Utilization of Arafura's Ocean Current Potential using Gorlov Helical Turbine as an Energy Source for Cold Storage Platforms and Fuel Distribution in Overcoming Fisheries Logistics Problems in Eastern Indonesia

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Abstract: Indonesia is a country that has the second largest fishery resource in the world after China. But the level of fish supply for public consumption is still very lacking. This is caused by various things including the uneven development of fishing port infrastructure, lack of appropriate technology to support fisheries activities, the amount of fuel used so that it is not proportional to the amount of fish catches obtained, and the absence of adequate fish storage places makes fishermen use tools that are not environmentally friendly. Not only that, fish is a commodity that is easily damaged and requires a means to reduce the rate of damage and deterioration of fish quality. To overcome these problems an Integrated Fishing Platform was made by utilizing the potential of ocean current energy for fish storage and distribution of fuel in overcoming the problem of fisherman logistics in eastern Indonesia. The working principle of this platform is to utilize the current potential with gorlov helical turbine to change the potential current into electrical energy, where the electricity output is to electrify cold storage and semi-submersible construction as a bunker or fuel storage for fishermen.

1 INTRODUCTION

Indonesia is an archipelago with an ocean region reaching two-thirds. It is full of sustainable potential of Indonesian marine fish resources which reaches 65 million tons per year scattered in the waters of the Territorial Zone and the Indonesian Exclusive Economic Zone. Indonesia has an area that has the most fisheries resources, namely in the Arafura Sea. Arafura is one of the waters in Indonesia "the golden fishing ground" in the Indonesian fishing industry. The sustainable potential (MSY) of 771,600 tons / year consists of pelagic fish, demersal fish, shrimp, squid, lobsters and reef fish, Arafura Sea has become an "interesting factor" for large-scale capture fisheries that use ships¿ 30 GT (Mulyana, 2012).

Consumption far exceeds the number of the world community, which is 30 kg per capita per year, while the level of fish supply for world consumption is 17.2 kg per capita per year. However, all the sustainable potential of Indonesian marine fish resources, only 20% have been utilized (KKP, 2011). This is very much influenced by the fishing process by Indonesian fishermen.

Unfortunately, Indonesian fishermen are still not able to maximize their catch because they experience many problems, such as the uneven development of fishing port infrastructure, lack of appropriate technology to support fisheries activities, the amount of fuel used is not proportional to the amount of fish catches obtained, and the absence of a place Adequate fish storage makes fishermen use all means to get lots of fish so they use tools that are not environmentally friendly such as cantrang. Cantrang is a fishing gear that is active with operations carried out at the bottom of the waters. Not only that, fish which is a commodity that has perish ability requires a means to reduce the rate of damage and deterioration of fish quality.

Therefore, the means that must be available in the Indonesian fishing industry is a place for storing fish in the form of cold storage that serves to preserve fish so that freshness and quality are guaranteed, and also facilitate the distribution of fish to consumers. In Indonesia, the spread of cold storage is uneven and only concentrated in Java. The amount of electricity needs is an important problem in the development of cold storage. By looking at the energy potential of Indonesia's ocean currents reaching 5 m/s in the Capalulu

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Strait, North Maluku, and reaching 3 m/s in the waters of Nusa Tenggara (Lubis, 2016) and from various problems, a solution is created, an independent platform that utilizes the potential of ocean current energy as a cold storage power source, and utilizes a semi-submersible system for the distribution of ship fuel in Eastern Indonesia. In this study the authors used a research method that is a simulation method.

2 LITERATURE REVIEW

Indonesia has a lot of energy resources. As for the potentials energy, the greatest potential is in the marine sector. From the table can be concluded the theoretical potential of ocean energy is very large (Nyuswantoro, 2012). But only a little for its technical potential, this is due to limited technology that is insufficient to develop this ocean energy. In addition to the technological limitations that are still less developed, there is no concrete solution from the government to maximize the potential of energy source from ocean sector (LIPI, 2017). According to the World Energy Council (WEC) trends in Europe are beginning to switch to alternative energy using wind turbines (Wang et al., 2017), and it will be predicted by 2050 that most of Europe has already turned to alternative energy using turbine (Kumar and Saini, 2015).

