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INTERACTION ANALYSIS HULL AND PROPELLER AND IMPROVEMENT OF EFFICIENCY PROPELLER ON FISHING VESSELS

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ABSTRACT

The determination of propeller and hull adjustment of both small and large fishing vessels is indeed very important; in general, fishing vessels at the port of Lamongan only use hereditary techniques. many weaknesses in the problem of synchronization between the hull, the main propulsion engine, and the propeller. therefore, after analysis, it can be concluded that at the coastal port of Lamongan, an Ijon-Ijon type fishing boat, with a main size of 5-10 GT. In one ship using the Mitsubishi Fuso 120 ps 2 engine type, using 2 gearbox advance ratio 3.1 rated input speed 1000- 2500 r/min and rated trans capacity 0.039 kW/min with a total resistance value of 17.599 kN, wake fraction value 0.235, value thrust deduction 0.197 and using a propeller with type B-series B3-35 with a diameter of 1.54 with a KT value of 0.31, a value of 10KQ 0.37, a value of J 0.52 and an average efficiency value of 0.48. By changing the propeller diameter to 1.75 and changing the gearbox ratio with the same engine, a comparison can be made between the efficiency of the propeller previously and the efficiency after changing the propeller diameter, with a KT value of 0.30, a value of 10KQ 0.345, a value of J 0.55, and an average efficiency value of 0.565.

Keywords: Fishing boat, hull shape, propulsive coefficient

Introduction

Determining the propeller and adjusting the hull of both small and large fishing boats is very important; in general, fishing boats in Lamongan harbor only use techniques passed down from generation to generation. This traditional shipbuilding is far from modern technology and has many weaknesses that must get more attention, especially the synchronization problem between the hull, main engine, and propeller [1]. Therefore, after analysis, it can be concluded that Kranji Village, Lamongan Regency, is one of the fish-producing areas in East Java. The characteristics of the Kranji Village area are coastal areas with fisheries activities as the dominant activity in areas located along the coast.

However, the research will raise several problems, including analyzing the type of ship engine, gearbox, and propeller type that is appropriate and optimal, and by the obstacles of traditional fishing boats. Based on observations made in the field, there are fishing boats that have three main engines. The fishermen there get engines for ships from trucks or buses whose engines are no longer in use. In ships that exist in this modern era, there is a fairly sophisticated drive system. Some components of the drive system on the ship are the main drive engine, gearbox, and propeller shaft, which will later be analyzed for characteristics to find the efficiency of performance of the propeller [2].

While in general the optimal characteristics of fishing boat propellers are with Ae/Ao = 0.550; P/D = 1.3; J = 0.5, the reason for using several propellers is so that fishing boats can operate at high speeds for the fishing process, based on the main size ratio of standard fishing boats, namely the value of the L/B ratio of 4.30 - 4.50; L/D 10.00 - 11.00; B/D 2.10 - 2.15. If the B/D value is getting bigger, the ship's stability and ship's motion are getting better, and the relationship between the B/D ratio value and the engine power and net size of the fishing boat means that the weak or low thrust of the ship can be supported by large engine power. stated that the driving force used by fishing boats must be calculated properly and correctly [3].

Based on these conditions, it can be concluded that in planning the propulsion system of fishing boats on the Lamonga coastline, using the right calculations and studies to determine the use of engines and propulsion systems on ships can produce optimal ship performance according to existing standards [4].

Methodology

a. Location and Time of Research

This research was conducted on the coast of Lamongan for the collection of ship data to be tested, as well as photographic images of ships that will be examined. This will strengthen the objectives of this study for the time of the data to be taken after obtaining the requirements of the supervisor.

b. Fishing Boat Data

On this page, we will explain the data of the fishing boat to be examined, along with the type of engine and gearbox on the fishing boat. This data collection is based on the results of a survey of the Lamongan shipport located in East Java. The ship data used is the main Nabila fishing boat data.

