

Modification of Traditional Fishing Boat Outriggers into a Simple Electric Power Plant

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KEYWORDS

*Traditional Fishing Boat
Outrigger
Battery
Electric Power Plant*

ABSTRACT – The outrigger is one of the components of the boat attached to the outside of the boat. Outrigger has a fairly vital function because it can make the boat stable when fishermen do activities at sea. This research aims to determine the potential of electrical energy that can be generated in the outrigger. This research uses experimental methods carried out in the hydrodynamics laboratory of the Department of Shipping Engineering, Hasanuddin University. The outrigger shape was modified so that the water flow could be directed into the outrigger cylinder and rotate the turbine to produce electrical energy. This modification was carried out without eliminating the main function of the outrigger supporting the stability of fishing boats. The electrical energy produced is stored in the battery to be used as a source of electricity for lighting at night. The results of this research indicate that the electrical energy produced by outriggers can be used as a source of lighting for traditional fishing boats. However, further research is still needed to determine the loss of ship resistance with this modification.

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INTRODUCTION

People who have a livelihood and earn as fishermen are one of the community groups who carry out business activities by earning income from the fishing activities themselves. Fishermen are people whose livelihood is fishing [1]. Based on their characteristics, fishermen are categorized into two types, namely modern fishermen, those whose job is to find fish in the sea or rivers by using capital or modern fishing equipment/machines; and traditional fishermen who use fishing facilities. simple/traditional fish [2, 5].

A fishing vessel is a boat or vessel used to catch fish in the sea, lake, or river. In the South Sulawesi region, several types of fishing boats are used depending on the distance to be used as fishing grounds. Usually, there is a 20-mile or 2-3 hours journey. There are traditional fishing boats known in the Makassar Strait that use outriggers and sails such as Sandeq boats, a characteristic of fishermen in Majene. Phinisi ship that uses the typical Bulukumba sail. Some do not use sails, such as jollorok, katingting, pagae, bagang. Some use outriggers such as lopi-lopi/lepa-lepa, and sometimes jollorok, katinting also uses outriggers [1].

Most fishermen in Indonesia need lighting when sailing at night especially in terms of fishing techniques. In the current condition, fishermen generally incur additional costs to overcome this [3]. One way that can be done to overcome the above problems is to apply the application of alternative renewable energy sources such as the installation of water turbines on outriggers. This can be done by modifying the outrigger using a turbine or the like which can rotate when the ship is moving. This rotation will be converted into electrical energy.

Farraday's law states that "Every change in the magnetic field in the coil will cause an induced electromotive force (EMF) which is proportional to the rate of change of flux". The factors that affect the magnitude of the electromotive force (EMF) are the number of turns in the coil, the more turns in the coil, the greater the induced voltage. The speed of motion of the magnetic field, the faster the magnetic field lines of force or flux hitting the conductor, the greater the induced voltage. The number of magnetic field lines of force or flux, the greater the number of magnetic field lines of force or flux hitting the conductor, the greater the induced voltage [2, 4].

A simple power plant that can be applied to traditional fishing boats is the Archimedes screw turbine, this turbine is fish-friendly and also relatively inexpensive to manufacture [7]. One way that can be done to increase the efficiency of this turbine is to use pumped storage [8], in other words, take advantage of the water flow along with the speed of the ship.

This research aims to determine the potential of electrical energy that can be generated from the modification of the outrigger into a simple power plant.

METHOD

This research used a sample ship in Wae Tuoe Village, Pinrang Regency, South Sulawesi. Based on the results of interviews with several fishermen, the following Table 1 shows the data obtained.

Table 1. Traditional fishing boat data

Item	Value
Ship Type	<i>Katinting</i>
Length over All	8 metres
Voyage to the fishing ground	2-3 hours
Ship speed	±7 knots
Night light source	5 W LED lamp

The tensile test is a method for testing the strength of a material or material by providing an axial force. The Universal Testing Machine is used to test the tensile strength of composite materials. The extensometer is used to measure changes in length, while the loadcell sensor will measure the tensile force at the crosshead. After the test object has been stretched a length measuring tool or a length meter on the test piece shall be used to measure the distance between the two points. The tensile strength of the composite can be determined by testing the sample according to the ASTM D638-14 standard which can be seen in Figure.1.



Figure 1. Sample of a traditional fishing boat with an outrigger.

