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SPILLED OIL CLEANING DEVICE

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Abstract: It sounds like this paper is focused on finding a better solution for separating oil and water to recover oil from a water surface mixture, specifically in the context of the Empress Oil spill. The paper describes the fabrication of mechanical equipment, such as an oil and water separator, which can be used in environmental pollution control to remove oil from leaked water and produce oil-free water.The oil separator described in the paper appears to be made of acrylic material and can be used in effluent treatment plants. The paper includes details on the construction, fabrication, assembly, working, and applications of the oil and water separator. While there are different methods for removing oil from water, the paper notes that the disc type oil skimmer is commonly used.It's important to note that while the development of mechanical equipment for separating oil and water is an important part of addressing oil spills and environmental pollution, it's also crucial to focus on prevention and reducing the likelihood of spills in the first place. Additionally, it's important to consider the potential environmental impacts of any oil recovery method, as well as the economic and social costs and benefits.

Keywords:oil spill, Skimmer, CAD, Yield Strength, Density. Cleaning Device.

1. Introduction

Crude oil is a fossil fuel that is formed over millions of years through the decay of organic matter such as plants and animals. It is a complex mixture of hydrocarbons, with varying properties depending on its source and composition. The production, processing, and distribution of crude oil have become increasingly important to the global economy over the past century, with crude oil being used as a feedstock for the production of a wide range of consumer and industrial products, including gasoline, diesel fuel, and lubricating oil, among others. Fractional distillation is a common process used to separate crude oil into its various components, which are then further processed into final products[1].When an oil spill occurs, it can have devastating effects on the environment, economy, and human health. Oil spills can contaminate water bodies, killing fish and other marine life, and can also lead to the destruction of important habitats such as wetlands and coral reefs. They can also have serious economic impacts, such as loss of revenue for fishing and tourism industries, as well as cleanup and restoration costs. Additionally, exposure to oil and its components can cause health problems for humans and wildlife, ranging from skin irritation to cancer. Therefore, it is crucial to take measures to prevent oil spills and to effectively respond to them when they occur [1, 5, 10, 7, 29, 2, 18].

Oil skimming is a widely used technique for oil-water separation. It relies on the principle of specific gravity, which means that oil and water have different densities, and the surface tension that causes oil to stick to certain materials more than water. The skimming media, which can take different forms such as belts, disks, or drums, is made of materials that attract oil and grease, while repelling water.

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As the media passes through the fluid's surface, it picks up the oil and grease, which are subsequently removed by wiper blades or pinch rollers.

Oil skimmers are commonly used in various industries, including manufacturing, power generation, transportation, and oil and gas production, to separate coolants, lubricants, and other hydrocarbons from water. They are simple, reliable, and cost-effective tools that can achieve a high level of water purity by removing most of the oil and grease before more complex and expensive treatments are needed.

Oil skimmers are available in different sizes, designs, and configurations, depending on the specific application and environmental conditions. Some of the factors that affect the choice of an oil skimmer include the type and thickness of the oil, the flow rate and depth of the water, the temperature and pH of the fluid, and the presence of solids and other contaminants.

Figure 1. Marine life struggling in oil spillage

There are several devices and methods that can be used to clean up spilled oil, depending on the size of the spill and the location where it occurred. Here are a few examples:

1. Oil Absorbent Pads: These pads are made of materials that can absorb oil but repel water. They can be used to soak up small spills and can also be used to clean up oily surfaces. The pads can then be disposed of in accordance with local regulations.
2. Oil Booms: These are long, cylindrical floats that are used to contain and absorb oil spills in water. They are typically deployed around the perimeter of the spill to prevent the oil from spreading. Once the oil is contained, it can be absorbed using absorbent materials or skimmed off the surface of the water.
3. Skimmers: These devices are used to skim oil off the surface of the water. They work by using a rotating drum or belt that collects the oil, which can then be separated from the water using a separator.
4. Vacuum Trucks: These trucks are equipped with powerful vacuum systems that can suck up oil and water from spills. The oil and water are then separated using a separator, and the oil can be disposed of in accordance with local regulations.

   It's important to note that cleaning up spilled oil can be dangerous and should only be done by trained professionals using appropriate equipment and safety gear.

Additionally, it's important to consider the potential environmental impacts of using certain cleaning methods or devices. For example, chemical dispersants can be effective in breaking up oil spills, but they can also have negative impacts on marine life and ecosystems. Therefore, it's important to assess the potential risks and benefits of different cleaning methods before choosing a particular approach.