Table 1. Principal dimensions

Principal Dimensions	
Ship Type	Ijon ijon
Ship Name	Nabila Utama
The overall length of the vessel (LOA)	12.70 m
Waterline length (LWL)	12 m
Ship width (B)	5.00 m
Ship height (D)	2.80 m
Ship draft (T)	1.30 m
Displacement	62,34256 Ton
Cb	0,779769
Ship speed	7 knots
CB wl	0,758
CM	0,8557
CP wl	0,6520
Cwp	0,837
Fishing gear	Fishing rod
Owner ship	Warsujud
Phone number	081212342548

Table 2. Main engine

Main Engine	
Mitsubishi Fuso, Engine 4D34-2AT8 Fuso	
Number of machines	2
Machine type	4 water-cooled cycle
Maximum power	228 kW/2900 rpm
Maximum torque	33 kg.m/2800 rpm
Emissions	Non-emissions
Bore x stroke	104 x 115 mm
Displacement	11.945
Length	1473 mm
Width	881 mm
Height	1209 mm
Dry weight	1000 kg
Cylinder	4 cylinder
Cylinder diameter	104 mm
Cylinder length	115 mm

Table 3. Gearbox data

Gearbox Data	
Brand	*Advance*
Model	16A-1
Input speed	1000-2000r/min
Reduction ratio	2.07,2.48, 2.95, 3.35, 3.83
Trans capacity	0.012kw/r/min
Control method	Manually
L x W x H	422 x 325 x 563 mm
Thrust value	3,5 kn
Net weight	84 kg

Table 4. Propeller data

Propeller Data	
Propeller type	B3-35
D_b(m)	0,54 m
(P/D_b)	0,745
η propeller	0,480
RPM propeller	228 rpm
Control method	Manually

Figure 1. Propeller

c. Simulation

Simulation, or what is commonly called the process of knowing with this engineering form, is calculated using the Holtrop mathematical system and simulated with the KT-KQ-J method and using the ANOVA method, where this method can find ship efficiency, ship thrust, and drive motor power.

The conclusions received after using the ANOVA method can be filtered again to find the maximum results in an analysis.

The simulation I made was a model that fits the real size that was scaled, and then I added other model variations that changed the radius of the propeller as a comparison to get a thrust value, and used AUTOCAD software to make a more optimal propeller model.

Result and Discussion

a. Holtrop Mathematical Resistance

In Holtrop's mathematical calculations, by entering the main data on the ship, the calculation of the total resistance of the ship is obtained.

Rtotal = RF (1+k1) + RApp + RW + RTR + RB + R

RF = frictional resistance according to the ITTC-1957 formula

1 + k1 = form factor of the hull

RAPP = appendage resistance

RW = wave resistance

RB = additional pressure resistance of the bulbous bow near the water surface

RTR = additional pressure resistance due to transom immersion

RA = model-ship correlation resistance

Rtotal = RF(1+k1) + RApp + RW + RTR + RB + RA
= 1,621 kN + 1,390 kN + 0,010 kN + 14,9488822 kN + 0 kN + 0 kN + 0,388 kN
= 17,599 Newton

Therefore, the wake fraction

W = C9 x C20 x Cv x L/T (0.050776 + 0.93405 x C11 x CV/1 – Cp1)) + 0.27951 x C20 √ ((B/(L(1-CP1))) + C19.C20
= 12.561 x 0.988 x 0.000559624 x (11/1,3) x (0.050776 + 0.93405 x 1.538 x 0.000559624/ (1 – 0,652) + 0.27951 x 0.988 √ (5/ (11 (1- 0.652)) + (0.072 x 0.988)
= 0,235

b. Calculating Trust Deduction Factor (t)

t = 0,25014 (B/L) 0.2896 (√((B.T)/D) 0.2646 / (1- CP + 0,225LCB) 0.01762 + 0.0015 CSTERN
= 0.25014 (5/11) 0.2896 (√(5x1,3)/0,8) 0.2646 / (10. 652 + 0.0225 x 0.068) 01762 + 0.0015 x (-8)
= 0,197