The government has actually mapped potential areas for energy development in the marine sector. The map covers potential areas for the development of ocean currents, sea breezes and ocean waves (Hardisty, 2017). The area covers most of eastern Indonesia, which we know that eastern Indonesia still has a low electrification ratio of less than 40% (Ministry of Energy and Mineral Resources, 2016). Actually, the government has started to develop by creating a prototype renewable energy implemented by Research and Technology Centre (BPPT) (LIPI, 2017). One of them is by installing the ocean currents energy under the Suramadu bridge and on one of the beaches in Yogyakarta. Both prototypes are Oscillating Wave Column (OWC).

However, this solution is considered less because the powerplant system is only utilizing the tidal energy of ocean waves. Therefore, we make a proposal by helix turbine. It is expected that with our new idea will be more effective in exploiting the energy potential from the marine sector. And hope is as a solution to handle the energy crisis in Indonesia and to state the development in Indonesia. This is because to grow up the regional economy must have infrastructure, including the most important is the availability of electricity (Ministry of Energy and Mineral Resources, 2014).

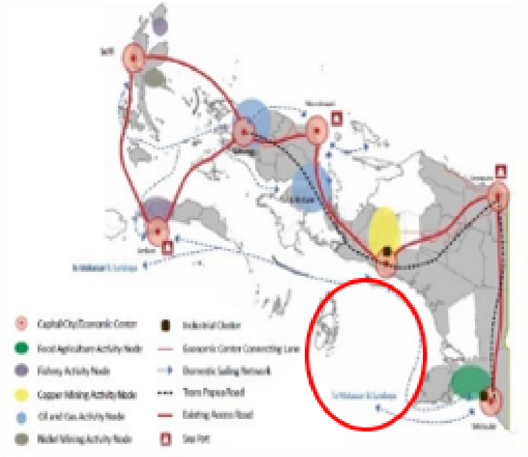

Figure 1: Fisheries Distribution in Arafura Sea

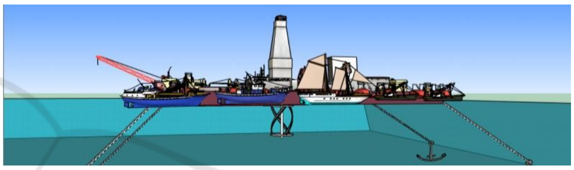

Figure 2: Design Platform

3 DISCUSSION

3.1 Potential Application Selection Area

Based on the results of the location survey that the author has reviewed, a suitable location is found to lay the platform, namely the waters of the Arafura Sea between Australia and Papua Island in the Pacific Ocean. The Arafura Sea has an average sea flow velocity of 2 m/s (Ministry of Energy and Mineral Resources, 2014). The map of Arafura sea as shown in Figure 1.

3.2 Design Platform Analysis

This platform is designed with 40 m x 40 m with height of platform 6 m. with volume ballast that can be replaced to bunker of fuel for fisherman ship is 1585.60 ton.

Gorlov Helical Turbine is very suitable to be applied to straits in Indonesia. This is due to Gorlov Helical Turbine characteristics that are able to operate with very low sea current velocities of below 2.5 m/s and produce about 4 MW of energy. Helix Tur-