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Finally, preventing oil spills from occurring in the first place is the most effective way to minimize their environmental impact. This can be done by implementing strict safety protocols, maintaining equipment regularly, and investing in spill prevention technologies.

2. Literature Survey

The movement of crude oil and processed goods from the site of production to the customer is a complicated process. As a result, there is constant oil leakage, which has terrible effects on the environment. As a result, many people have expressed grave worries about the potential environmental effects of severe oil spills [2, 18, 33, 25, 12].Many different methods are used, including the application of sorbents to remove oil from water through absorption and/or adsorption (Figure 2) [35, 25, 34, 10]. These methods include the use of mechanical means like skimmers, pumps, booms, and mechanical separators; the use of microorganisms to break down the oil; the adoption of chemical dispersants like detergents to break large oil slicks into tiny droplets. Each strategy has advantages and disadvantages, and the selection of a specific technique relies on a number of variables, including the type of oil that was spilt, the temperature, the wind's direction and speed, and the topography of the area where the oil was spilled [10].

It's true that transportation of crude oil and refined products carries a risk of oil spills, which can have devastating environmental consequences. As mentioned, oil spills can harm marine life, ecosystems, and human health, and they can also result in significant economic losses for oil companies and origin states.

To address the problem of oil spills, various remediation technologies have been developed. These technologies fall into several categories, including physical/mechanical, chemical, thermal, and biological remediation. Each category of technology has its own set of advantages and disadvantages, and the choice of a particular technique will depend on various factors, such as the type of oil spilled and the location of the spill.

Some examples of physical/mechanical remediation technologies include the use of skimmers, pumps, booms, and mechanical separators to remove oil from the surface of the water. Chemical dispersants, which break down large oil slicks into smaller droplets, are another option. In-situ burning, or controlled burning of the spilled oil, can also be used to mitigate the impact of an oil spill. Finally, biological remediation technologies, which involve the use of microorganisms to break down the oil, can also be effective.

It's worth noting that each of these techniques has its own limitations and potential drawbacks. For example, chemical dispersants can have negative impacts on marine life, and in-situ burning can release harmful pollutants into the air. Additionally, some remediation techniques may not be effective in certain circumstances, such as when the oil is too thick or viscous.

In conclusion, the problem of oil spills is a complex and ongoing challenge that requires ongoing efforts to prevent and mitigate their environmental and economic impacts. The use of remediation technologies is an important part of this effort, but it's also crucial to address the root causes of oil spills, such as inadequate safety protocols and equipment maintenance.

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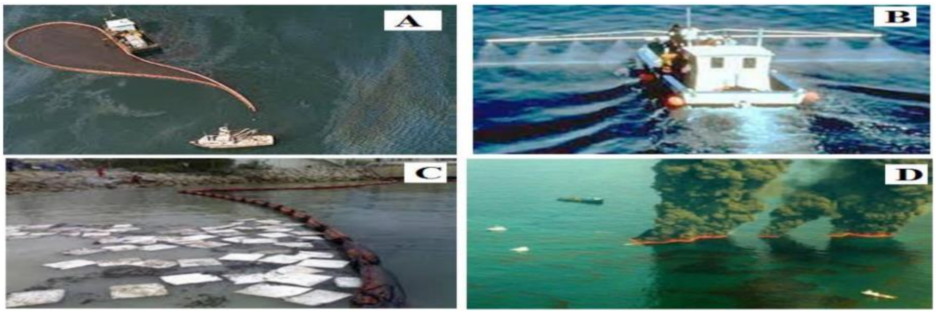

Figure 2. Common techniques for cleaning up an oil spill include (A) utilising booms to confine the spill; (B) using a vessel to spray chemical dispersants; (C) employing adsorbents; and (D) burning the spill in place [10, 25, 34, 35].

3. Proposed work

The procedure is explained in the following fig. To achieve the objective of the study activity, the process flow indicated above will be taken into consideration.