c. Hull-Propeller Interaction

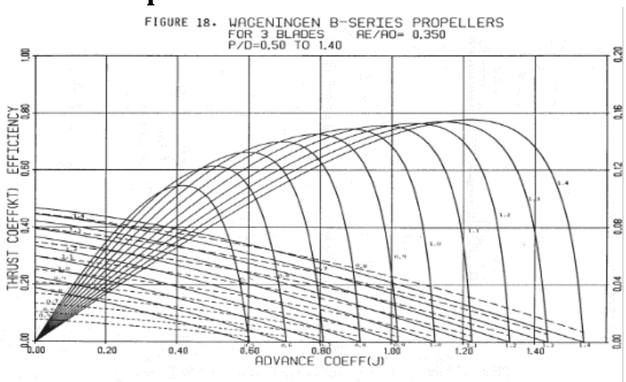

Figure 2. Wagening diagram of B3-35

Propeller-hull interaction describes the correlation between ship resistance and propeller performance characteristics. Ship resistance is transformed into the form of a propeller loading curve, and propeller performance characteristics are shown by the results of propeller testing called the propeller open water test. The characteristics of the open-water test propeller are approximated by the B-series propeller type through the B-series propeller polynomial equation.

The mathematical formulation of the open-water test propeller performance is as follows:

$$J = \frac{Va}{nD}$$

$$Kt = \frac{T}{\rho.N^2.D^4}$$

$$Kq = \frac{Q}{\rho.N^2 D^5}$$

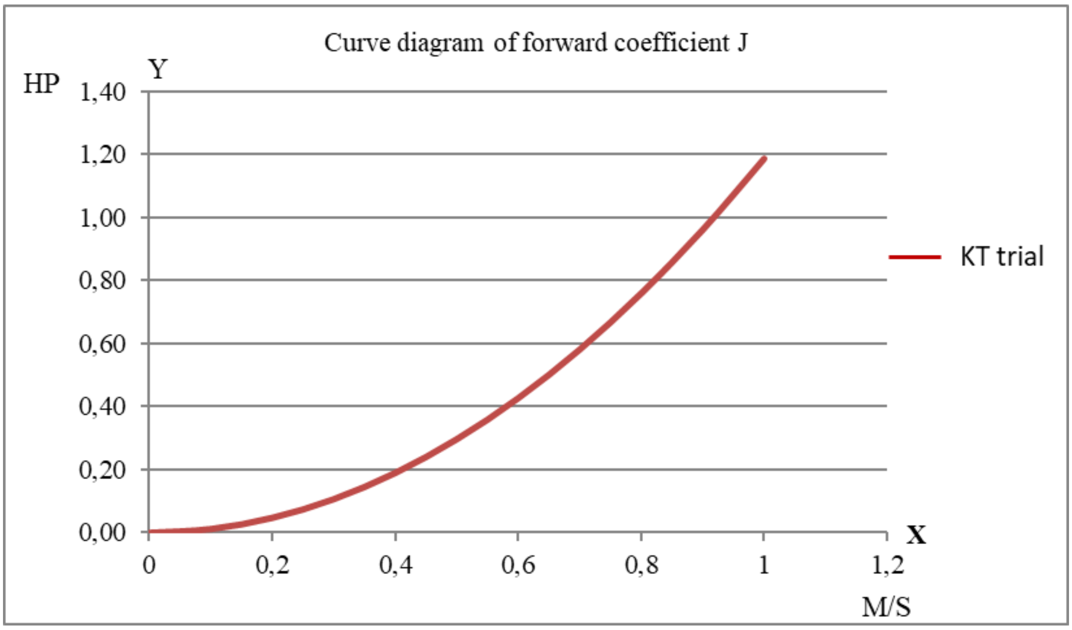

Figure 3. Diagram of forward coefficient

$$\pi_0 = \frac{Pt}{Pd} = \frac{T.Va}{2.\pi.n.Q} = \frac{J.Kt}{2.\pi.Kq}$$

Where:

