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Thrust Analysis of 250 Watt DC Motor with a Voltage of 12, 18, and 24 Volts, as Well as a Propeller Diameter of 26, 30, and 32 Inches

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ABSTRACT

The purpose of this study was to reduce the damage to the plantation gutters caused by the shock of the water from the propellers, the team pushed using air as the fluid. The driving force used is a 250 Watt DC motor which gets power from the sun's heat to drive the boat, then testing the propellers with variations in the diameter of 660 mm, 762 mm, and 812.8 mm, as well as variations in voltage 12 volts, 18 volts, and 24 volts on the propeller. The solar panels needed are 2 solar panels of 170 WP. From the calculation, the proper size of the shaft diameter is 10 mm. The results of the thrust test, for a diameter of 812.8 mm, obtained a power of 218.2 watts and a thrust of 5.8 Kg. The highest current produced is 9.1 amperes, this value is qualified because it does not exceed 10 amperes. From the test results of the propeller thrust test, it can be said that the design and analysis meet the needs

Keywords: Thrust, Solar Panels, Propeller

INTRODUCTION

The Central Statistics Agency (BPS) noted that large plantations in Indonesia were dominated by oil palm plantations in 2020. The number reached 8.9 million hectares, an increase of almost 300 thousand hectares compared to the previous year which was 8.6 million hectares [1].

Behind the success achieved by farmers, especially oil palm, several factors must be considered, one of which is that transportation activities are very important because it is a means to carry out all activities within the plantation, in one of the new companies in Central Kalimantan, plantations there only use water transportation, namely using a barge [2].

The manufacture of boats/ships needs to consider planning in the field of propulsion systems. The aspect of the propulsion system is planning a good propeller design in order to achieve the purpose of the boat/ship function in terms of speed according to the required premises. Speed on the boat/ship can not be separated from a good propeller design in order to get the optimal thrust (Thrust). Variations in the diameter of the propeller greatly affect the high force of the Thrust value generated by the workload of the ship, if the manufacture of the propeller is not good, there will be a decrease in the performance efficiency of propellers [3].

In the beginning, many sources of energy in this world were used as generators or propulsion. One of the energy sources that we often encounter is renewable energy that comes from nature with sustainable processes [4]. In Indonesia, the use of renewable energy continues to increase. Renewable energy includes solar energy, wind energy, hydro energy, geothermal energy, and biomass energy [5].

Solar energy has the potential to be used directly as alternative energy, both thermally and electrically [6]. Solar panels are a tool that uses solar energy for electrical energy [7]. Therefore, the authors use solar energy as a source of electrical energy. The electrical energy produced comes from solar panels, then the energy is stored in a battery with the aim that the electrical energy is used to drive a DC motor [8]. A DC motor is an electric motor that requires a direct current supply to the field coil to be converted into mechanical motion energy [9]. The rotation of this DC motor will produce a thrust from the shaft to the propeller which is directed directly through the air [10]. The propeller functions as a generator of thrust by creating a pressure difference between the front and back of the blade [11], while the propeller shaft functions to transfer or transmit power from the motor to the propeller into thrust [12]. Thrust is used to overcome drag, and to overcome gravity [13]. Thrust is a mechanical force, so the propulsion system must be in physical contact with the working fluid to generate thrust [14]. Currently, in lowland areas, many farmers are engineering by designing transportation wheels [15] as well

as designing tools that can support the plantation field, such as designing ships in small trenches. In general, ships use water as their fluid. In testing, the authors chose air as the fluid. Because if you use water fluid, the rotation of the propeller can damage the flow of water that is passed [16].

RESEARCH METHOD

This research was conducted at the UKI Mechanical Engineering Laboratory by designing tools and conducting tests. In this study, the method used is a literature study (library). This research is the design and testing of propellers with diameter variations of 26, 30, and 32 Inch, and by using a DC motor with a voltage of 12, 18, and 24 Volts [17]. The DC motor is supplied by electricity from the solar panel through 2 batteries which are installed in parallel. The design and testing stages are shown in Figure 1 [18]:

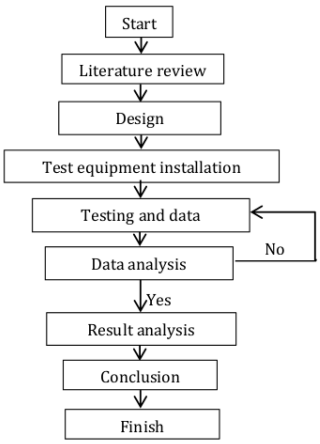

Figure 1. Research flowchart

Before testing, it is necessary to determine the specifications of the tool used as a control system, namely using a DC motor dynamo with a power of 250 Watt, 12 volts, 18 Volt, and 24 Volt, to drive the propeller (fan) as boat propulsion. In this test, 3 variations of voltage were used, namely 12 volts, 18 volts, and 24 volts, and based on 3 variations in diameter, namely 660 mm, 762 mm, and 812.8 mm [19]. Then the test was carried out in a laboratory belonging to the Faculty of Mechanical Engineering, Indonesian Christian University, with the test installation shown in Figure 2 [20].

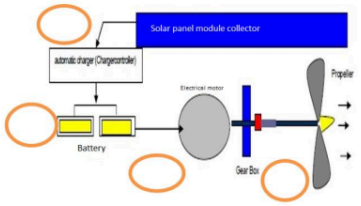

Figure 2. Test sketch

In this design, several tools and auxiliary materials used to obtain test results include: a 250 Watt DC motor is used as a driver to rotate the propeller [21], the supporting leg as a support for the DC motor and the propeller can stand upright, the scale as a measuring tool for thrust, propeller as a fluid booster, battery to store electrical energy [22], dimmer to regulate the speed of rotation of the propeller, MCB 20 A as a connector and electrical breaker, cables as a medium for transmitting electric current [23]. voltmeter

to measure the electric voltage in the electrical circuit, an ammeter to measure the value of electric current flowing, solar panels as a supply of electrical power, and controllers to regulate current and excess charging and voltage from solar panels [24].

