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Analisys of Hull Shape Art, Speed, Resistance, Power Using Holtrop Method On A Vessel With DWT 12,335 Ton

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Abstract

The ship's resistance affects the selection of the main engine of the ship, especially the bulk carrier ship, which has a significant block coefficient. This study aims to obtain ship resistance with the Holtrop method on bulk carrier ships with a DWT of 30,000 tons. Holtrop method for calculation of tanker, general cargo, fishing vessel, tug, passenger, container and frigate by using the main dimensions of the ship with Length Between Perpendicular (LPP) 175.27 m, Length on Load Waterline (LWL) 177.95 m, Breadth (B) 24.33 m. height (H) 14.5 m, Draft (T) 10.4 m, Speed (V) 14.5 Knots. Based on computerized results for a speed of 14.5 knots, the ship resistance value is 481.0 KN.

Keywords: Ship Power, Ship Resistance, Holtrop Method

1. Introduction

The ship's main motor is determined by the power requirements of the ship's engine to move the propeller. The ship's engine or brake horsepower (BHP) is the sum of the initial BHP added correction of engine location and ship shipping area. Initial BHP is obtained from the distribution of delivery horsepower (DHP) with shaft and reduction gear efficiency. The installation process for the machine requirements can be seen in Figure 1.

Currently, ship resistance can be calculated using the experimental method on towing tanks, but the costs required to carry out tests are prohibitive. Numerical methods using shipping software can be a solution in calculating ship resistance, especially for ships with significant block coefficients and low speeds, such as bulk carriers. This research is intended to obtain ship arrest by computerization for bulk carrier vessels. Then the results are validated using the Holtrop mathematical approach calculation method.

Ship resistance is essential in designing a ship because this factor leads to costs. The more excellent the ship's resistance, the greater the use of main engine power needed to generate ship thrust. The greater the main engine power used, the linearly proportional to the price of the main engine. The impact of the stop will affect the ship's high operating costs because it requires a lot of fuel consumption to drive the main engine. Thus, the ship designer must design the ship so the hull's shape will produce low resistance when the ship is moving in the sea.

The traditional fishing boats used in the coastal areas of Indonesia are built using methods that rely on specific techniques from skills inherited from generation to generation by shipbuilders. One of the design optimization targets is getting the optimum ship speed with the most negligible possible use of engine power. The problem is that the ship's resistance is still too significant, an essential factor for efficiency when operating at sea.

This study aims to predict the total resistance

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of bulk carrier ships of 30,000 DWT with shipping routes Tanjung Emas port to Batu Ampar port with Holtrop method. That it will reduce energy consumption when the ship is operating.

Fig. 1. The installation process for the machine requirements.

2. Materials and Methods

This study uses computer modelling and running models to predict ship resistance. The method used is to perform data processing analysis using the finite element method. Then the value of the ship's resistance and the power needed to move the ship will be obtained. For modelling, running and tools are used in modelling and running. The main dimension of the ship analyzes as follows:

Table 1. Main Dimensions

Information	Dimension	Units
DWT	12,335	Tons
LOA	129.8	m
LBP	110	m
LWL	112.75	m
T	7.2	m
B	18	m
H	9	m
V	12.5	Knots

2.1. Holtrop Method

Data of general cargo obtained, which includes the shape of the water line, displacement, hull type, and the main dimension of the vessel, from the results of field surveys and measurements of the width of each tusk and water line distance, the calculation of the resistance and practical power of this ship using several methods as a reference, namely the Holtrop Method and the Yamagata Method, in calculating ship resistance using the Yamagata Method and carried out with the help of the Maxsurf and Hull Speed Programs [4]. Holtrop (1978), the total resistance is the sum of the resistances:

- Friction resistance between the hull and water (friction resistance)
- Wave resistance
- Resistance due to added pressure in the submerged transom area
- Correlation resistance of the model ship which is written in the form of the equation:

$$Rtotal = R_F (1 + k_1) + R_w + R_{TR} + T_A \quad (1)$$

2.2. Power

In determining the motor power that must be considered is the BHP (*brake horsepower*) required to propel the ship, both in SCR (*service continuous rating*) and in MCR (*maximum continuous rating*) conditions. The BHP of motor needed is obtained from calculating the ship's resistance. It is necessary to pay attention to the rotation and characteristics

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of the propeller. At the same time, the factors that must be known are the working area of the power and motor rotation. The difference between the BHP MCR and SCR is called engine margin. The price of engine margin is usually around 10-15% of SCR conditions. In operational requirements, there are considerations of weather and water conditions.