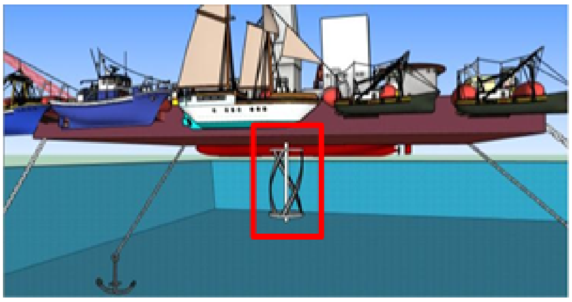

Figure 3: Gorlov Turbine Under Platform

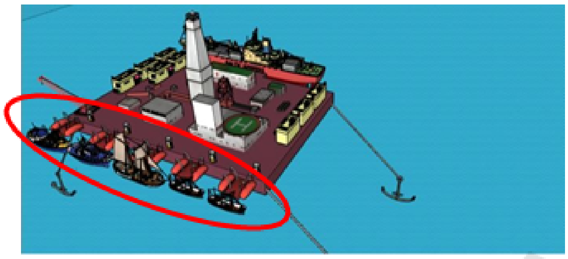

Figure 4: Five Dock in Platform

bine also examined the characteristics of the foil. The research was carried out using various turbine models with different foil angles. The results showed that the angle of foil has an effect on turbine efficiency. When the angle δ = 135°, the turbine shows the best efficiency. With an angle of 135°, so the efficiency increases to 54%. So, the best turbine design is the Helix Turbine with 135°foil angle (Akimoto et al., 2013). The figure of gorlov helical turbine as shown in Figure 3.

There are five docks that can accommodate 10 vessels measuring 20 gt, 5 ships measuring 40 gt, 3 vessels measuring 40 gt, and 1 vessel measuring 100 gt. The figure of dock as shown in Figure 4.

One cargo ship with a capacity of 100 gt will be used to distribute fish in cold storage to land. Delivery is done every three days. The figure of cargo ship as shown in Figure 5.

At each pier there is a refueling vessel that can fill Heavy Fuel Oil (HFO) and Marine Diesel Oil (MDO). The figure of Refueling Component for Fishing Ship

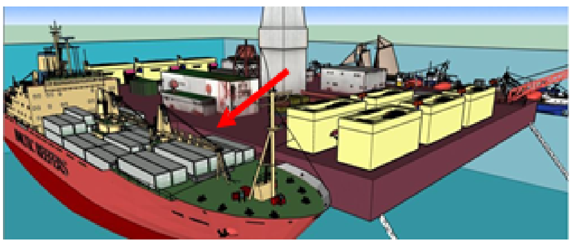

Figure 5: One Cargo Ship That Can Deliver to Dobo

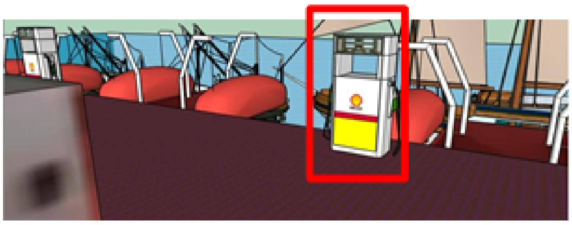

Figure 6: Refuiling Component for Fishing Ship

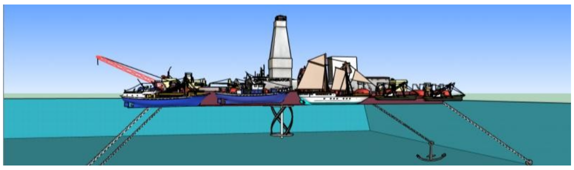

Figure 7: Semi - Submersible Platform

as shown in figure 6.

The platform structure is made with the concept of semi-submersible which is equipped with anchor that is lunged under the sea. This is so that the platform can be easily moved from one place to another. The figure of Semi - Submersible Platform as shown in Figure 7.

There are eight cold storage units with the required total power capacity of 300 kW. This cold storage has a capacity of 10 tons each with details of two cold storage for shrimp, three cold storage for tuna fish, and three cold storage for skip-jack fish. The figure of cold storage unit as shown in Figure 8.

3.3 Gorlov Helical Turbine Analysis

The following will show the Gorlov Helical Turbine simulation calculation with the specified specifications for Platform that will be placed in the Arafura Sea which has an average ocean current velocity of 2 m/s.