The initial step in this research is a literature study on energy conversion, characteristics of fishing boats, water turbines, electricity generators, and power supply methods in water energy power generation systems that will be applied to ship outriggers. Then, data were collected on the speed of the ship and the use of electric power used by traditional fishing boats when catching fish by interviewing several fishermen at the research location.

The results of these field observations are then used as a reference in planning the outrigger modification of traditional fishing boats using a turbine that will be used as a power plant. From the observations, the size of the outrigger according to the object of the ship with a length of 2.2 m and a diameter of 7.62 cm was obtained. In this research, 2 additional turbines were designed, so that a total of 3 turbines will be tested, the three turbines are different from the turbine capture angle which affects the blade distance, this is done to determine the optimal angle of the turbine blade which is capable of producing large electrical energy as shown in Fig. Figure 2 and Figure 3 below. Based on research by Abdullah et.al., [9] it is known that torque can be increased by increasing the pitch length, but

torque can be reduced by adding a few blades to the turbine. The detailed dimensions of each turbine can be seen in Table 2.

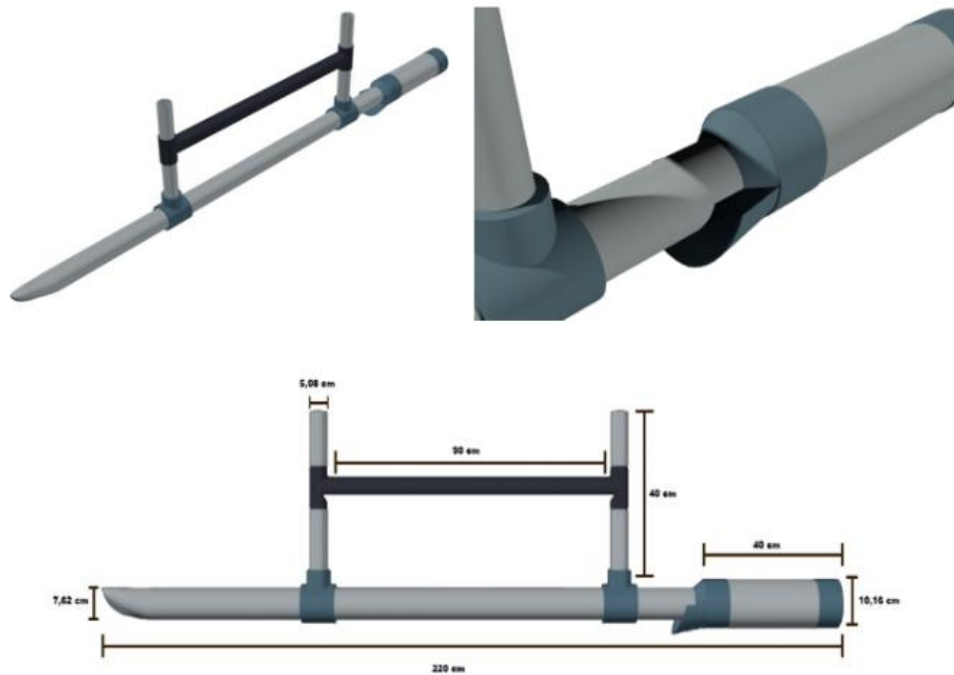


Figure 2. The result of modification on outrigger shape.

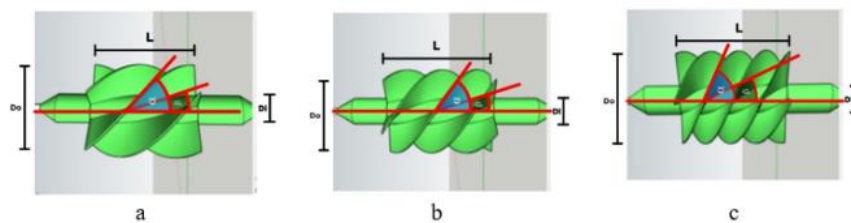


Figure 3. Turbine design; a. models 1, b. models 2, and c. model 3.

After the modification process is complete, it is continued with the outrigger towing test to determine the performance of the turbine that has been installed. The tests were carried out in the Hydrodynamics towing tank laboratory, with a towing speed of 2.5 m/s (Figure 4).

