Economiser Water Velocity and Pressure Drop

Water velocity, Reynolds number, Colebrook friction factor and pressure drop in an economiser's parallel circuits with bend losses (IF97 water).

Method: Darcy–Weisbach with Colebrook friction factor; water properties from IAPWS-IF97 and IAPWS 2008 viscosity

Input parameters

Unit system: SI

Parameter	Value	Unit
Feedwater flow	60.000	t/h
Parallel tube circuits	24.000	
Tube inside diameter	38.100	mm
Length of one circuit	120.00	m
Roughness	0.046000	mm
Bend and header losses (sum of K)	20.000	
Water pressure (absolute)	75.000	bar
Mean water temperature	190.00	°C

Calculated results

Parameter	Value	Unit
Water velocity	0.69181	m/s
Reynolds number	161,598	
Darcy friction factor	0.022070	
Pressure drop	0.18860	bar

Notes for this case

- Static head of vertical circuits is not included; add it for up-flow and down-flow passes.

Formula and method

$$v = \frac{\dot{m}}{n\rho\pi d_i^2/4}, \quad \Delta p = \left(f\frac{L}{d_i} + \Sigma K\right)\frac{\rho v^2}{2}$$

$$Re = \frac{\rho v d_i}{\mu}, \quad f = \frac{64}{Re}\ (Re < 2300), \quad \frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon/d_i}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)\ \text{otherwise}$$

Variables

$\dot{m}$	Feedwater flow	kg/s
n	Parallel tube circuits	-
d_i	Tube inside diameter	m
L	Length of one circuit	m
ε	Roughness	m
ΣK	Bend and header losses (sum of K)	-
p	Water pressure (absolute)	Pa
T	Mean water temperature	K
v	Water velocity	m/s
Re	Reynolds number	-

f	Darcy friction factor	-
Δp	Pressure drop	Pa
$\rho\$, \$\mu$	water density and viscosity at p, T (IAPWS-IF97, IAPWS 2008)	kg/m³, Pa·s

Method and standards

Darcy–Weisbach with the Colebrook friction factor (laminar 64/Re below Re 2300), water properties from FireCAD's IAPWS-IF97 and IAPWS 2008 viscosity.

Assumptions and limits

- Single-phase water; static head of vertical passes not included.
- The friction factor jumps from 64/Re to Colebrook at Re 2300; in the transition range the result is uncertain and a note appears.
- A note appears when the velocity is outside 0.6–1.5 m/s.

References

- Darcy–Weisbach with Colebrook friction factor; water properties from IAPWS-IF97 and IAPWS 2008 viscosity

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/furnace-heating-surfaces/economiser-water-pressure-drop

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Reopens the calculator with the inputs of this report.