Ship Propulsive Efficiency: Wake, Thrust Deduction and Power Chain

Hull, quasi-propulsive and overall efficiency, delivered and shaft power, propeller thrust and advance coefficient from effective power, wake and thrust deduction.

Method: Propulsion factors and the ship power chain

Input parameters

Unit system: SI

Parameter	Value	Unit
Effective power	3,500.0	kW
Ship speed	15.000	kn
Taylor wake fraction	0.28000	
Thrust deduction fraction	0.20000	
Open-water propeller efficiency	60.000	%
Relative rotative efficiency	1.0100	
Shaft transmission efficiency	98.000	%
Propeller speed	110.00	rpm
Propeller diameter	5.0000	m

Calculated results

Parameter	Value	Unit
Hull efficiency (1 − t)/(1 − w)	1.1111	
Quasi-propulsive efficiency η_H η_O η_R	0.67333	
Delivered power at the propeller	5,198.0	kW
Shaft power at the engine	5,304.1	kW
Propeller thrust R_T/(1 − t)	566.96	kN
Speed of advance V(1 − w)	10.800	kn
Advance coefficient V_A/(nD)	0.60611	

Notes for this case

- Power chain P_S = P_E/(η_H η_O η_R η_S). Wake, thrust deduction and η_R come from self-propulsion tests or regressions (Holtrop); η_O from the propeller's open-water curves at J.

Formula and method

$$\eta_H = \frac{1-t}{1-w}, \quad \eta_D = \eta_H \eta_O \eta_R, \quad P_D = \frac{P_E}{\eta_D}, \quad P_S = \frac{P_D}{\eta_S}$$

$$V_A = V(1-w), \quad J = \frac{V_A}{nD}, \quad T = \frac{R_T}{1-t}$$

Variables

P_E	Effective power	W
V	Ship speed	m/s
w	Taylor wake fraction	-
t	Thrust deduction fraction	-

η_O	Open-water propeller efficiency	-
η_R	Relative rotative efficiency	-
η_S	Shaft transmission efficiency	-
n	Propeller speed	1/s
D	Propeller diameter	m
η_H	Hull efficiency (1 − t)/(1 − w)	-
η_D	Quasi-propulsive efficiency η_H η_O η_R	-
P_D	Delivered power at the propeller	W
P_S	Shaft power at the engine	W
T	Propeller thrust R_T/(1 − t)	N
V_A	Speed of advance V(1 − w)	m/s
J	Advance coefficient V_A/(nD)	-

Method and standards

Ship propulsion efficiency breakdown.

Assumptions and limits

- Steady calm-water service; factors from tests or regressions.

References

Propulsion factors and the ship power chain

Report details

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Reopens the calculator with the inputs of this report.