In general, ships moving in water media at a certain speed will experience resistance opposite the direction of the ship's motion. The amount of drag that occurs must be overcome by the ship's thrust resulting from the ship's propulsion tool (propulsor) work. The power distributed (DHP) to the ship's propulsion equipment is derived from the Shaft Power (SHP), while the Shaft Power itself is sourced from the Brake Power (BHP), which is the output power of the ship's propulsion motor. Several definitions of power are often used in estimating the power requirements of the ship propulsion system [5].

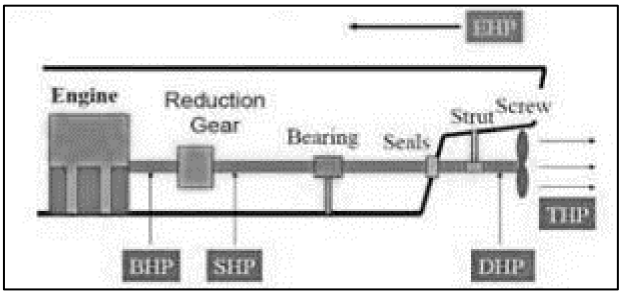

Figure 2. Engine Power Distribution to Propeller [4]

2.3. Brake Horse Power

BHP is the power generated by the ship's main propulsion. The ship's prime mover is part of the propulsion system that converts heat energy into mechanical energy (rotation). Most ships' main propulsion is a steam turbine, gas turbine, or diesel motor [1].

$$BHP = \frac{SHP}{G} \quad (2)$$

Where BHP is *Shaft Horse Power* (HP), G is the Efficiency of the transmission gear system wheel(%)

2.4. Shaft Horse Power

SHP is the output power of the reduction gear (if there is a reduction gear). The reduction gear is needed to reduce the prime mover's high speed per minute (rpm) until it reaches a speed that matches the propeller's rotation at optimal operation.

$$SHP = \frac{DHP}{s\ b} \quad (3)$$

Where DHP is Delivery Horse Power (HP), s b is shaft transmission efficiency. 2% ~ 3% reduction for engine room at the aft. Ship s b = 0.98 (for engine room at aft = 100%-2%)

2.5. *Delivery Horse Power*

Delivery *Horse Power* is the power circulated by a shaft to the *propeller*. The power supplied to the propeller will be less than the shaft horsepower due to the loss of power when transmitting on the shaft. Losses that occur are relatively small, 2-3%.

$$DHP = \frac{EHP}{pc} \quad (4)$$

Where EHP is effective Horse Power (HP), Pc is Coefficient Propulsive (%)

2.6. Thrust Horse Power

Thrust Horse Power same with thrust propeller. THP is smaller than DHP because of the loss of power that occurs when converting the propeller rotational force into thrust to move the ship.

$$THP = EHP \times H \quad (5)$$

Where EHP is *Effective Horse Power*(HP), H is *Hull Efficiency* (%).

2.7. Effective Horse Power

Effective Horse Power is the amount of power used to *move* the ship.

$$EHP = RT \times Vs \quad (6)$$

Where Vs. is the speed of ship (m/s) and RT is the Total of ship resistance (kN)

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2.8. Speed

Speed is one of the ship's characteristics in addition to maneuverability, endurance, navigation range, construction, facilities handling, and fishing machinery, if in the context of fishing vessels. Speed is mentioned a lot in the design process, but in this process, many factors are still in static calculations while the ship will interact with a dynamic aquatic environment. Thus, many aspects affect the ship's internal and external speed. The method used in determining the speed is through calculations, model tests, and real-scale experiments. Speed is the displacement during a specific time interval, the speed in the ship using units of knots (1 knot is equal to 1 mile/hour). In physics, speed and velocity have different meanings.

3. Results

3.1. The relationship between speed, resistance, power

The resistance calculation is carried out using the Holtrop method with various variations of ship speed from 0 knots to 13 knots. The Holtrop method is a method of calculating resistance using a mathematical approach formula. The calculation results obtained a graph as shown below.

	Speed (kn)	Froude No. LWL	Froude No. Vol.	Holtrop Resist. (kN)	Holtrop Power (kW)
10	2.813	0.044	0.099	8.8	14.971
11	3.125	0.049	0.110	10.7	20.284
12	3.438	0.054	0.121	12.8	26.701
13	3.750	0.059	0.132	15.1	34.320
14	4.063	0.064	0.144	17.6	43.238
15	4.375	0.069	0.155	20.2	53.551
16	4.688	0.073	0.166	23.0	65.356
17	5.000	0.078	0.177	26.0	78.747
18	5.313	0.083	0.188	29.2	93.820
19	5.625	0.088	0.199	32.5	110.670
20	5.938	0.093	0.210	36.0	129.391