RESULT AND DISCUSSION

Based on the results of the design and manufacture of the tool, a thrust test with variations in the diameter of the propeller is carried out as shown in table 1 below [25]:

Table 1. Results of thrust test with variation of diameter

Test	Voltage (V)	Currents (A)	Thrust (Kg)
Diameter 26 inches			
1	12	5,5	1,6
2	18	6,1	1,9
3	24	7,4	3,1
Diameter 30 inches			
1	12	6,5	2,3
2	18	7,9	2,8
3	24	9	3,2
Diameter 32 inches			
1	12	6,4	3,8
2	18	7,7	4,6
3	24	9,1	5,8

With the obtained test data, the calculation of each thrust test can be carried out as follows [26]:

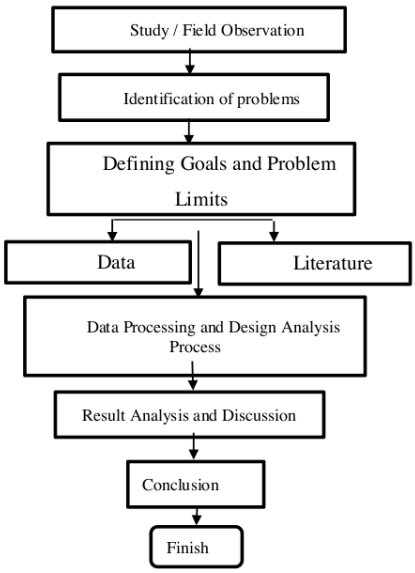

Figure 1. Research flowchart

Solar Panel Capability Analysis

The load used is a 250W DC motor with 12 Volts and is assumed to be on for 3 hours a day [27]. From the test results table data, the highest power is taken, which is 218,4 watts, then the total daily load of the DC motor can be calculated as follows: Total load = 218,4 × 3 hours = 655,2 Watt hours, so if you add 20% of the controller then the total power required is $W_p = 655 + (655{,}2 \times 20\%) =$ 786,24 W [28]. The general voltage that the battery has is 12 V, then the required current is $I = \frac{P}{V} = 65{,}52$ A, if we choose to use a 70 Ah 12 V battery, it takes 2 batteries 70 x 12 x 2 = 1680 W, assume we choose to use a panel

size of 170 WP (Watt Peak), and it is known that 5 hours is the effectiveness of sunlight time [29]. So in a day, the panel is able to produce a supply of 170 WP x 5 hours = 850 Watt. For 1 panel, it can supply 850 watts of electricity, so the total panels needed are $\frac{1680\ \text{Watts}}{850\ \text{Watts}} = 1{,}97$ or 2 panels [30].

Calculation Of Shaft Diameter

The shaft is used to connect the DC motor with the propeller [31], it is necessary to calculate and analyze the size of the shaft using the formula $d = \sqrt[3]{\frac{16\times T}{\pi\,\tau}}$, with a torque of $P=\omega\times T$ *or* $T=\frac{P}{\omega}=\frac{300}{2\times\pi\times n}=1{,}09$ Nm, where the motor power is 250 Watts, and taking the design factor (Pd) is 1,2 then the total power P is 300 Watts [32]. By obtaining torque, it can be calculated the diameter of the shaft used is $d=\sqrt[3]{\frac{16\times T}{\pi\,\tau}}=\sqrt[3]{124}=5$ mm.

In this calculation, the shaft is reduced due to the installation of pegs, so the diameter of the shaft used is 10 mm.

From the calculated data, we can compare the thrust between the diameter variations shown in the following figure:

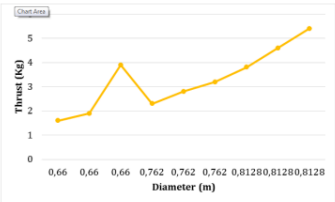

Figure 3. Graph of thrust and diameter variations

In Figure 3, the variation graph shows that the larger the diameter of the propeller used, the higher the thrust generated, which is 5,8 Kg.

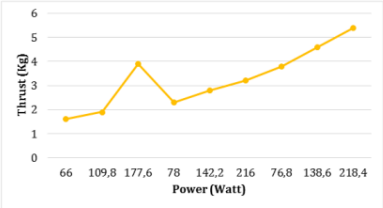

Figure 4. Graph of power and thrust

Figure 4 shows that the greater the power used, the greater the thrust generated. When using 218,4 power, the thrust generated is 5,8 Kg.

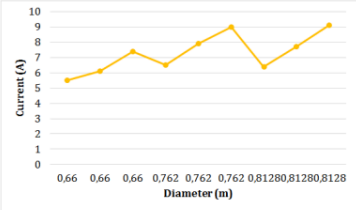

Figure 5. Graph of current strength and diameter

Figure 5 shows that the larger the diameter used, the higher the current generated. In this test, when using a propeller diameter of 0,8128, the resulting current is 9,1 Ampere [33].

CONCLUSION

From the results of testing the thrust using several variations of the diameter of the propeller, it can be concluded that an adequate variation of the diameter of the propeller is to use a diameter of 812,8 mm and a current strength of 9,1 Ampere. This value is qualified because it does not exceed 10 Ampere. For adequate power, which is 218,2 Watts and a thrust of 5,8 Kg while the current is 9,1 A. Thus, the larger the diameter of the propeller used, the greater the thrust, power, and strength. strong current generated

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