

Resistance and effective power on various casco models of purse seiner

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Abstract. This study aimed to find out the magnitude of resistance and effective power on the three casco models of purse seiner i.e. round bottom, round flat-bottom and U-V bottom. In the present study, we employed a numerical simulation using Holtrop and Mennenn method. To get the values of motion resistance and effective power on various purse seiner, it was used the purse seiner speed of 0-12 knot. We developed the simulation using 12 purse seiner sampling data which were operating in Makassar Strait. Simulation results indicated that the increasing main dimension of purse seiner was proportional to the increasing the magnitude of resistance and effective power. This study suggested that the round flat of casco model has greater resistance compared with the other casco model for purse seiner operating in Makassar Strait.

Keywords: Purse seiner, resistance, effective power, casco.

Introduction

Generally, a moving vessel with certain speed will get resistance motion known as resistance. The resistance for vessel comprises form resistance, wave making and wave breaking resistance, frictional resistance and air resistance (Holtrop and Mennen, 1984). In conducting operation, a vessel moves through water medium due to propulsion of ship power system. Water will give resistance force on a moving vessel called ship resistance. Part of the vessel that is immersed in the water will experienced resistance from the wind. However, water has a significant effect on vessel movement compared with air resistance (Djatkiko et al., 1983). Resistance affects the magnitude of power effective from engine to drive the ship. The power of resistance for the ship was usually determined by dimension and ship casco.

Purse seiner with miscellaneous cascos is one of fishing vessels which is operated familiar by fishermen in South Sulawesi Waters. This vessel operates purse seine fishing gear in which has fishing principle of pursing free swimming-fish schools with net. Based on this reason, purseiner is built up with the specific speed design to optimally purse the fish schools. Apart from this, the purseiner has the ship hull form designed for getting optimum load and has the optimal maneuver. The purseiner operation is generally driven by diesel engine. This fishing vessel is highly mobile to move with high speed, though the fishermen usually do not take into consideration the power efficiency of diesel engine. When the purse seiner moves quickly, the efficiency is strongly related to the magnitude of ship resistance. On the same propulsion, the increasing resistance for the ship will cause the decrease in speed (Djatkikoet al., 1983).

Base on all the previous points, it is important to assess in more detail on the purseiner resistance and power effective needed to solve the problems related to the resistance with particular objectives as follows: (1) to find out the magnitude of purse seiner resistance and (2) to understand the effect of the resistance of various purseiner cascos on the effective power produced.

Materials and Methods

This study used 12 purse seiner fishing units and collected the data which consisted of vessel main dimension, the vessel speed, horse power level as well as hydrostatic parameters. For all purse seiner samples, the vessel geometry form, figures of lines plan, calculation of hydrostatic parameters were measured. Furthermore, a numerical simulation was carried out on the purse seiner speed between 0 and 20 knot to get the resistance value as well as effective power according to Holtrop dan Mennen (1984).

Results and Discussion

Purse seiner sample specification

Purse seiner samples used in the present study were originated from Takalar, Barru and Bulukumba districts. All the sample specifications were shown in Table 1. Purse seiner samples used in this study have the capacity of 6 – 66.46 tonnes. According to lines plan for all samples, it was found that there are three casco models for purse seiner i.e Round Flat Bottom, Round Bottom, and V Bottom as shown in Figure 1 to Figure 3.

