating and rubber scraper is attached to the disc it collects oil in storage container.

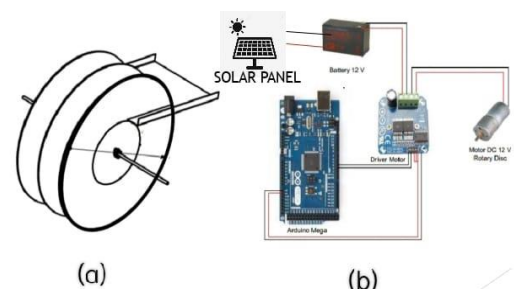


Fig -2: [a]. Design of rotary disc, [b]. Drive circuit of the rotary disc.

### 5.1 Joystick and Arduino circuit design

The joystick is used as an operator to adjust the direction and the movement of the solar oil skimmer system also to regulate the speed of the rotating disc. Movement of oil skimmer in the form of forward, backward, turn right, and turn left. The movement of the oil skimmer is regulated by moving the right and left propellers on the oil skimmer.

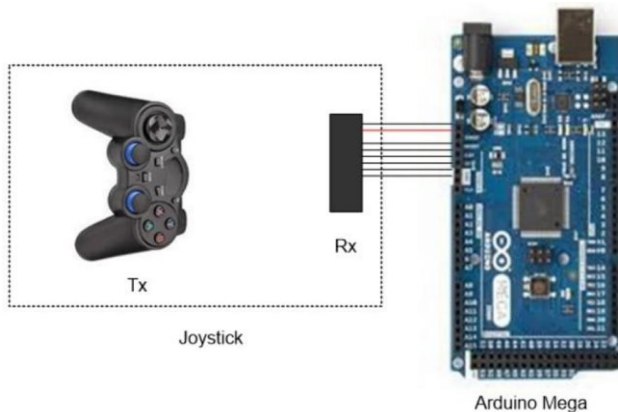


Fig -3: The joystick and Arduino mega circuit

### 6.WORKING OF OIL SKIMMER:

1. The discs were rotated through the belt, and the oil will be collected on the disc wall and then removed by using the scrapers between every discs. Oil flowed from the discs, down the scrapers, and into a tank, where a pump offloaded the oil to collection tanks.
2. The oil skimmer's main body is made of aluminium alloy and a stainless steel box frame. It is resistant to seawater corrosion and has a strong and durable structure.
3. The floating box is sealed with foam filling. The buoyancy is stable and reliable, and the anti- crushing performance is strong.
4. The flexible oil scraper can automatically compensate for the gap with the oil skimmer turntable. This can improve the collection effect of low-viscosity oil
5. The power type can be selected from solar power to battery charge DC motor start.
6. Powerful and reliable hydraulic transmission, step-less variable speed. Imported hydraulic parts, more reliable performance. Easier operation, the most cost-effective.
7. Convenient maintenance and disassembly.

### 7. MODEL AND IMPLEMENTATION

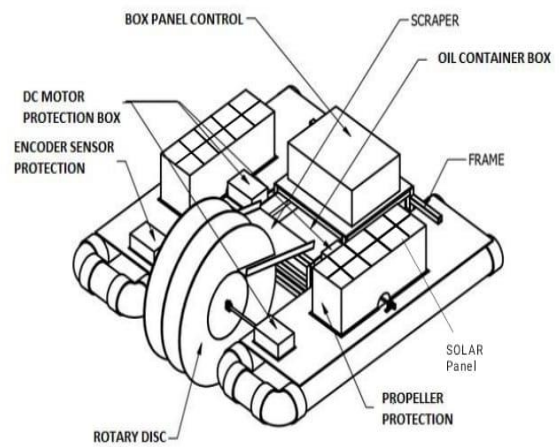


Fig -4: Model diagram

### 8.Advantages of Oil Skimmer Mechanism:

1. Renewable Energy: Uses solar power, reducing reliance on fossil fuels and minimizing carbon footprint.
2. Low Operating Costs: No fuel costs, reducing operational expenses.
3. Environmentally Friendly: Non-polluting, eco-friendly solution for oil spill cleaning up.
4. Autonomous Operation: Can operate independently, ideal for remote or hard-to-reach areas.
5. Low Maintenance: Fewer moving parts, reducing maintenance needs.
6. Quiet Operation: Solar-powered, eliminating noise pollution.
7. Portability: Lightest weight, easy to carry, and deployment.
8. Scalability: Can be designed for various oil spill sizes and locations.
9. Reliability: Continuous operation, even in remote areas with limited access.
10. Cost Effective: Reduces costs associated with fuel, maintenance, and labour.
11. Increased Efficiency: Can operate continuously, improving oil recovery rates.
12. Reduced Carbon Emissions: Contributes to a cleaner environment, supporting sustainability goals.

## 9. OBSERVATION TABLE

SI NO:	DISC SPEED (RPM)	OIL SPILLED (ml)	OIL COLLECTED (ml)	TIME (Min)	RECOVERY RATE (ml/min)	AVERAGE RECOVERY RATE
1.	30	400	380	3.06	124.18	123.41
2.	30	500	485	4.10	118.29	
3.	30	575	575	4.50	127.77	

## 10. CONCLUSION

RECOVERY RATE	RPM	OIL FILM THICKNESS
565 ml/min	30	1 mm

Volume rate of oil recover per turn when shaft is rotating at 30 rpm.

Here we assume 1mm thickness of oil film.

Volume rate = Thickness of film × Width of the disc × circumferential area of the shaft × speed rotation of the shaft.

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

$$V = 0.0010 \times 0.3 \times \pi \times 0.02 \times 30$$

$$= 565.2 \text{ ml/min}$$

- PER ONE DISC: 565.2 ml/min, 1/hr = 9.42 litre
- IN 8 NUMBER OF DISC: 4,521.6 ml/min, 1/hr = 75.36 litre

## REFERENCE[S]:

- [1] "Recovery of floating oil rotating disc type oil skimmer" by Atlantic research systems. division marine system, <https://www.instructables.com>
- [2] Suraj Nair, Kajol Kamble, Sayali Shewale, Sanjay Lohar "Design & Fabrication of Disc Type Oil Skimmer".
- [3] Wibowo M 2018 Seawaters J. Teknologi. LINGKAMGAN 19 191.
- [4] Clark R B 1986 Marine Pollution (New York: Oxford University Press).
- [5] Elzahaby A, Bakry A, Kabeel AE and Khaira A M 2010 International Congress of Fluid Dynamics & Propulsion 1-9.

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