J	=	Propeller forward coefficient,
Va	=	Forward speed (m/s),
D	=	Propeller diameter (m),
n	=	Propeller rotation (rpm),
Kt	=	Propeller thrust coefficient,
T	=	Propeller thrust force (N),
Kq	=	Propeller torque coefficient,
Q	=	Torque propeller (N.m),
ηo	=	Open water efficiency,

The mathematical description of ship resistance characteristics converted to a propeller loading curve is:

$$R = c.V^2$$

$$T.(1-t) = c.\left[\frac{Va}{(1-w)}\right]^2$$

$$Kt.\rho.n^2.D^4 = \frac{c}{(1-t).(1-w)^2}Va^2$$

$$Kt = \frac{c}{\rho.(1-t).(1-w)^2.D^2}\left[\frac{Va}{n.D}\right]^2$$

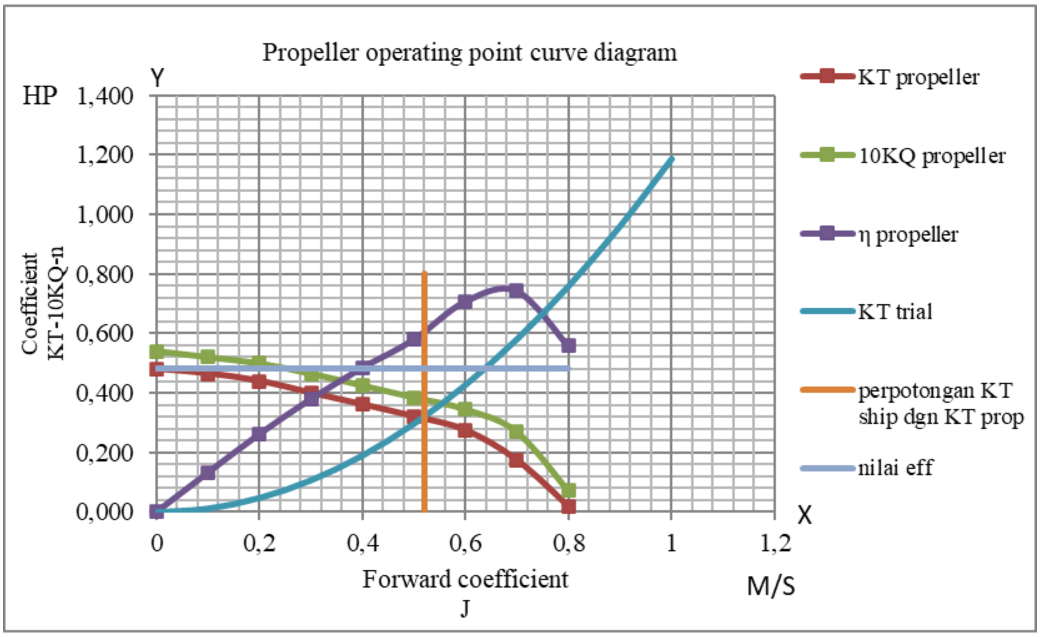

Figure 4. Propeller operating point diagram

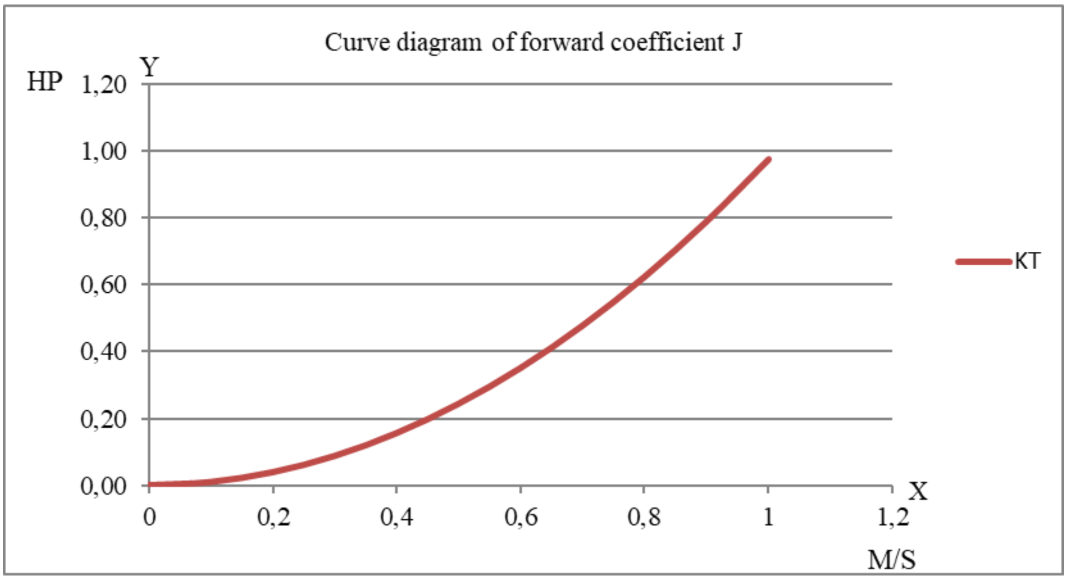

Figure 5. Diagram of forward coefficient

$Kt = Cons\tan t\,.J^2$

Where:

W = Wake fraction coefficient,
t = Thrust deduction coefficient,
Kt = Propeller thrust coefficient,
c = Constant,
ρ = Density of seawater (kg/m3).

d. Calculating the coefficient α

$R = c.V^2$

= 17,599 x 3,601= 1357,35 In the unfilled position

Calculating the coefficient

$$Kt = \frac{c}{\rho.(1-t)(1-w)^2 D^2}[\frac{Va}{nD}]$$

= 1.19

e. Create an open water test diagram

After calculating the value of the constant coefficient, the next fishing boat will be able to create an open water test curve as follows: with the open water test curve that has been made from a speed of 7 knots and plotted to the open water test image, you can also create a thrust coefficient (KT) diagram when the ship is in an empty hull position and get the propeller operating point of 0.54 m propeller diameter.