Table 1. Specification for the Purse Seiner samples used in this study

Purse seiners	L (m)	B (m)	D (m)	d (m)	GT (ton)
PS 1	20	3.7	1.2	1.1	20.16
PS 2	21	4.5	1.2	0.9	25.60
PS 3	24	5.3	2.2	1.7	66.46
PS 4	15.7	3.8	1.4	0.9	11
PS 5	20.0	3.3	1.1	0.9	41
PS 6	17.9	3.6	1.2	0.9	8
PS 7	16	3.5	1	0.4	6
PS 8	18.5	3.6	1.2	0.6	15
PS 9	14.6	3.7	1	0.6	7
PS 10	21	4.4	2	1.2	27.61
PS 11	20	4	1.8	0.9	27.77
PS 12	21	4.4	1.4	0.6	24.34

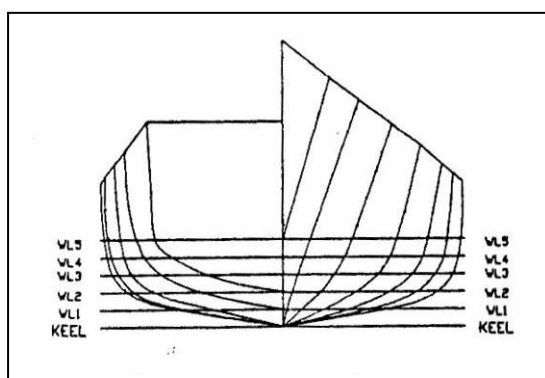


Figure 1. Casco model (form) with Round Flat Bottom

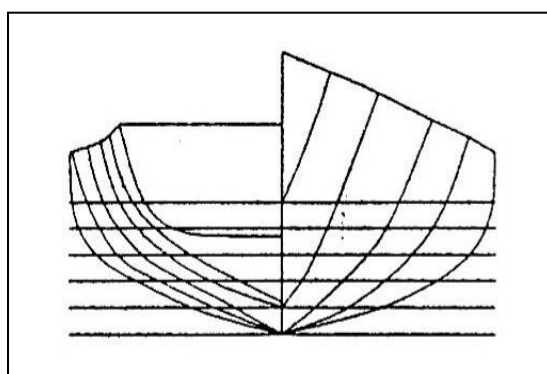


Figure 2. Casco model (form) with Round Bottom

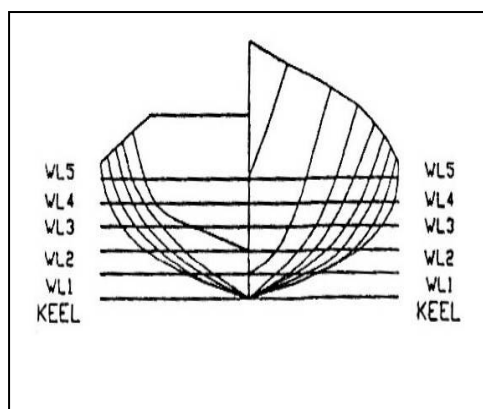


Figure 3. Casco model (form) with V Bottom

Fyson (1985) described the casco model (form) of the vessel as a coefficient of fineness, level of casco form (ship hull) for each water line level. This coefficient of fineness indicates the shape of the hull based on the relationship between different ship hull area and ship hull volume on the ship main dimension. The coefficient of fineness consists of coefficient of block (C_b), Coefficient of midship (C_o), Coefficient of Water plan (C_w), Coefficient of prismatic (C_p), Coefficient vertical prismatic (C_{vp}). The coefficients of fineness for are shown in Table 2. From this coefficient (Table 2), we can see that purse seiners used in this study are casco form of round bottom (PS 1, PS 3, PS 5, PS 6 dan PS 11). The fishing vessels have generally the coefficient of fineness greater than the others casco

model. We found that the shape of hull influence on the ship resistance in which the increasing casco form will causes the increase in the ship resistance as well.