This turbine was chosen because of its characteristics which are able to operate with a speed of ocean currents below 2.5 m/s. Gorlov Helical Turbine also analyzed the characteristics of the foil. The research was carried out using various turbine mod-

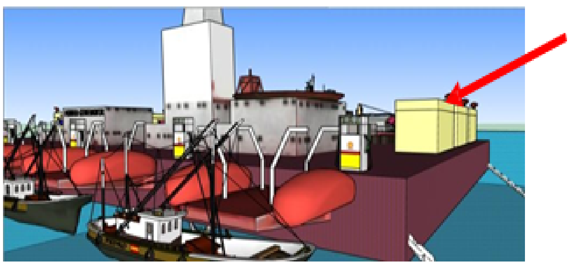

Figure 8: Cold Storage Unit

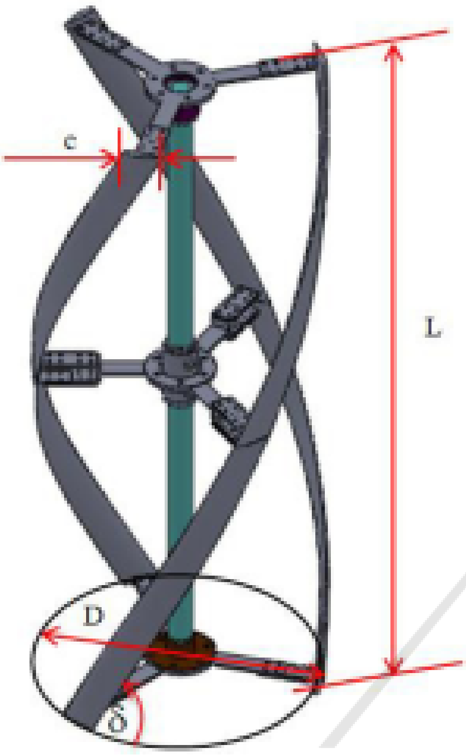

Figure 9: Gorlov Helical Turbine with 135°foil (Akimoto et al., 2013)

els with different foil angles. The results showed that the angle of foil has an effect on turbine efficiency. When the angle δ = 135°, the turbine shows the best efficiency. With an angle of 135°, so the efficiency increases to 54%. So, the best turbine design is Gorlov Helical Turbine with 135°foil corners (Pongduang et al., 2015). The figure of gorlov helical turbine with 135°as shown in Figure 9.

Gorlov Helical Turbine will be installed in the center, center of the generating platform. Gorlov Helical Turbine installed in this power plant has innovations, namely the ball bearing system on its axis which makes the turbine can move more freely in all directions, so that it can receive ocean current energy from various directions. This makes the energy of ocean currents that can be used more.

From the results and calculations on the generator and gearbox, the total power produced by Gorlov Helical Turbine is 4866.66667 kW. The figure of CFD

Table 1: Calculations of Available Fuel volume

Volume Bunker	40x40x1m	1,600m^3
Density	0.991 ton/m^3	
Capacity of Bunker	1,600m^3x0.991	1,585.6ton

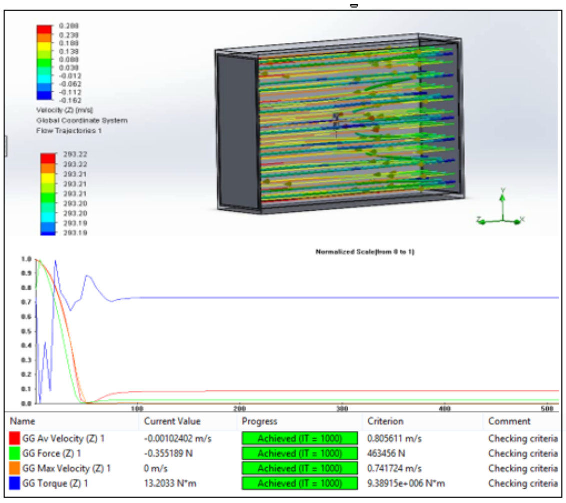

Figure 10: CFD Results for Selected Turbine

turbine with 135°as shown in Figure 10. From the calculation of the electricity distribution, the total power produced by Gorlov Helical Turbine is 4866.67 kW while the electricity demand for 1 cold storage is 300 kW, so that the energy produced can meet the needs of up to 16 cold storage units but on this platform, the energy is utilized to meet the needs of 8 cold storage units in accordance with the potential of fish in the waters of the Arafura Sea.

3.4 Fuel Calculation Analysis for Fishing Vessels

Table 1-3 will show the calculation of the fuel planned to be distributed on fishing ship in Eastern Indonesia.