	Speed (kn)	Froude No. LWL	Froude No. Vol.	Holtrop Resist. (kN)	Holtrop Power (kW)
21	6.250	0.098	0.221	39.7	150.083
22	6.563	0.103	0.232	43.5	172.845
23	6.875	0.108	0.243	47.5	197.792
24	7.188	0.113	0.254	51.7	225.009
25	7.500	0.118	0.265	56.1	254.850
26	7.813	0.122	0.276	60.7	286.845
27	8.125	0.127	0.287	65.4	321.753
28	8.438	0.132	0.298	70.4	359.558
29	8.750	0.137	0.309	75.6	400.477
30	9.063	0.142	0.320	81.1	444.759
31	9.375	0.147	0.331	86.8	492.700
32	9.688	0.152	0.342	92.9	544.641
33	10.000	0.157	0.353	99.3	600.979
34	10.313	0.162	0.364	106.1	662.169
35	10.625	0.167	0.375	113.3	728.733
36	10.938	0.171	0.386	121.0	801.261
37	11.250	0.176	0.397	129.3	880.418
38	11.563	0.181	0.408	138.2	966.938
39	11.875	0.186	0.419	147.7	1061.637
40	12.188	0.191	0.431	158.0	1165.445
41	12.500	0.196	0.442	169.1	1279.368

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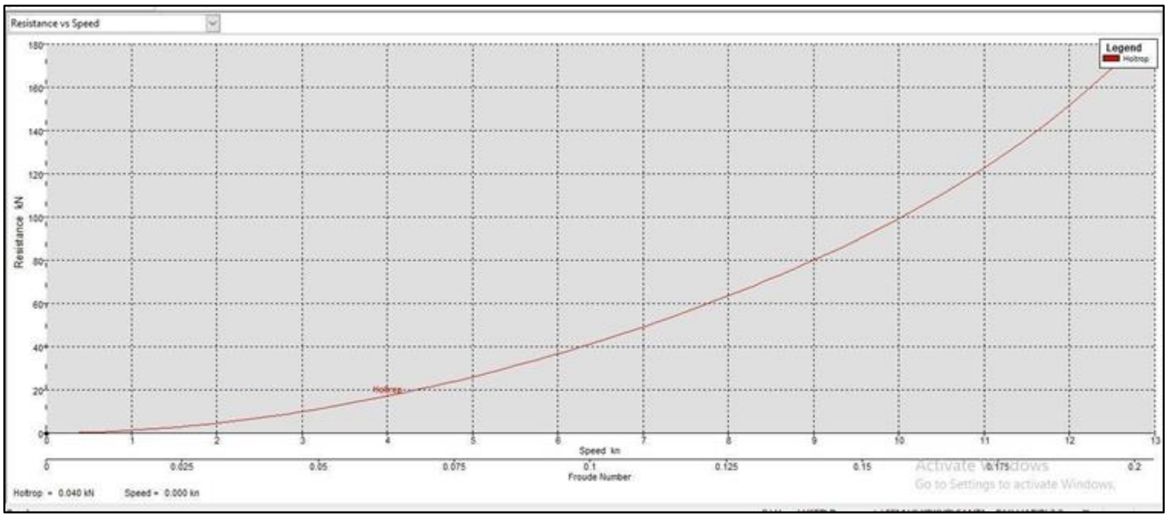

Fig. 3. Graph of Resistance vs. speed

Figure 3 shows that at a speed of 0 to 1 knot, the ship's resistance is 0 kN. Furthermore, at a speed of 2 knots to 13 knots, the resistance gradually increases following the increase in ship speed. The line trend between speed and resistance also follows the Lewis equation. Namely, resistance is the square of the ship's speed. The more excellent the resistance that hits the ship, the speed of the vessel will automatically increase so that the ship's speed remains stable. For the maximum speed of the bulk carrier ship with 13 knots, the resistance value is 180 Kn.

