COMPARISON OF PROPELLER TYPE B-SERIES AND AU-OUTLINE GAWN SERIES FOR IMPROVING ON SUBMARINE PROPULSION PERFORMANCE USING CFD

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ABSTRACT

Submarine propeller need some unique criteria can give bigger amount of thrust with noiseless. The submarine propeller design must able to produce the high thrust value, low pressure value, and smooth propeller streamline. This study investigates and compares some type of propeller that are B – 7 series, B – 8 series, Au – 7 Outline gawn series, and Au – 8 outline gawn series with some different parameters, that is blade diameter, number of blades, skew angle and pitch. From some models that have been compared, the best propeller is B – 8 series on 500 rpm with thrust value 25481 N, torque value 3927 Nm, average value pressure about 10608,92 Pa, and turbulance flow with average value velocity stream under 14,33 m/s.

Keywords: Submarine, B-series propeller, Au-series propeller, CFD.

1. INTRODUCTION

Submarine is a one of ship can dives independently. The submarine requirement with effective hull is designed for diving with long time under the sea, and it equipped by the periscope and torpedo for war [1]. Submarine propeller need some unique criteria in which the propeller can give bigger amount of thrust with noiseless for spying in submarine, so it has designed for moving without make noise or detected from other enemy radar and it can fast move under the water.

For the study purpose, the variable of parameters are choiced, that is; the number of blade, skew angle, diameter and blade type based on amount of effect that can reacted with propeller

cavitation. The skew angle will make an effect on torque and thrust fluctuation in which it can increase the effect of propeller cavitation. The number of blade will effect on thrust fluctuation that cause thrust noise. Otherwise, the minimum number blade selected is about 7 for decrease the effect of turbulence for submarine propeller have limit for propeller diameter different with ordinary ship and the increase of diameter can make the decrease of propeller thrust and increase average of streamline speed [2, 3].

The purpose of this study is to obtain the comparison between thrust and torque values and streamline flow around propeller on several kind of the B-Series type propeller and Au – outline gawn series propeller type for applying on submarine.

2. SUBMARINE PROPELLER

Design and development of propellers for submarines are different from propellers for surface vessels. The most important demand is low acoustic signature that has priority over propeller efficiency, and the submarine propeller must be optimized with respect to acoustics rather than efficiency. Moreover, the operating conditions of a submarine propeller are quite different. These aspects are discussed as well as the weighing of the various propeller parameters against the design objectives [4, 5, 6]. That thing can cause the cavitation that can make some noise. The propeller may cause the cavitation in the highest speed that produce and lowest pressure on the propeller so it can make some steam bubble. That bubble mix with some other gas around and it cause cavitation flow [7]. From that cavitation flow cause noise that must avoid when we design a submarine propeller causes noise that must be avoid in design submarine propeller.

The propeller design process with CAD propeller software (Figure 1). After the coordinate data is obtained, so the surface data propeller is also found.
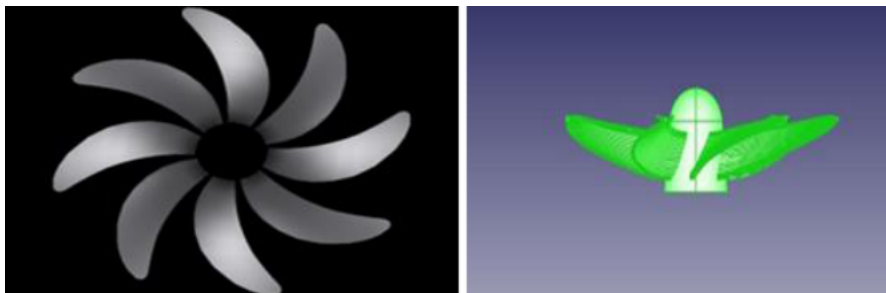

