Kaplan Turbine Runner Diameter, Hub and Speed

Flow, runner tip and hub diameters, flow velocity and speed of a Kaplan or propeller turbine from power, head, efficiency and the speed and flow ratios.

Input parameters

Unit system: SI

Parameter	Value	Unit
Shaft power	20,000	kW
Net head	15.000	m
Overall efficiency	90.000	%
Hub to tip diameter ratio	35.000	%
Speed ratio u_tip/√(2gH)	2.0000	
Flow ratio V_f/√(2gH)	60.000	%
Water density	1,000.0	kg/m³

Calculated results

Parameter	Value	Unit
Flow	151.07	m³/s
Axial flow velocity	10.291	m/s
Runner tip diameter	4.6151	m
Hub diameter	1.6153	m
Tip speed	34.304	m/s
Speed	141.96	rpm
Specific speed (rpm, kW, m)	680.10	

Notes for this case

- Choose the nearest synchronous speed and recompute the diameter from it. Kaplan speed ratios of 1.4–2.0 at the tip and flow ratios of 0.35–0.75 are usual.

Formula and method

$$Q = \frac{P}{\rho g H \eta_o}, \quad Q = \frac{\pi}{4}(D^2 - d^2)V_f, \quad V_f = \psi\sqrt{2gH}$$

$$u = \phi\sqrt{2gH} = \frac{\pi D N}{60}$$

Variables

P	Shaft power	W
H	Net head	m
η_o	Overall efficiency	-
d/D	Hub to tip diameter ratio	-
ϕ	Speed ratio u_tip/√(2gH)	-
ψ	Flow ratio V_f/√(2gH)	-
ρ	Water density	kg/m³
Q	Flow	m³/s
V_f	Axial flow velocity	m/s

D	Runner tip diameter	m
d	Hub diameter	m
u	Tip speed	m/s
N	Speed	rad/s
N_s	Specific speed (rpm, kW, m)	-

Method and standards

Axial-flow turbine continuity and speed relations.

Assumptions and limits

- One-dimensional flow; uniform axial velocity.

Report details

Report reference	FCC-C65W-DCGZ (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/hydro-power/kaplan-runner-sizing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.