Cooling Water Pump Head for a Condenser and Tower Circuit

Total head and power of a cooling water pump from static lift to the tower distribution, pipe friction (Colebrook), condenser pressure drop and nozzle pressure.

Method: Darcy–Weisbach with the Colebrook friction factor (FireCAD engine) and static and component heads (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Water flow	3,000.0	m³/h
Pipe inside diameter	600.00	mm
Equivalent pipe length (pipe plus fittings)	400.00	m
Pipe roughness	0.045000	mm
Static lift (basin level to distribution)	12.000	m
Condenser water-side pressure drop	60.000	kPa
Pressure needed at the distribution nozzles	10.000	kPa
Pump efficiency	82.000	%
Water density	996.00	kg/m³

Calculated results

Parameter	Value	Unit
Pipe velocity	2.9473	m/s
Darcy friction factor	0.012265	
Pipe friction head	3.6214	m
Total pump head	22.788	m
Pump shaft power	226.20	kW

Notes for this case

• Water viscosity taken as 0.8 mPa·s (about 30 °C). In an open tower circuit, the static lift is to the hot-water distribution level; the return falls back by gravity. Add margin for fouling and future plugging.

Formula and method

$$H = H_s + f_D \frac{L_e}{D}\frac{V^2}{2g} + \frac{\Delta p_c + p_n}{\rho g}, \quad P = \frac{\rho g Q H}{\eta}$$

$$V = \frac{4Q}{\pi D^2}, \quad Re = \frac{\rho V D}{\mu}, \quad \frac{1}{\sqrt{f_D}} = -2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f_D}}\right)$$

Variables

Q	Water flow	m³/s
D	Pipe inside diameter	m
L_e	Equivalent pipe length (pipe plus fittings)	m
ε	Pipe roughness	m
H_s	Static lift (basin level to distribution)	m
Δp_c	Condenser water-side pressure drop	Pa

p_n	Pressure needed at the distribution nozzles	Pa
η	Pump efficiency	-
ρ	Water density	kg/m³
V	Pipe velocity	m/s
f_D	Darcy friction factor	-
Re	Reynolds number	-
μ	water viscosity, fixed at 0.8 mPa·s (about 30 °C)	Pa·s
g	standard gravity, 9.80665	m/s²
H_f	Pipe friction head	m
H	Total pump head	m
P	Pump shaft power	W

Method and standards

Darcy–Weisbach pipe friction with the Colebrook friction factor, plus the static lift and the condenser and nozzle pressure drops converted to head.

Assumptions and limits

- Single-phase water at about 30 °C: the viscosity is fixed at 0.8 mPa·s whatever density is entered. For much colder or warmer water the Reynolds number, and slightly the friction, differ.
- Relative roughness ε/D up to 0.1, the range of the Colebrook equation; above it the input is rejected.

References

- Darcy–Weisbach with the Colebrook friction factor (FireCAD engine) and static and component heads (definitions)

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/condensers-cooling/cooling-water-circuit-pump-head

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Reopens the calculator with the inputs of this report.