Figure 1 shows the submarine propeller model

3. THEORETICAL ANALYSIS

Each type of each ship's propeller has different performance curve characteristics. The study of the characteristics of a ship's propeller cannot be generalized to the overall shape or type of the propeller. The equation is as follows [8]:

$$KT = \frac{T}{\rho n 2 D 4} \tag{1}$$

$$KQ = \frac{Q}{\rho n 2 D 4} \tag{2}$$

$$J = \frac{Va}{nxD} \tag{3}$$

Where; KT = propeller thrust coefficient

KQ= propeller torque coeffitcient

J   = propeller advance coefficient

Va = advance velocity

D = propeller diameter

n   = propeller rotation speed in rpm

T   = thrust propeller in N

Q = torque propeller in Nm

ρ = fluid density

Thrust force is produced by the operation of the propeller is caused by a momentum difference that occurs when the propeller leaves move fluidized. The flow of water due to rotation the propeller in the water, then the reaction force will arise which is the force produced by the propeller leaves.

4. RESULTS AND DISCUSSIONS

Boundary condition for CFD calculation is generated with using propeller specification as follow:

- Propeller Diameter   : 1,00 m
- Blade Number   : 7
- Pitch/diameter   : 1,03
- Skew, Degree   : 30,8

Table 1 shows the result for validation between the experiment and the CFD calculation.

Table 1 Validation of Experiment result and CFD result at 500 rpm

Rotation speed (rpm)	Experiment Result (K_T)	CFD Result (K_T)	Diff. (%)
500	0.2594	0.2458	5.23

Table 2 Thrust values on several types of propeller at 450 rpm and 500 rpm

	Propeller Type			
	Au- 8	Au-7	B - 8	B – 7
Thrust at 450 rpm (N)	23,683	11,723	203,47	21,009
Thrust at 500 rpm (N)	27,742	11,967	25,481	22,436

Table 3 Torque values on several types of propeller at 450 rpm and 500 rpm

	Propeller Type			
	Au- 8	Au-7	B - 8	B – 7
Torque at 450 rpm (N m)	3,532	2,001	2,975	3,063
Torque at 500 rpm (N m)	4,330	2,153	3,927	3,543

Table 2 shows the result of thrust analysis at 450 rpm and 500 rpm on several types of propeller. Au – 8 series propeller type has the highest thrust with 23683 N at 450 rpm and also at 500 rpm is obtained the highest thrust with 27,742 N. While Table 3 shows the result of torque analysis at 450 rpm and 500 rpm on several types of propeller. Au – 8 series propeller type has the highest torque with 3,532 Nm at 450 rpm and also at 500 rpm is obtained the highest torque with 4,330 Nm.
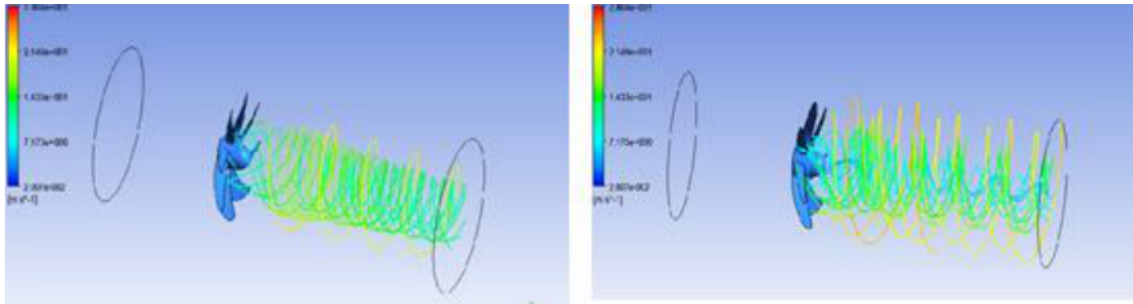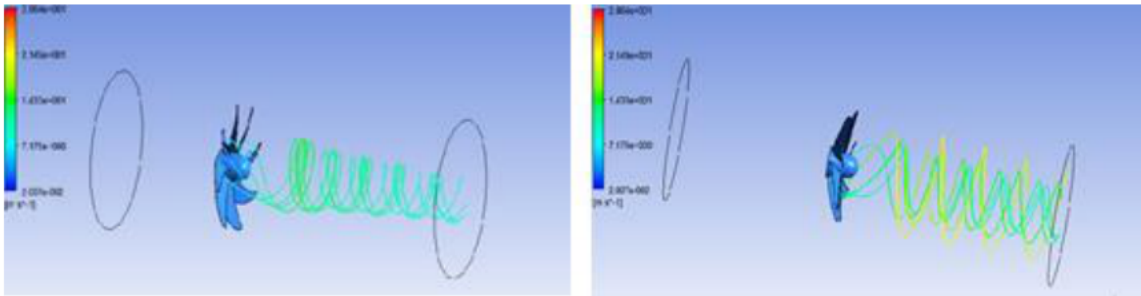
Figure 2 Streamline simulation Au– 8 and Au – 7