Table 2. Turbine model size

Symbol	Name	Model 1	Model 2	Model 3
In	Thread inside diameter	3 cm	3 cm	3 cm
Do	Thread outside diameter	9.6 cm	9.6 cm	9.6 cm
L	Turbine length	12 cm	12 cm	12 cm
^	Turbine blade thread range	30 cm	20 cm	15 cm
β	Thread angle at Di position	17°	26°	34°
α	Thread angle at Do position	45°	55°	65°
n	Number of spoons	5	5	5

The analysis is carried out by comparing the results of the outrigger towing test on the towing tank with Equation 1 about the potential difference [6, 10]:

$$\varepsilon = NBA\omega \tag{1}$$

Where N is the number of loops in the coil, B is the magnetic field, A is the area of the loop and ω is the angular velocity.



Figure 4. Towing Test on the towing tank.

RESULTS AND DISCUSSION

Based on the test results, it is found that there is a difference in the power that can be produced by each turbine being tested. Testing of each turbine without load can be seen in Table 3. Data obtained that the voltage that can be generated in turbine model 2 is better than the other two models. This also happened when testing by adding a load of 5 Watt (LED lamp), the lamp was able to light quite brightly on the use of turbine 3 with an average voltage and current of 4.24 Volts and 0.98 Ampere, while on the turbine 1 and the turbine 2 The light conditions were slightly dim with a voltage of 1.43 Volts and 1.49 Volts respectively at 1.02 Ampere and 0.46 Ampere currents (Figure 5).

Table 3. Voltage measurement in no-load turbine

Iteration	Model 1	Model 2	Model 3
	Voltage (V)	Voltage (V)	Voltage (V)
1	12.95	33.57	19.79
2	13.71	33.99	19.71
3	11.04	32.85	19.90
4	10.12	34.16	20.22
5	10.28	33.63	19.57
Average	11.62	33.64	19.84

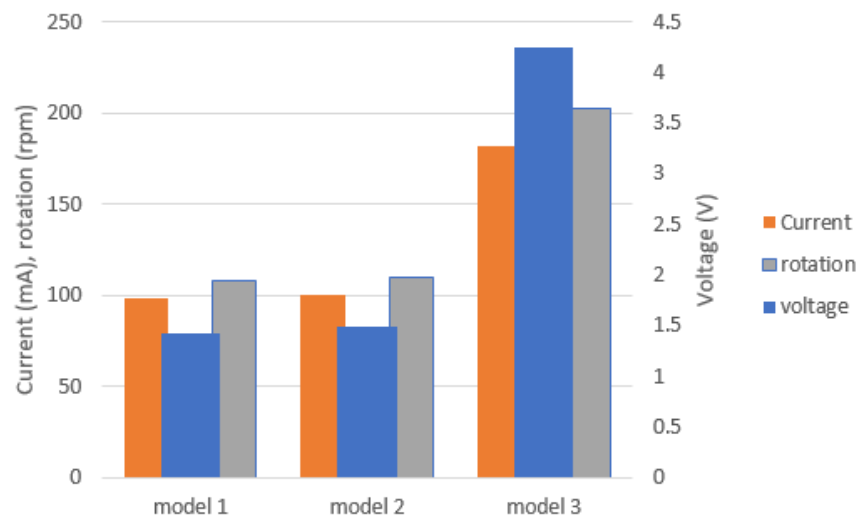


Figure 5. Comparison of voltage and current in tests.

This is influenced by the difference in turbine density of each turbine model. The turbine in the initial research (model 1) was modified by adding a density of 26° in model 2 and 34° in model 3. In model 1, not all of the water flow that hits the turbine blades is transferred to power to rotate the turbine, while in model 3, with the blade position tighter than before, the flow of water hits the active point of the blades so the turbine can rotate properly.

In turbine 1 and turbine 2, the lights are slightly dim. Turbine 3 obtained an average power of 0.769 Watts at 202 rpm, while turbine 1 and turbine 2 only obtained an average power of 0.140 Watts at 108 rpm and 0.148 Watts at 110 rpm.

Based on the foregoing, it can be concluded that the use of turbines (especially model 3) on fishing boats' outriggers can be used as an alternative solution to provide electricity for lighting needs on board, of course by utilizing a storage system (battery) so that the power obtained during the voyage can be accommodated for use on the ship, especially at night.

CONCLUSION

The use of outriggers on traditional fishing boats can generate electrical energy that can turn on lights 5W LEDs. Considering the relatively short sailing time from shore to the fishing ground, storage media (batteries) should be used so that the electricity generated can be accommodated for use at night. The electrical energy generated from the turbine mounted on the outrigger is connected using a cable from the generator to the lamp/load, starting from the generator to the battery, a rectifier circuit in the form of a diode is installed, then from the battery to the load.

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