TransNav
http://www.transnav.eu
the International Journal on Marine Navigation and Safety of Sea Transportation
Volume 8
Number 1
March 2014

DOI: 10.12716/1001.08.01.17

Experimental Analysis of Podded Propulsor on Naval Vessel

M.P Abdul Ghani, O. Yaakob, N. Ismail, A.S.A Kader & A.F Ahmad Sabki
Marine Technology Centre, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia

P. Singaraveloo
Ship Clasification Malaysia, Shah Alam, Selangor

ABSTRACT: This paper describes the effect of pod propulsor attachment to the existing Naval Vessel hull form which was designed for conventional propulsor in aspects of resistance and motion characteristics. These investigations were carried out on a 3.0 m model by experimental works in the towing tank 120m x 4m x 2.5m at the Marine Technology Centre (MTC), Universiti Teknologi Malaysia (UTM). The basis ship chosen for this study is Sealift class type MPCSS (Multi Purpose Command Support Ship). In this study, the design for the new pod propulsor is based on a proven design and scaled down to suit this type of hullform accordingly. This paper describes the resistance comparison between bare and podded hulls in calm water as well in waves. The seakeeping test for hull with and without pod in regular waves at service speed of 16.8 knots were carried out at wavelength to model length ratio, Lw/Lm between 0.2 and 1.2. The outcomes from this experimental works on hull with and without pod were compared.

1 INTRODUCTION

Podded propulsion system is a new propulsion systems have been used for both commercial and naval ships. Propulsion pods are gondola shaped devices, hanging below the stern of a ship, which combine both the propulsive and the steering functions.

Pod propulsion offers attractive performance benefits over more conventional propulsion syatems, especially in the areas of ship noise, hydrodynamic efficiency and fuel economy. The elimination of long shaftlines, support bearings, stern tubes, and other underwater protrusions typically with conventional system creates a smoother laminar flow over the hull and propeller

The first patent for a podded propulsion system was in 1826 by William Church and the first application was by John Ericson in 1836. The real application for this propulsion system in the past was applied to torpedoes. In Japan there are some vessels operating with podded propulsion system and the results from the application are good especially in reducing vibration level but rather complicated due to the conventional propulsion system using long shaft located between each other[5].

The podded propulsion system normally uses an electric motor driven by diesel electric drive. This propulsion drive has been used in icebreakers and other special purpose vessels. A pod consists of a motor located in a hydro-dynamically optimizes housing and stay attached to the hull. Well designed pods reduce resistance to motion by 5-10%. An optimally designed pod shape, positioning and angle in relation to ship’s hull can increase propulsion efficiency up to 15% in comparison with an in hull propulsion system. Pods also decrease the vessel vibrations and noise levels and provide a more environmental friendly vessel to ship operators. Pods can be dismounted and serviced at sea, making dry docking for major propulsion repairs unnecessary.

Several model test series have been carried out to define a shape with optimal efficiency. CFD calculations have been made to investigate the flow and pressure pattern around the Pod. To reach a good propulsion efficiency, the underwater housing should be as small as possible.

2 BACKGROUND

Basically, a podded propulsion system consists of a fixed pitch propeller driven by an electric motor through a short shaft. The shaft and the motor are located located inside a pod shell. The pod unit is connected to ship's hull through a strut and slewing bearing assembly. This assembly allows the entire pod unit to rotate and thus the thrust developed by the propeller can be directed anywhere over 360° relative to the ship.[4]

A small pod diameter or gondola diameter should be used to get a high total efficiency and to reduce the interaction effects between propeller and pod housing.

The pod diameter depends on the size of the electric motor inside the pod. The definition of the geometric parameters is shown in *Fig.* 1 and its proposed particulars as shown in Table 1.

The basis ship chosen for this study is Sealift Class Type MPCSS (Multi PurposeCommand Support Ship). The ship particulars and its body plan are shown in Table 2 and *Fig*. 2 respectively.

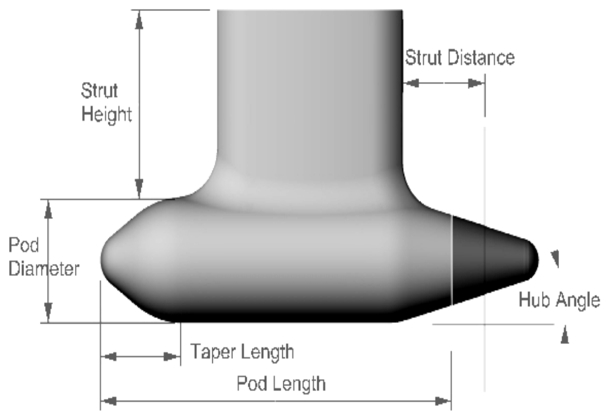

Figure 1. Pod Anatomy

Table 1. Proposed Pod Particulars

Parameter	Value
Propeller diameter, D m	3.887
Pod length, Lp, m	5.995
Pod diameter, Dp, m	2
Pod length ratio, Lp/D	1.542
Pod diameter ratio, Dp/D	0.514