Table 2. The Coefficient of Fineness Values for Purse Seiners

Purse Seiners	Coefficient of Fineness			
	Cb	Cp	Cw	Cm
PS 1	0.49	0.51	0.67	0.97
PS 2	0.49	0.51	0.78	0.97
PS 3	0.54	0.55	0.63	0.98
PS 4	0.50	0.64	0.74	0.79
PS 5	0.47	0.65	0.75	0.72
PS 6	0.46	0.64	0.73	0.71
PS 7	0.49	0.62	0.73	0.78
PS 8	0.42	0.58	0.74	0.73
PS 9	0.45	0.60	0.70	0.75
PS 10	0.34	0.43	0.46	0.78
PS 11	0.35	0.42	0.36	0.84
PS 12	0.42	0.43	0.60	0.97

Form Resistance

Holtrop dan Mennen (1984) reported that total resistance on a given speed is the power needed to drive a vessel. The resistances occurring in the ship are frictional resistance, wave making and wave breaking resistance, form resistance, and air resistance. Base on the specification and coefficient of fineness values, numerical simulation was conducted for the speed of purse seiners of 0-12 knot. The results showed that the purse seiner speed has a linear relationship with the form resistance (Figure 4). Base on the variation in the vessel speed, the highest form resistance was found on PS3 within the ranges of 0-6.35 kN. This is because the coefficient of fineness of PS3 was higher than the others. This facts indicate that the PS3 needs the greater effective power and high speed to encircle the fish schools when the fishing operation was carried out. The lowest form resistance was found on PS7 which has values of 0-2.153 kN. The greater form resistance is not suitable for fishing vessel because of reducing vessel speed and effective power used during fishing operation.

The purse seiner length of < 20 m has form resistance between 0 and 3.458 kN, whereas that of > 20 m has the form resistance between 0 and 6.306 kN. From the data, most purse seiners have casco form of round flat bottom and have lower form resistance/casco than the others casco form such as Round Bottom and U-V Bottom. The difference is dependent on the magnitude of coefficient of fineness for each purseiner. The increasing the coefficient of fineness value as well as the vessel speed will also increase the form resistance on the vessel. These results are consistent with the previous studies (Muckle, 1975; Saksono, 2009). The increasing values of *coefficient of block* (Cb), *coefficient of prismatic* (Cp) and *coefficient of midship* (Co) will increase in moving resistance of the Purse Seinners.

Wave Making Resistance

Figure 5 shows that the increasing in vessel speed causes the higher wave resistance. Using various vessel speed (0-12 knot), the wave making resistance value was highest on PS4 with the ranges of 0 –30.056 kN. This is due to the highest Fraude number on PS4 compared with another purse seiner samples. In principle, wave resistance is strongly influenced by the vessel length and speed known as Froude number. The wave resistance was lowest on PS1 with range values of kisanan 0 – 6.0643 kN. The wave resistance arises as a result of divergence wave and transfer from the stern and bow of the vessel. Base on purse seiner dimension, the purse seiner length of < 20 m has wave resistance value of 0 - 30.0562 kN, Whilst that of > 20 m has wave resistance value of 0 - 17.7318 kN. These results are consistent with the previous findings suggesting that the magnitude of wave resistance was affected by length, shape and vessel velocity. Hence, the increasing the vessel velocity will be followed by the increase in the wave resistance.

