Hydro Turbine Specific Speed, Unit Quantities and Synchronous Speed

Specific speed, unit speed, unit power and unit discharge of a hydraulic turbine, the generator poles for synchronous speed and the usual turbine type.

Input parameters

Unit system: SI

Parameter	Value	Unit
Shaft power per runner	10,000	kW
Net head	100.00	m
Flow per runner	41,400	m³/h
Proposed speed	500.00	rpm
Grid frequency	50.000	Hz

Calculated results

Parameter	Value	Unit
Specific speed (metric: rpm, kW, m)	158.11	
Specific speed in metric horsepower units	184.37	
Unit speed N/√H	50.000	
Unit power P/H^1.5 (kW)	10.000	
Unit discharge Q/√H	1.1500	
Generator poles (even, nearest)	12.000	
Synchronous speed with those poles	500.00	rpm
Specific speed at the synchronous speed	158.11	

Notes for this case

- Typical metric specific speeds (rpm, kW, m): Pelton about 8–50 (more with several jets), Francis about 50–350, Kaplan and propeller about 250–850; the head range narrows the choice further.
- At this specific speed the usual choice is a Francis turbine.

Formula and method

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}, \quad N_u = \frac{N}{\sqrt{H}}, \quad P_u = \frac{P}{H^{3/2}}, \quad Q_u = \frac{Q}{\sqrt{H}}$$

$$N = \frac{120 f}{p}$$

Variables

P	Shaft power per runner	W
H	Net head	m
Q	Flow per runner	m³/s
N	Proposed speed	rad/s
f	Grid frequency	1/s
N_s	Specific speed (metric: rpm, kW, m)	-
$N_{s,hp}$	Specific speed in metric horsepower units	-

N_u	Unit speed N/√H	-
P_u	Unit power P/H^1.5 (kW)	-
Q_u	Unit discharge Q/√H	-
p	Generator poles (even, nearest)	-
N_{syn}	Synchronous speed with those poles	rad/s
$N_{s,syn}$	Specific speed at the synchronous speed	-

Method and standards

Similarity laws of hydraulic turbines.

Assumptions and limits

- Geometrically similar machines; one runner (divide power by the number of jets or runners as the convention requires).

Report details

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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/hydro-turbine-specific-speed

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.