Thermic Fluid Heater Coil Pressure Drop and Pump Power

Velocity, Reynolds number, pressure drop and pump power of thermic fluid in a heater coil and circuit, from fluid properties, coil size, length and bends.

Method: Darcy–Weisbach with Colebrook (FireCAD engine) and bend losses (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Fluid flow	54,000	kg/h
Fluid density at mean temperature	780.00	kg/m³
Fluid dynamic viscosity at mean temperature Dynamic viscosity in cP (mPa·s). Fluid tables usually give kinematic viscosity in cSt: multiply cSt by the density in g/cm³ (e.g. 0.6 cSt × 0.76 = 0.46 cP).	0.45000	cP
Coil inside diameter	62.700	mm
Parallel coil passes	2.0000	
Developed length per pass	250.00	m
Return bends per pass	40.000	
Loss coefficient per bend	0.30000	
Roughness	0.045000	mm
Rest of the circuit (users, piping)	150.00	kPa
Pump efficiency	60.000	%

Calculated results

Parameter	Value	Unit
Velocity in the coil	3.1142	m/s
Reynolds number	338,448	
Darcy friction factor	0.019221	
Coil pressure drop	335.25	kPa
Total pump differential	485.25	kPa
Pump shaft power	15.553	kW

Formula and method

$$V = \frac{\dot{m}}{n_p \rho \pi d_i^2/4}, \quad \Delta p_{coil} = \left(f_D \frac{L}{d_i} + n_b K_b \right) \frac{\rho V^2}{2}, \quad P = \frac{\dot{m}}{\rho} \frac{\Delta p}{\eta}$$

$$Re = \frac{\rho V d_i}{\mu}, \quad f_D = \text{Colebrook}(Re, \varepsilon/d_i)\ (64/Re \text{ laminar}), \quad \Delta p = \Delta p_{coil} + \Delta p_{ext}$$

Variables

$\dot{m}$	Fluid flow	kg/s
ρ	Fluid density at mean temperature	kg/m³
μ	Fluid dynamic viscosity at mean temperature	Pa·s
d_i	Coil inside diameter	m
n_p	Parallel coil passes	-
L	Developed length per pass	m

n_b	Return bends per pass	-
K_b	Loss coefficient per bend	-
$\mathcal{E}$	Roughness	m
Δp_{ext}	Rest of the circuit (users, piping)	Pa
η	Pump efficiency	-
V	Velocity in the coil	m/s
Re	Reynolds number	-
f_D	Darcy friction factor	-
Δp_{coil}	Coil pressure drop	Pa
Δp	Total pump differential	Pa
P	Pump shaft power	W

Method and standards

Darcy–Weisbach friction with the Colebrook friction factor from FireCAD's engine, plus a fixed loss coefficient per return bend; the pump power is the volume flow times the total differential over the pump efficiency.

Assumptions and limits

- Single phase; even flow per pass.
- The bend loss is a fixed K per bend, independent of Reynolds number and bend radius. If the developed length L already includes the bends, do not count their friction twice.

References

• Darcy–Weisbach with Colebrook (FireCAD engine) and bend losses (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/thermic-fluid-heaters/thermic-fluid-coil-pressure-drop

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Reopens the calculator with the inputs of this report.