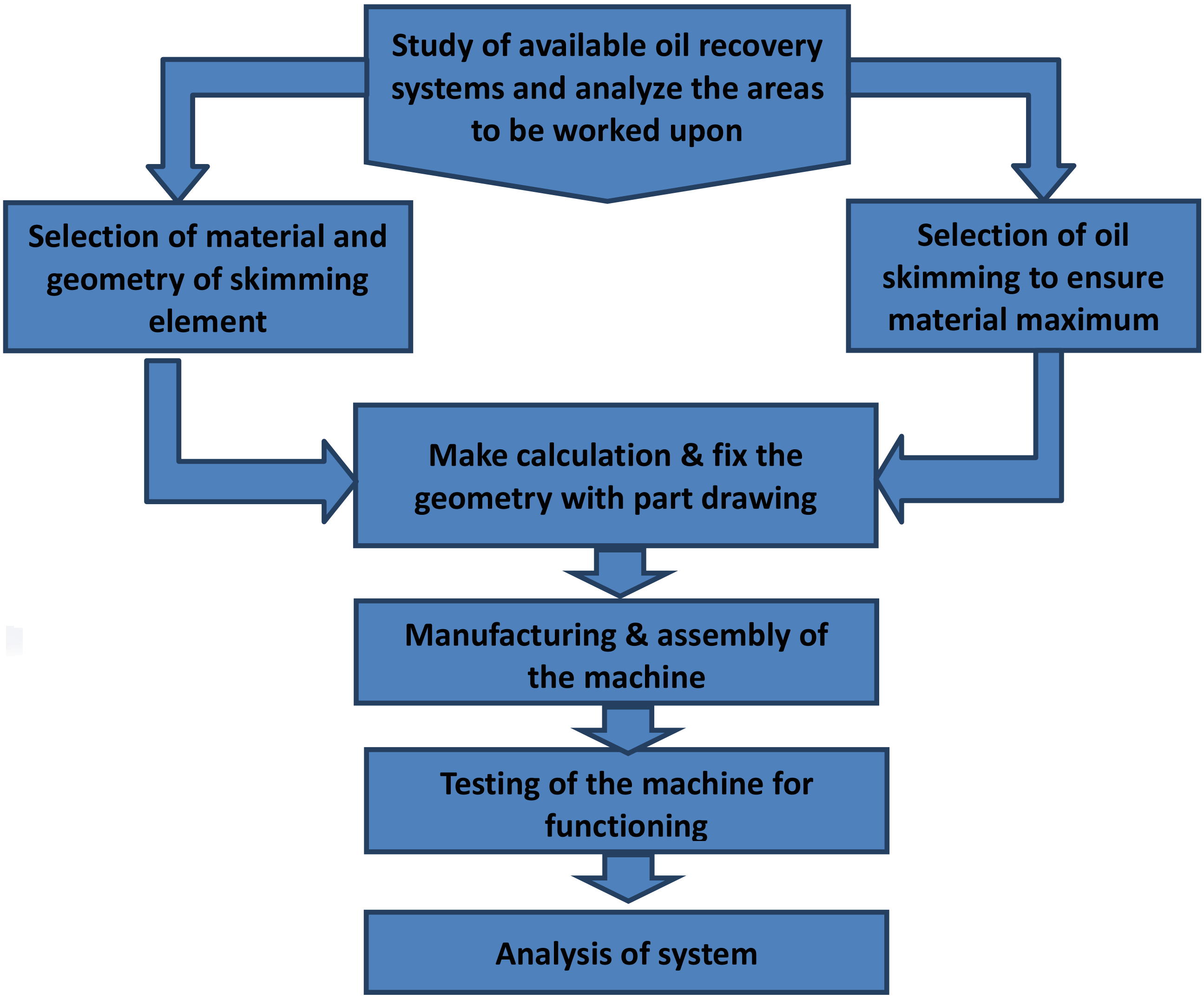

Figure 3. Steps of Execution

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3.1 CAD drawing

Solid Works, a design software programme, was used to create the complete model. The entire model is given colours with the aid of the colour function.

Figure: A Solidworks 2018-designed CAD model of the completed project. Solid Works, a design programme, was used to create the complete model.