Table 2: Fuel Tank Capacity of Each Ship

No	Ship Dimension	Tank Capacity	Fuel Mass
1	100 GT	200	0,1982 ton
2	40 GT	90	0,0892 ton
3	20 GT	40	0,0396 ton

From the calculations, the fuel on the platform with a capacity of 1,585 tons can be distributed to three types of vessels each day that sail in the Ara-

Table 3: Total Capacity of Ship Tanks in a Day

Dimension	Amount	Capacity	Endurance
100 GT	50 Unit	10.000	Total platform capacity Fuel consumptions of fish ships
40 GT	70 Unit	6.300	
20 GT	100 Unit	4.000	
Amount	20.300		79 Days

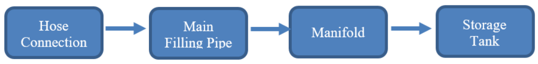

Figure 11: Flow of Fuel Distribution from Land to Platform

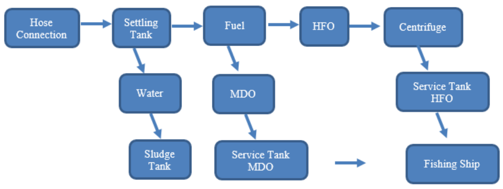

Figure 12: Fuel Distribution Flow from the Platform to the Fishing Ship

fura sea as many as 50 ships measuring 100 GT, 70 ships measuring 40 GT, and 100 vessels measuring 20 GT with each each tank is 200 l, 90 l, and 40 l. So this platform can supply fuel needs in the Arafura sea waters within 79 days.

3.5 Fuel Filling System for Fishing Ship

The ship refueling system is applied to the platform. Fuel on land will be transferred to the Oil Tanker vessel via a hose connection on the right and left sides of the vessel connected to the main filling pipe. Furthermore, when the Oil Tanker ships arrive at the platform, the manifold is transferred to the fuel pipe to the tail pipe to each storage tank. On the platform, semi submersible construction serves as a storage tank.

Furthermore, the fuel in the storage tank will be processed with the following stages:

- Fuel from storage tanks will be transferred to settling tanks. Settling tanks are tanks that are designed to precipitate dirt and water that are carried away by fuel. The settling tank capacity is designed to be able to supply minimum fuel for 24 hours of engine operation when the settling tank is fully charged.;

- Furthermore, specifically for heavy fuel oil will be channeled to the centrifuges to produce clean fuel. The clean fuel will be distributed to the Service Tank, while the water will be accommodated in the Sludge Tank.;

- Service Tank Serves to supply fuel to the fishing ship engine.

4 CONCLUSIONS

4.1 Conclusions

Based on the problems and objectives of this study, some conclusions were obtained to answer the formulation of the problem in this paper, there are :

- This Platform is designed using Gorlov Helical Turbine as a cold storage electric power source with a capacity of 80 tons. In addition, is built with semi submersible construction that can accommodate ship fuel supply.;
- This Platform can be used as a solution to overcome the lack of infrastructure in the form of scarcity of cold storage in eastern Indonesia. We utilize gorlov helical turbines to utilize the energy potential of ocean currents in the target area, namely the Arafura sea which reaches 2 m/s. With the simulation method using solid works flow simulation, we get a power of 4.8 Mw. This energy output is sufficient to meet the power requirements for using 80 tons of cold storage.;
- This Platform can overcome the problem of fuel distribution for fishermen in eastern Indonesia. This platform is able to accommodate a fuel volume of 1585 tons, with the assumption that the ships that sail in the Arafura sea waters as many as 50 vessels measuring 100 GT, 70 vessels measuring 40 GT, and 100 vessels measuring 20 GT with each tank of 200 l, 90 l and 40 l. So this platform can supply fuel needs in the Arafura sea waters within 79 days.;

4.2 Suggestions

The number of fishermen in eastern Indonesia precisely in the Arafura sea waters has enormous potential but there are still many obstacles in the form of cold storage and distribution of fuel. So, we should be able to solve the problems faced by fishermen. With the completion of the existing logistical problems of fishermen, the utilization of potential in eastern Indonesia is more optimal.

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