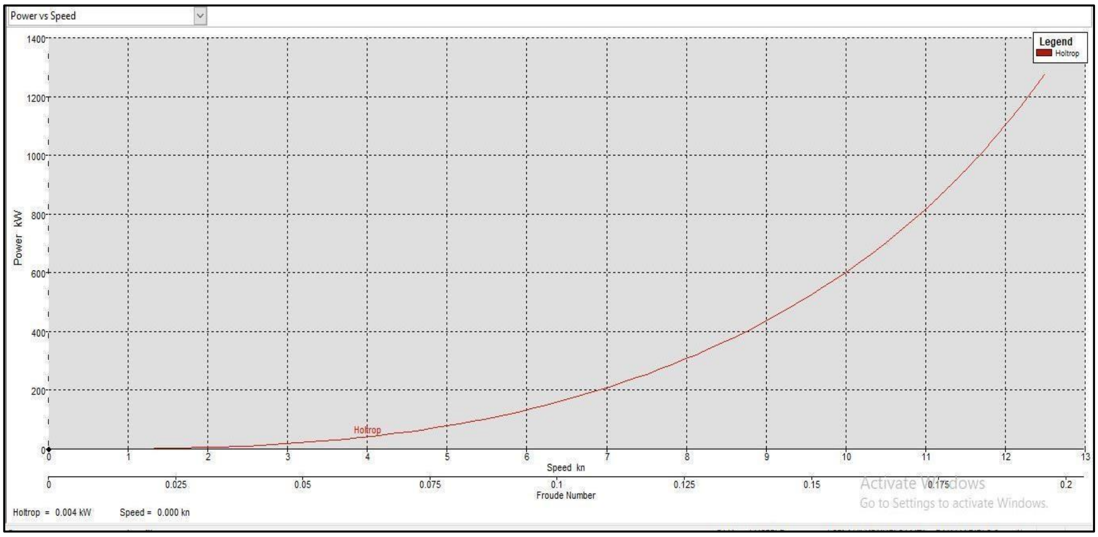

Fig. 4. Graph of Power vs. speed

The power obtained from the calculation of *the Finite Element software* is the effective power of the vessels due to the influence of the shaft, hull shape, and shipping area that has not been included. The results of the power calculation can be seen in Figure 4. Linear with the value of the ship's resistance, at a speed of 0 to 2.5 knots, the ship's power is 0. This is appropriate because effective power is the product of resistance and speed.

The line speed and power trend are almost the same as the speed and resistance of the ship, namely, the higher the rate, the higher the power required. The line equation between speed and power is also a linear quadratic function. The view of the wave path when the ship is moving can be seen in Figure 5. The image is a top view image when the ship is sailing at a certain speed.

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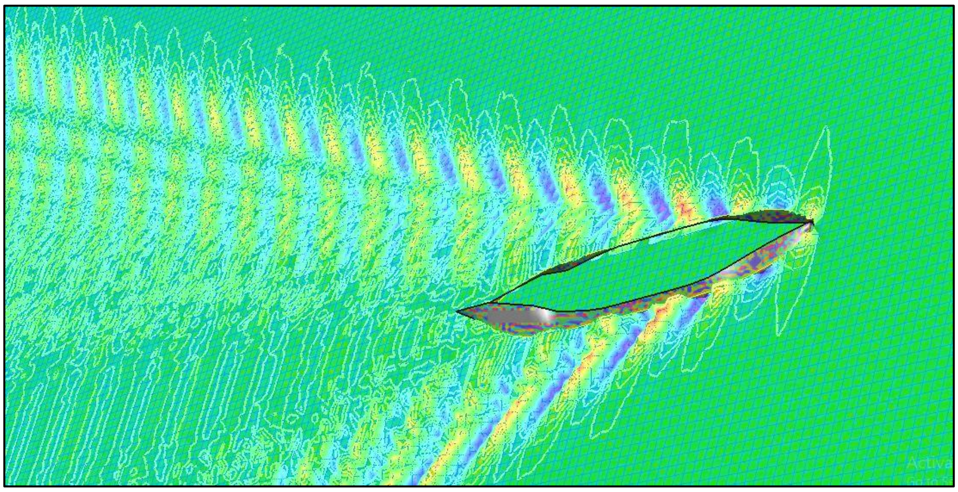

Fig. 5. View of the wave path when the ship is moving

Critical analysis for predicting the level of wave excitation that occurs when a ship moving at a certain speed passes through a rough sea. This analysis still uses the hull speed part. Although the program still uses a linear approach, the information generated is good enough for the initial analysis of the occurring wave characteristics. The Kelvin wave contour that occurs at a ship speed of 12 knots can be seen in Figure 5.

4. Conclusions

From the analysis and discussion, for a speed of 0 to 1 knots, the ship's resistance is 0 kN. Furthermore, at a speed of 2 knots to 13 knots, the resistance gradually increases following the increase in ship speed. At a maximum speed of 13 knots, it produces a resistance value of 180 kN. While at a speed of 0 to 2.5 knots, the ship's power is worth 0, then at a maximum speed of 13 knots, the power needed by the vessel is 1400 kW. So it can be concluded that the more excellent the resistance on the ship, the more the speed value will increase so that the vessel can continue to run stably. Then if the speed issued by the ship is higher, the power released will require greater power.

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