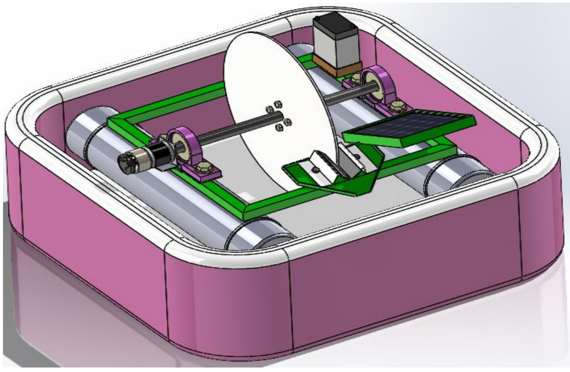

Figure 4. isometric view

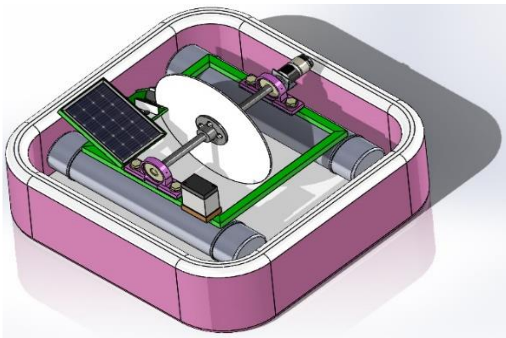

Figure 5. Isometric-2 view

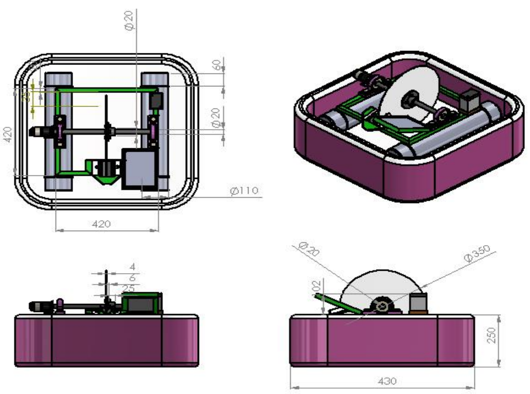

Figure 6. Drafting

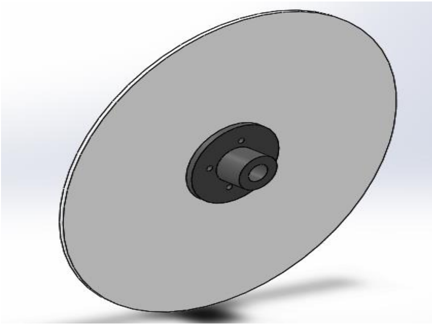
Figure 7. Skimmer disc

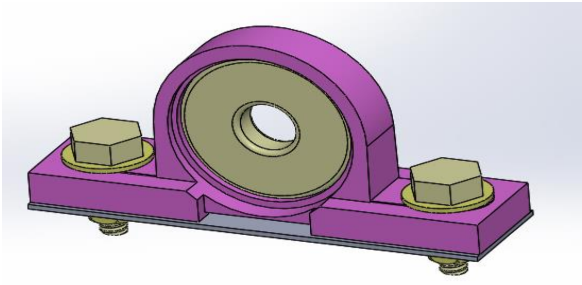
Figure 8. Pedestal bearing

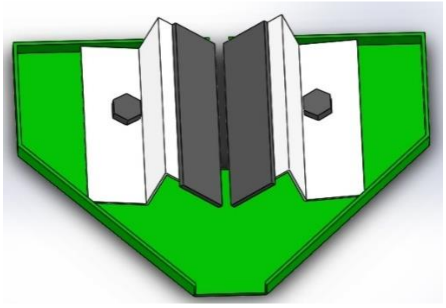
Figure 9. Scrapper

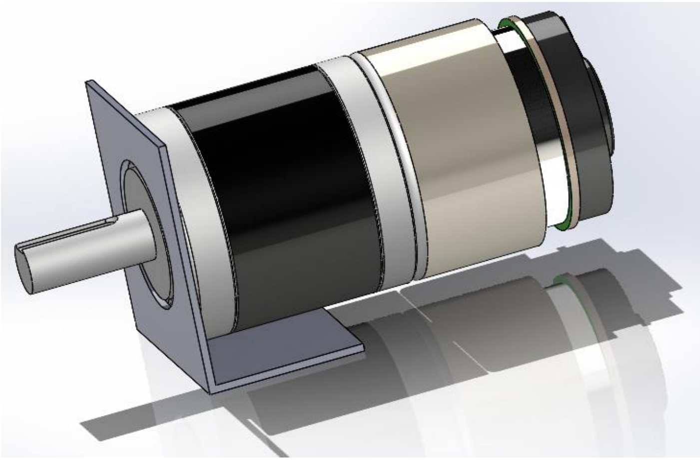
Figure 10. Gear motor

Figure 11. Solar panel

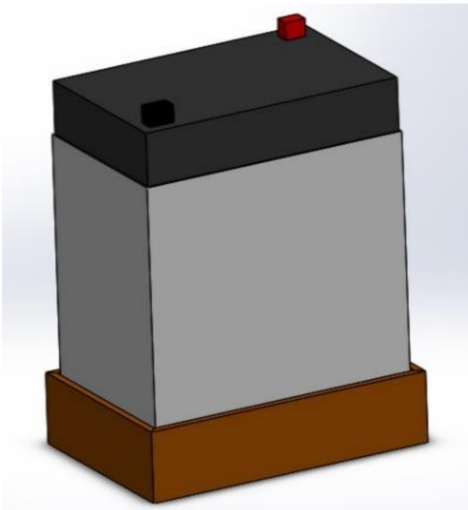

Figure 12. Battery

3.2 Calculations

EN 10083 C45 steel carbon steel

Steel Sheet C45 Tensile testing, hardness testing, impact testing, flattening testing, and chemical composition analysis are a few of the physio-chemical testing procedures for plant-produced goods. Cold drawing is the procedure used to create C20 and C45 steel pipes.

When more strength and hardness are necessary than in the "as rolled" form, C45, a medium carbon steel, is employed. In high speed applications, extreme size precision, straightness, and concentricity work together to reduce wear. polished, ground, and turned.

Heat to 680–710°C and then slowly cool in a boiler for soft annealing. A maximum Brinell hardness of 207 will result from this.

Air temperature normalisation range: 840–880 oC.

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Harden at a temperature between 820 and 860 °C, then quench with water or oil.
Temperature for tempering: 550–660 oC/air.
C45 steel plate, EN 10083 C45 steel plate, C45 steel plate is classified as high carbon steel under EN 10083 standard.