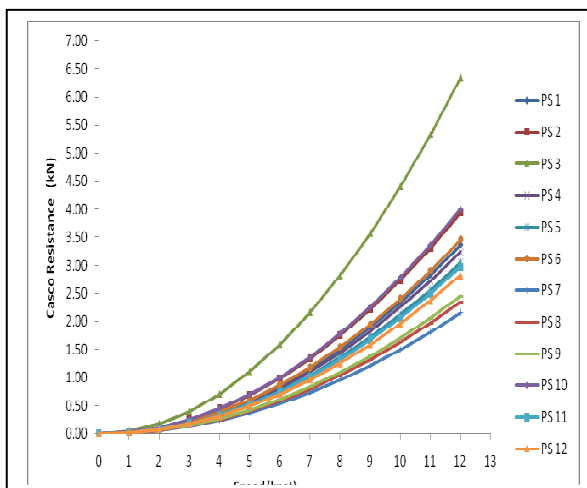


Figure 4. Relationship between speed and form resistance on purse seiners

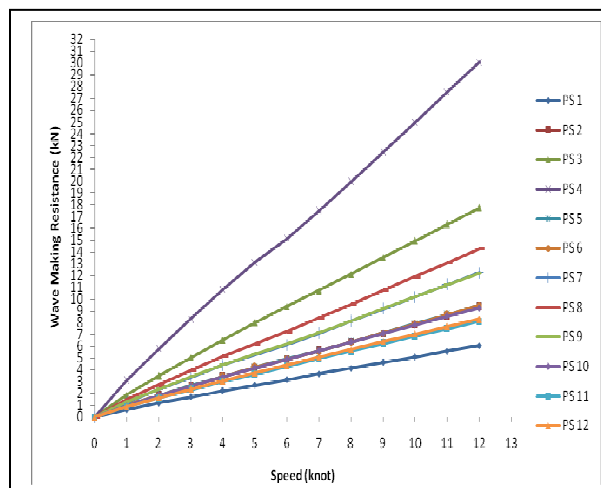


Figure 5. Relationship between speed and wave making resistance on purse seiner.

Resistance

One of the factors affecting the vessel speed is the resistance. On the same horse power, the increasing resistance of the vessel, the speed will decrease (Djatkiko *et al.*, 1983). If the ship does not get additional load called hull resistance under lightweight condition. The power needed to overcome this resistance is called effective horse power (EHP) (Fyson, 1985).

The results of this study showed that the higher speed of the purse seiners, the resistance value increase. On the various level of vessel speed (0-12 knot), the highest resistance was obtained on the PS3 with the range value of 0 – 119.0140 kN. This suggests that the values of main dimension and coefficient of fineness for PS3 are greater than the other purse seiner samples. Conversely, the lowest form resistance was found on PS7 (0 – 38.3063 kN). These results were strengthened by Nelly (1999) in which reported that the speed was proportional with the resistance arising from the vessel.

The higher resistance value is not suitable for fishing vessel since it can cause the increasing speed and the power effective used toward and search the fishing ground. This also leads to inefficient to conducting fishing operation in expansive ocean environment. These conditions are found on PS3 with round bottom casco model, so that it will need a greater power effective compared with the other vessel with different casco model.