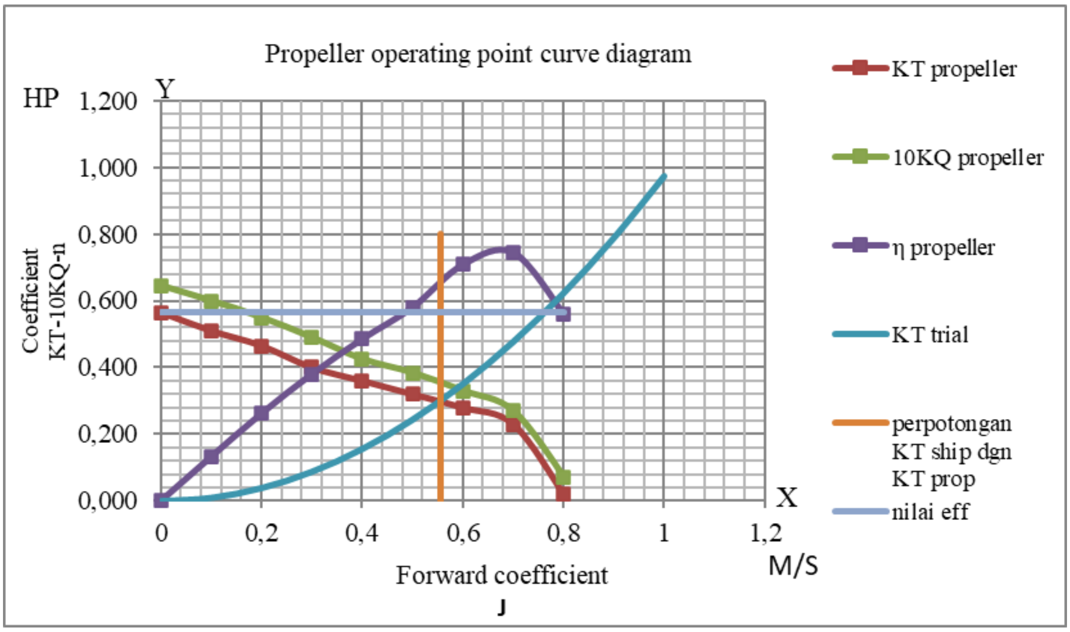

Figure 6. Propeller operating point diagram

Furthermore, from the results of these calculations, the KT design can be made at a speed of 7 knots and plotted against the open water test image to get the value of the intersection point of the curve. After looking for the KT trial value, it can then make a curve diagram of the table value accordingly and accurately.

From the results of Figure 4 above, we can determine the X-axis value of the forward coefficient (J), as well as the Y-axis value of the propeller thrust coefficient (KT propeller) and the propeller torque coefficient (10KQ) at the intersection of the KT design. At a speed plot of 7 knots, the resulting forward coefficient (J) value is 0.52 m/s, the propeller coefficient (KT) value is 0.31 HP, and the propeller torque coefficient (10KQ) value is 0.37 HP by determining the efficiency on the ship of 0.48%.

f. Changing the propeller diameter

To find out the optimal propeller performance, it is necessary to change the diameter of the propeller to find a more efficient propeller.

This propeller data comes from a type

Propeller type = B3-35
Db(m) = 0.75 m
(P/Db) = 0.745
η propeller = 0.565
Propeller rpm = 228 rpm

Calculating the coefficient α

$$R = c.V^2$$

= 17,599 x 3,601 = 1357,35

Calculating the coefficient

$$Kt = \frac{c}{\rho.(1-t)(1-w)^2D^2}[\frac{Va}{nD}]$$

= 0,82

Diagram of an open water test after calculating the constant coefficient value on the next fishing boat, it will be able to create an open water test curve as follows: with the open water test curve that has been made from a speed of 7 knots and plotted to the open water test image, it can also create a thrust coefficient (KT) diagram when the ship is in an empty hull position and when the hull is fully loaded.Getting the propeller operating point of 0.74 m propeller diameter from the results of Figure 4.7. Above, we can determine the X-axis value of the forward coefficient (J) from the highest point to the lowest point value of the forward coefficient (J), following the explanation in Table 5.

From the results of Figure 6 above, we can determine the X-axis value of the forward coefficient (J), as well as the Y-axis value of the thrust coefficient (KT) and the torque coefficient (10KQ) at the intersection of the design KT. At a speed plot of 7 knots, the forward coefficient (J) value of 0.55 m/s is obtained, the value of the intersection of the thrust coefficient (KT) with the KTtrial is 0.30 Hp, and the value of the intersection of the torque coefficient (10KQ) with the KTtrial is obtained by 0.345 Hp by determining the efficiency of the ship by 0.565%.

Table 4. Comparison of old and new propellers

Old propeller	New propeller
Tipe B3-35	Tipe B3-35
D 0,54 m	D 0,74 m
(P/D) 0,745	(P/D) 0,745
J 0,52 m/s	J 0,55 m/s
KT 0,31 Hp	KT 0,30 Hp
KQ 0,37 Hp	KQ 0,345 Hp
η 0,48 %	η 0,565 %

Conclusion

The ship uses a propeller type B-series B3-35 with a diameter of 0.54 m and an average efficiency value of 0.48% based on the initial efficiency value of 0.48%. At a speed plot of 7 knots, the resulting forward coefficient (J) value is 0.55 m/s, with the value of the intersection of the thrust coefficient (KT) of 0.30 HP and the value of the intersection of the torque coefficient (10KQ) of 0.345 HP by determining the efficiency on the ship of 0.565%. By increasing the diameter and also changing the angle of the propeller, the best propeller data results are a 0.74 m diameter propeller with an angle change of 20% for the B3-35 propeller type.

The results of this study are the calculation of engine estimation with a propeller to find efficiency on the fishing boat under study. We need to make a 3-dimensional image of the best propeller calculation results to be able to easily study them.

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