Table 2. Ship Particulars

Parameter	Value
Length overall, LOA m	103.000
Length Between Perpendicular, LBP m	97.044
Breadth, m	15.000
Depth, m	11.000
Draught, m	4.409
Displacement, tonnes	4431.57
Speed (Operational), knots	16.8
Speed (Max), knots	19.98

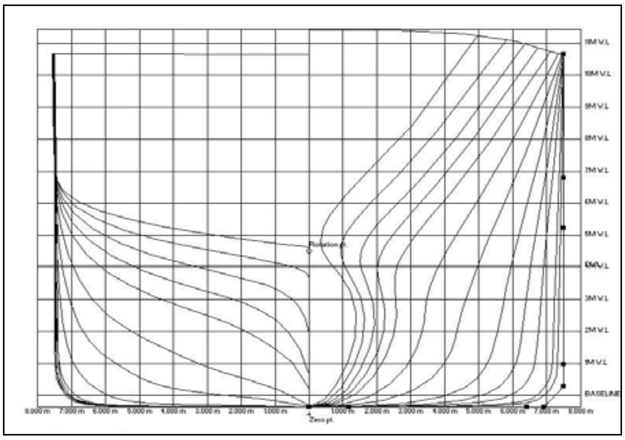

Figure 2. Sealift Class Type MPCSS of Naval Vessel

3 EXPERIMENTAL SET UP

The experiments have been carried out in the towing tank of the Marine Technology Centre (MTC), Univesiti Teknologi Malaysia (UTM). The dimensions of this tank are: length 120 meter, width 4.0 meter and water depth 2.5 meter. The maximum attainable speed of the towing carriage is 5 m/s with acceleration 1 m/s ^{2}.

Table 3. Model Test Matrix for Resistance in Calm Water

Run	V_S (knots)	Model Speed, V_m (m/s)	Fn
1	14	1.228	0.226
2	16	1.404	0.259
3	16.8	1.474	0.272
4	18	1.579	0.291
5	20	1.755	0.324

Table 4. Model Test Matrix for Resistance & Seakeeping in Regular Waves at Vm =1.474m/s

Fn	WAVE CHARACTERISTICS					
	Lw/Ls	Lw	Hw	Tw	ωw	Hw/Lw
0.272	0.5	1.5	0.015	0.980	6.02	1/100
0.272	0.6	1.8	0.018	1.074	5.85	1/100
0.272	0.8	2.4	0.024	1.240	5.07	1/100
0.272	1.0	3.0	0.030	1.386	4.53	1/100
0.272	1.2	3.6	0.036	1.518	4.14	1/100

4 RESULTS AND ANALYSIS

Most of the results of the measurements have been plotted based on the Froude number.

In general, podded hull has higher resistance value due to the additional wetted surface area. Based on the result obtained, at the design speed (16.8 knots), the total ship resistance value for hull with pod propulsor is higher than the hull without pod. Figures 3 and 4 shows the resistance for podded hull is higher than bare hull by differences about 22.5% but the differences between these two decreases with increasing of speed.

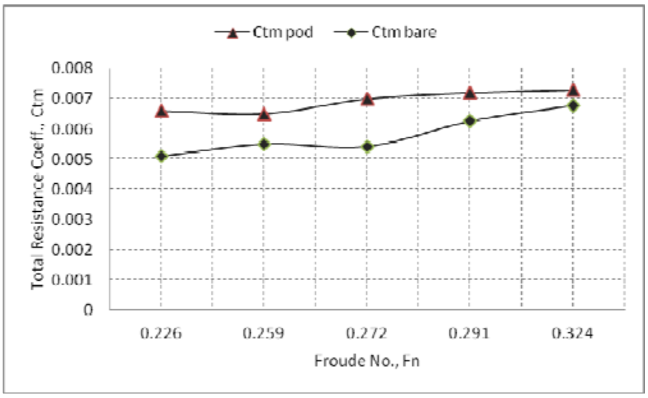

Figure 3. Ctm versus Fn

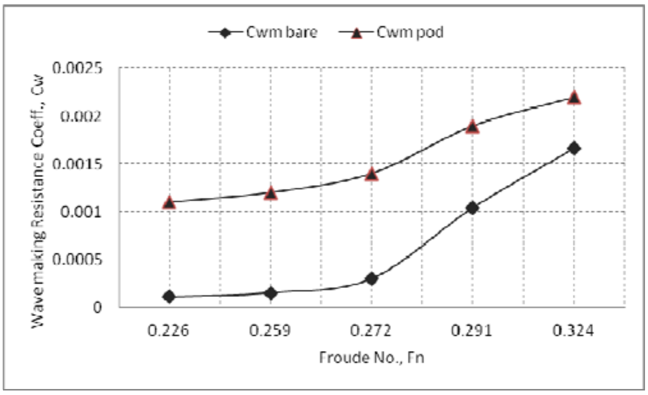

Figure 4. Cwm versus Fn

As shown in Figures 5 and 6, at the maximum (Lw/Lm=1.2) wave condition, the total ship resistance for podded hull is higher than for hull without pod. The difference between these two values is about 20%.

