

# Propeller Performance Analysis Using OpenFOAM

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## Introduction

This report presents a computational analysis of a propeller simulated using OpenFOAM. The objective is to evaluate key performance parameters such as thrust, torque, and propeller efficiency under specific operating conditions. The propeller geometry and flow conditions follow the OpenFOAM propeller tutorial case setup.

## Simulation Setup

The simulation setup involves a propeller of diameter  $D = 0.2$  m, operating in water with a density of  $\rho = 1000$  kg/m<sup>3</sup>. The inflow velocity is set to  $V_A = 5$  m/s, with the propeller rotating at an angular speed of  $\omega = 158$  rad/s. The simulation uses an appropriate mesh and boundary conditions to capture the propeller's thrust and torque accurately.

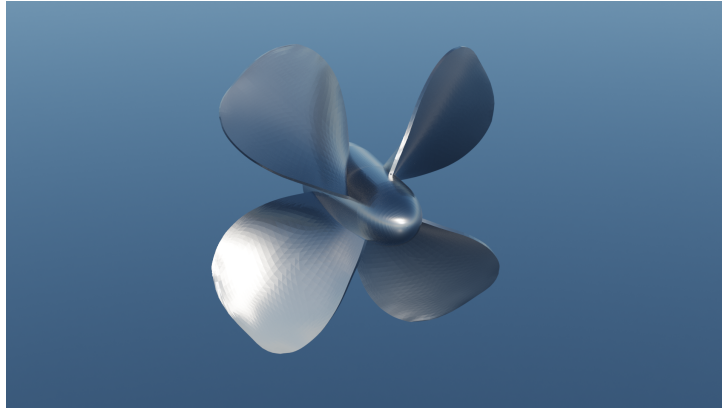


Figure 1: Propeller geometry used in the OpenFOAM simulation

## Parameter Analysis

### Thrust and Torque

The simulation generated the following results for thrust and torque:

- **Thrust ( $T$ ):** 365 N
- **Torque ( $Q$ ):** 21.5 Nm

These values represent the propeller's performance under the given conditions, providing the foundation for the further non-dimensional analysis.

## Coefficient Calculations

**Thrust Coefficient,  $C_T$ :**

$$C_T = \frac{T}{\rho n^2 D^4} = \frac{365}{1000 \times (25.15)^2 \times (0.2)^4} = 0.361$$

**Torque Coefficient,  $C_Q$ :**

$$C_Q = \frac{Q}{\rho n^2 D^5} = \frac{21.5}{1000 \times (25.15)^2 \times (0.2)^5} = 0.106$$

**Advance Ratio,  $J$ :**

$$J = \frac{V_A}{nD} = \frac{5}{25.15 \times 0.2} = 0.994$$

**Efficiency,  $\eta$ :**

$$\eta = \frac{J \times C_T}{2\pi C_Q} = \frac{0.994 \times 0.361}{2\pi \times 0.106} = 0.537 \text{ (53.7\%)}$$

## Summary of Results

The table below summarizes the calculated coefficients and efficiency:

Parameter	Value
Thrust Coefficient, $C_T$	0.361
Torque Coefficient, $C_Q$	0.106
Advance Ratio, $J$	0.994
Efficiency, $\eta$	53.7%

Table 1: Summary of propeller performance parameters

## Conclusion

The analysis demonstrates the propeller's performance characteristics, with a thrust coefficient of  $C_T = 0.361$  and a torque coefficient of  $C_Q = 0.106$ . The calculated efficiency, 53.7%, indicates a moderately efficient operation at the specified advance ratio.