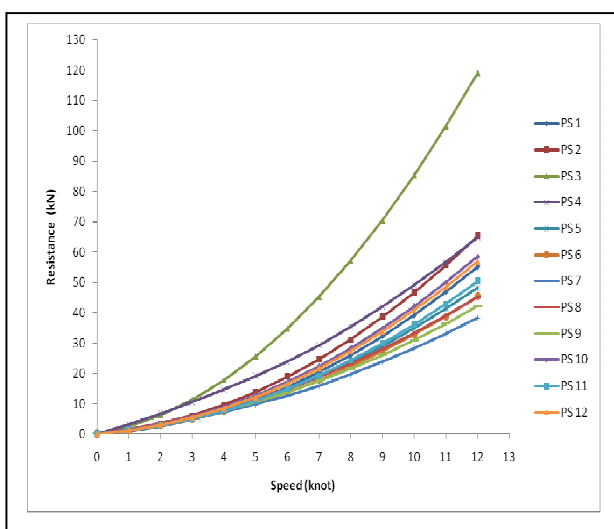


Figure 6. Relationship between speed and the resistance on purse seiner

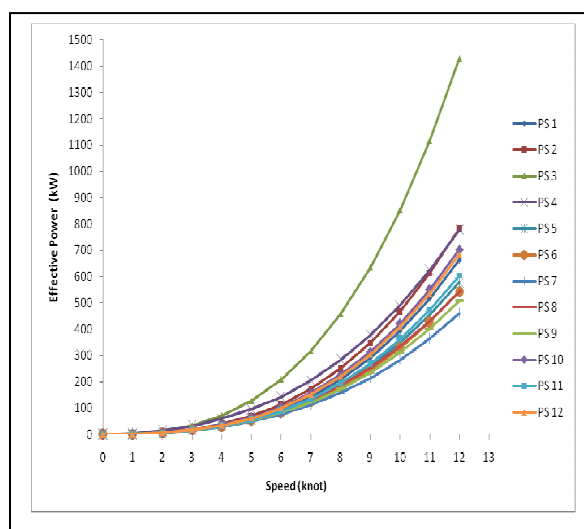


Figure 7. Relationship between speed and the effective power on purse seiner

Effective Power

Effective power is defined as the power used to drive a vessel expressed in Horse Power unit (HP). The horse power values for purseiner are shown in Figure 7. Figure 7 shows that the higher speed of purseiner, the effective power needed will also increases. Based on this study, the greatest effective power needed to move on the surface waters was found on PS3 with the range value of 0 – 734.6493 HP. This ship has the casco model of round bottom. From this standpoint, we can see that PS3 has greater ship main dimension and coefficient of fineness values than the other purse seiners. In contras, PS7 has the lowest effective power than the others (0 – 236.4572 HP). It has the casco model of round flat bottom. The purse seiner length of < 20 m has effective power ranged from 0 to 400.0019 HP and that of > 20 has the effective power of 0 – 734.6493 HP. The HP values were examined from the speed variation of 0 – 12 knot.

Overall, the increasing speed for all purseiners causes the resistance and effective power also increase. The higher resistance induced additional effective power needed to move in a given speed. It reflects that the effective power is directly proportional with the resistance. In general, the effective power is the main power which is capable of driving propulsion motion on the vessel to overcome the resistance operating in a certain speed. The relationship between the effective power and the vessel resistance can be seen in Figure 8. Base on various speed (0-12 knot), purse seiner 3 (PS3) has the highest resistance ranging from 0 to 119.0140 kN with the effective power as much as 734.6493 HP. Whilst, PS7 has the lowest resistance value with the effective power ranging from 0 to 236.4572 HP. Figure 8 clearly shows that the increasing resistance on purseiner, the effective power also increases suggesting that PS3 needs the higher effective power to move or to conduct fishing operation compared with the other purse seiners.

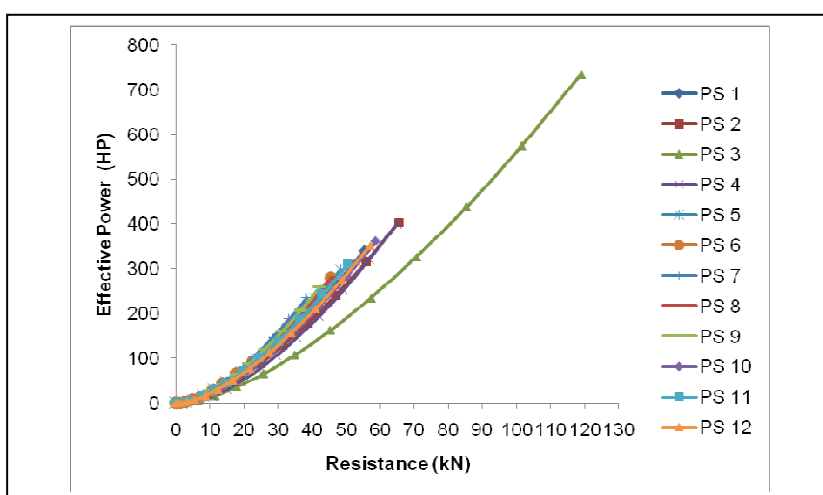


Figure 8. Relationship between resistance and the effective power on purse seiner over the various speed (0 – 12 Knot)

Conclusions

The important finding from this study can be illustrated that the casco model of round flat bottom is more effective for operating purse seiner fishing gear than the other models. The main reason for this since it has the lower resistance and the coefficient of fineness values. This will make the use of effective power become more efficient.

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