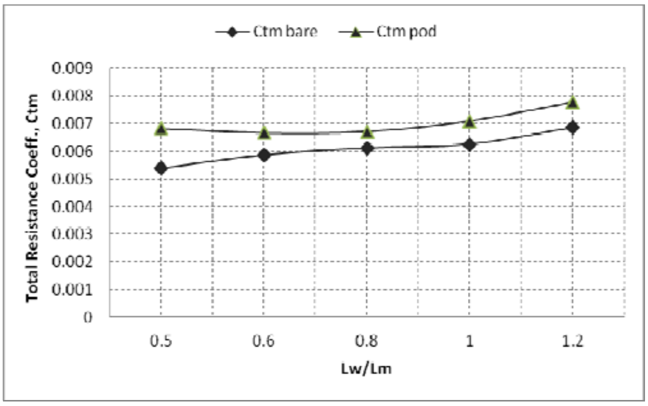

Figure 5. Ctm versus Lw/Lm at Fn=0.272

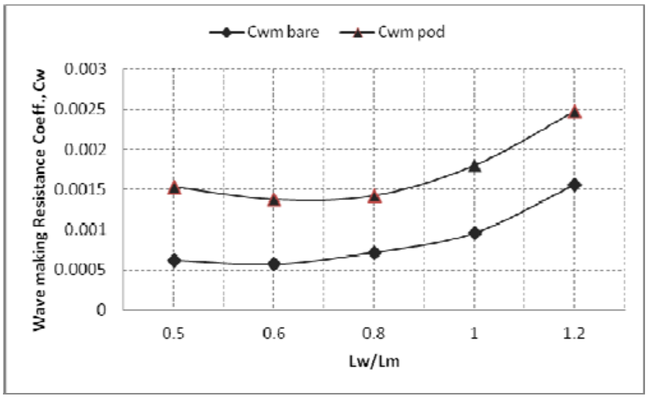

Figure 6. Cwm versus Lw/Lm at Fn=0.272

Figure 7 shows the pattern of pitch RAO for the model with and without pod are the same but there are small deviations in term of magnitude of the response whilst the values for model with pod are slightly higher hence the hull with pod produce higher pitching motion than than the hull without pod.

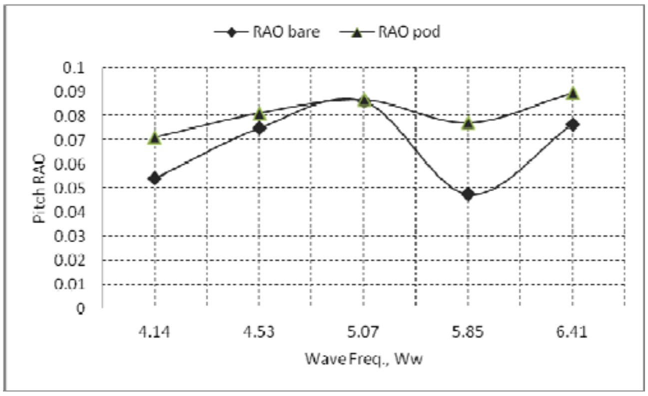

Figure 7. Response Amplitude Operator

5 CONCLUSIONS

From the above the following conclusions can be drawn:

It was found that the the hull with pod produce resistance 20% higher than the bare hull and also an increment about 22% higher in pitching response.

Generally pod technology has already made significant progress in the commercial shipbuilding industry. This new technology offers many unique advantages not offered by conventional electric propulsion systems. Pod propulsion is undoubtedly a viable option for future shipbuilding programs for the Malaysian navy.

ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to all staff of the Marine Technology Centre, UTM for their assistance in carried out this experimental works.

REFERENCES

[1] Abdul Ghani, M.P, Mohd Yusop, M.Z and Islam, M.R, Design Study of Podded Propulsion System for Naval Ship, Proceedings of the 4th BSME-ASME International Conference on Thermal Engineering, 27-29 December 2008, Bangladesh

[2] Marc Batsford, Pod Propulsion: A Viable Option for the Canadian Navy, Maritime Engineering Journal, Vol. 20, No. 2 Fall 2001/Winter 2002.

[3] Cornelia Heinke, Hans-Jurgen Heinke, Investigations about the use of Podded Drives for Fast Ships, FAST 2003

[4] Islam, M.F et al Numerical Study of Effects of Hub Taper Angle on the Performance of Propellers Designed for Podded Propulsion Systems, Marine Technology, 43, 1, pp. 1-10,2006