

Massachusetts Institute of Technology
DEPARTMENT OF OCEAN ENGINEERING
(Center for Ocean Engineering)
2.611 SHIP POWER and PROPULSION

Problem Set #1, Propeller Problems, Due: September 26, 2006

Assume: 1knot=1.688 ft/s, standard seawater density (at 59° F) = 1.9905 lb s²/ft⁴

1. A survey vessel has a 10 ft diameter, B 5-90 propeller with a pitch of 10 ft. The propeller speed is 200 rpm, the boat speed is 20 knots, and the thrust reduction factor (t) is 0.12, wake fraction (w) is 0.18, and the relative rotational efficiency η_R is 1.0.

The propeller operates as indicated by the Wageningen (Troost) Series B propeller charts. Determine:

- a. Thrust
- b. Shaft torque
- c. EHP of the boat
- d. The propeller shaft power (delivered power) P_D
- e. The (Quasi) PC or η_D

The propeller is also tested at zero ship speed (bollard pull) and it is found that the engine limits the torque to 50,000 lbf ft. Determine:

- f. the propeller rpm and thrust at this condition

2. A propeller is to be selected for a single-screw container ship with the following features:

EHP = 80000 HP, ship speed = 25 kts, maximum propeller diameter = 34 ft,
 $w = 0.249$, $t = 0.18$, $\eta_R = 1.0$, centerline depth, $h = 25$ ft

a. Using the maximum prop diameter, determine the optimum B 5-90 design. Use the metrics below to confirm your design.

- a. P/D
- b. K_T (optimum)
- c. K_Q (optimum)
- d. η_o (optimum)
- e. J
- f. Developed HP
- g. The (Quasi) PC or η_D
- h. RPM

From the consideration of cavitation, determine:

- i. The predicted cavitation (%) using the Burrill correlation
- j. The expanded area ratio (EAR) to provide 5% cavitation for a commercial ship.

Assume the operating conditions are similar to the B 5-90 propeller.

3. List the advantages and disadvantages of the fixed pitch propeller, controllable pitch propeller, and waterjet propulsion systems. List the best applications (or platform(s)) for each propulsor and supporting reasons considering the mission of the platform. (expectation: half a page of concise thought).