High carbon steel is mostly used in C45 steel plates, per EN 10083. For tempering and quenching, use C45 steel plate. Technical delivery requirements for non-alloy steels used in ordinary engineering applications.

	Comparison of steel grades	
C45 EN 10083-2 Number:1.0503	JIS G 4051	S 45 C
	DIN 17200	C 45
	NFA 33-101	AF65-C 45
	UNI 7846	C 45
	BS 970	070 M 46
	UNE 36011	C 45 k
	SAE J 403-AISI	1042/1045

Table 1: steel grades

Chemical Composition of EN C45 steel

Grade	C (%) min-max	Si (%) min-max	Mn (%) min-max	P (%) max	S (%) max	Cr (%) min-max
C45	0.42-0.50	0.15-0.35	0.50-0.80	0.025	0.025	0.20-0.40

Table 2: Chemical Composition

Mechanical Properties of EN C45 steel

Grade	Condition	Yield Strength R°(Mpa)	Tensile Strength Rm (Mpa)	Elon-gation A5(%)	Hardness HRC	Quenching Temperature (°C)	Bendability	Nominal Thickness, t 1.95mm≤t≤10.0mm	
								Rolled	Annealed
C45	Rolled Annealed Water-quenched Oil quenched	460 330	750 540 2270 1980	18 30	58 55	820 860	Min.reco-mmended Bending radius (≤90°)	2.0×t	1.0×t

Table 3: Mechanical Properties of EN C45 steel

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Product Information

ITEMS INFO

SPECIFICATION FOR OPTION:

Round bar	Diameter: 4mm~800mm or as required
Steel plate	Thick:8mm~300mm, Width:100mm~2300mm
Angle bar	Size:3mm*20mm*20mm~12mm*800mm*800mm
Square bar	Size: 4mm*4mm~100mm*100mm
	Width:10mm~2000mm
Hexagonal	Size: 4mm~800mm
Length: 2m,4m,5.8m,6m,11.8m,12m or as required	

MECHANICAL PROPERTY:

Annealing	Forging	Tempering and Hardening	Normalization
Subcritical annealing: 650~700	1100~850	Tempering: 550~660	840~880
Isothermal annealing: 820~860		Hardening : 820~860 water	

CHEMICAL COMPOSITION:

