Condenser Tube Count and Water Velocity

Number of tubes per pass and in total for a condenser or shell-and-tube cooler from cooling water flow, tube size, passes and design velocity, with the actual velocity.

Method: Continuity equation (flow = velocity × area)

Input parameters

Unit system: SI

Parameter	Value	Unit
Cooling water flow	2,400.0	m³/h
Tube outside diameter	19.050	mm
Tube wall thickness	0.71000	mm
Number of water passes	2.0000	
Design water velocity in the tubes A common design range is 1.5–2.5 m/s: lower fouls, higher erodes; the tube material sets the upper limit (take it from the tube maker).	2.0000	m/s
Effective tube length	8.0000	m

Calculated results

Parameter	Value	Unit
Tubes per pass	1,366.0	
Total tubes	2,732.0	
Actual water velocity	1.9992	m/s
Tube inside diameter	17.630	mm
Outside tube surface	1,308.0	m²

Formula and method

$$d_i = d_o - 2\,t_w \qquad n_p = \left\lceil \frac{\dot{V}}{v \cdot \pi d_i^2/4} \right\rceil \qquad n = n_p\,N_p$$

$$v_{act} = \frac{\dot{V}}{n_p\,\pi d_i^2/4} \qquad A_o = n\,\pi\,d_o\,L$$

Variables

$\dot{V}$	cooling water flow	m³/s
d_o	tube outside diameter	m
t_w	tube wall thickness	m
N_p	number of water passes	–
v	design water velocity	m/s
L	effective tube length	m
n_p	tubes per pass	–
n	total tubes	–
v_{act}	actual water velocity	m/s
d_i	tube inside diameter	m
A_o	outside tube surface	m²

Method and standards

Continuity: every pass carries the whole flow, so tubes per pass follow from flow, velocity and the tube bore, rounded up to a whole tube.

Assumptions and limits

- Equal flow in all tubes; straight tubes; plugging margin not included: add spare tubes for the plugging you expect.
- The actual velocity is not checked against a limit; the 1.5–2.5 m/s range in the help is common design practice, and the tube maker sets the limit for the material.

References

- Continuity equation (flow = velocity × area)

Report details

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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/condensers-cooling/condenser-tube-velocity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.