Figure 3 Streamline simulation B– 8 and B – 7
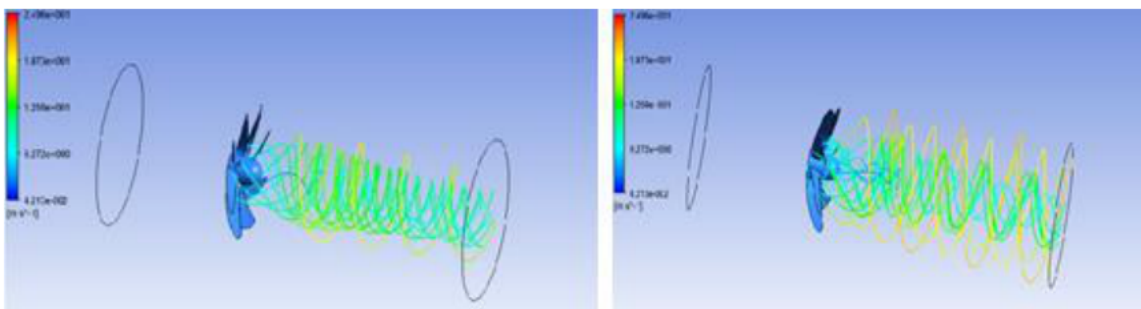

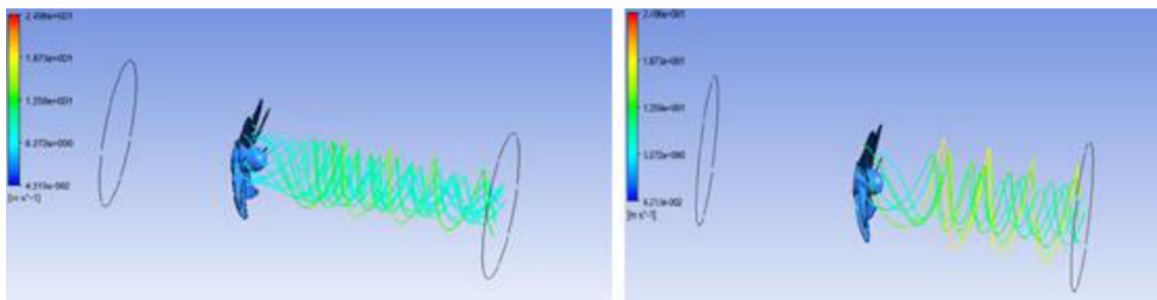**Figure 4** Streamline simulation Au– 8 and Au – 7

Figure 5 Streamline simulation B– 8 and B – 7

Figure 2 – figure 5 show the streamline comparison between four propeller type and be concluded that B – 8 Series is best streamline with average speed 14.33 m/s.

5. CONCLUSION

At 500 rpm, the propeller Au – 7 type produces a thrust 11,967 N at average pressure 87,231.83 Pa with average speed on streamline16.05 m/s but it has irregular flow. While the propeller Au – 8 type produces a thrust 27,742 N, average pressure 18,111.33 Pa with average speed on streamline 15.45 m/s but has irregular flow. The propeller B – 7 type is obtained a thrust 22,436 N, average pressure 43,251.75 Pa with average speed on streamline16.25 m/s but has irregular

flow. And the propeller B – 8 type has a thrust 25,481 N, average pressure 10,608.92 Pa with average speed on streamline 16.35 m/s with smooth flow.

The chosen propeller is used on the Submarine of Midget Type 150 m is Propeller B – 8 series type with thrust 25,481 N, average pressure 10,608.92 Pa, with average speed on streamline16.35 m/s with smooth streamline.

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