NO.	C	Mn	Si	Cr	Cu	Ni	P	S
Aisi 1045	0.43~0.50	0.6~0.9	0.10~0.60				⩽0.040	⩽ 0.050
DIN1.1191	0.42~0.48	0.6~0.9	0.15~0.35	≤0.15	≤0.3	≤0.2		
JIS S45C	0.42~0.50	0.5~0.8	≤0.40	≤0.40		≤ 0.4		
C45	0.42-0.50	0.5~0.8	0.4~0.8				⩽0.035	⩽0.035
GB45	0.42~0.50	0.5~0.8	0.17~0.37	⩽0.25	≤0.25	≤0.3	≤0.035	≤0.035
EN8	0.42~0.48	0.6~0.9	0.15~0.35	⩽0.20	⩽0.30	⩽0.20	⩽0.030	⩽0.030

Figure 13. Properties of steel C45

Material = C 45 (mild steel)

Take fos 2

$\sigma_t = \sigma_b = 540/\text{fos} = 270\ N/mm^2$

$\sigma_s = 0.5\ \sigma_t$

$= 0.5 \times 270$

$= 135\ N/mm^2$

Design of motor:

Power of Shaft = P = 10 watt

Power transmitted by shaft,

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

Where, N→ Rpm of motor shaft = 30

T →Torque transmitted

$$10 = \frac{2\pi 30T}{60}$$

T = 3182.6 N-mm

Design of shaft

Now, T_1 is the maximum torque among all shafts, so we will check shaft for failure here.

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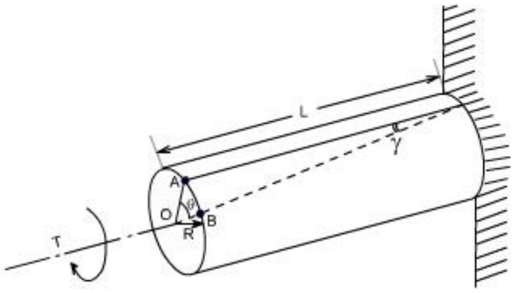

Figure 14. Shaft design

$$T = \frac{\pi \ \sigma s \ d^3}{16}$$

3182.6= π /16 x 135 x d^3
D= 4.9 mm
Motor shaft is 6mm and main shaft is 20mm, so our design is safe.

Selection of bearing

For 20mm Shaft diameter we take standard breaking no. P204

Figure 15. P-204 bearing

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Calculations for batteries

Batteries - 6V/4.5 Amp = 27 watt Charging Time

3 watt solar panel

Impedance (I) = PV

I = 3/10.2 I = 0.29 Amp

Battery Watt/Panel Watt = (27/3) = 9 hours for charging.

Time to Discharge = (Battery Watt/Total Watt Consumed) = 27/15 1.8 Hours = 108 min

Design of transverse fillet welded joint.

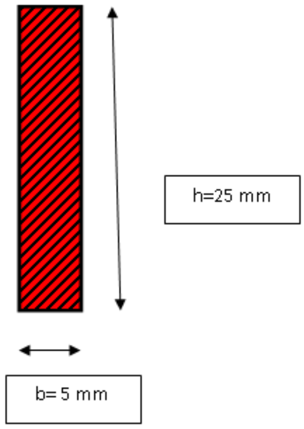

Figure 16. wielding

Hence, using a weld rod size of 3.2mm
Area of Weld = 0.707 times Weld Size times Length = 0.707 times 3.2 times 25 = 56.56 mm2
Force applied equals —-N.
Force exerted / Weld Area = Stress Induced 21 = F / 56.56 F= 1187.76 N = 121.07 kg
Maximum Allowable Stress = 21 N/mm2 for Welded Joints.

4. Experimental Validation

Table 4. Demonstration readings

Sr No.	Oil quantity	Time	% oil purity
1	100 ml	33 sec	90%
2	200 ml	55 sec	92%
3	300 ml	70 sec	95%
4	400 ml	82 sec	97%

5. Conclusion

The SOLAR BASED, DISC TYPE, OIL SPILL RECOVERY SYSTEM is a simple, efficient, cost-effective, and environmentally responsible solution to the oil spill dilemma. Compared to current technologies, it can clean up spilt water with various benefits. Effectively recovering the majority of the oil in useable form, it may clean the water's surface. The system is highly capable of surviving on its own since it can be automated and powered by solar energy. As a result, several human efforts are reduced, allowing for a quicker and more effective response to an oil spill. Hence, the harmful impacts of an oil spill are significantly diminished. Hence, SOLAR BASED, DISC TYPE, OIL SPILL RECOVERY SYSTEM looks to be a key instrument in the fight against the worldwide oil spill disaster.

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