Fluid Outlet Temperature in a Tube at Constant Wall Temperature

Film coefficient by Sieder–Tate and the outlet temperature, duty and log-mean difference for a fluid heated or cooled in a tube at constant wall temperature.

Input parameters

Unit system: SI

Parameter	Value	Unit
Tube inside diameter	20.000	mm
Tube length	6.0000	m
Flow	180.00	kg/h
Specific heat	2.0000	kJ/(kg·K)
Viscosity at the bulk temperature	50.000	mPa·s
Thermal conductivity	0.13000	W/(m·K)
Viscosity ratio bulk to wall (1 if unknown)	0.40000	
Inlet temperature	40.000	°C
Wall temperature	150.00	°C

Calculated results

Parameter	Value	Unit
Reynolds number	63.662	
Prandtl number	769.23	
Film coefficient	58.119	W/(m²·K)
hπDL/(ṁc_p)	0.21910	
Outlet temperature	61.644	°C
Heat transferred	2.1644	kW
Log-mean temperature difference	98.783	K

Notes for this case

- Laminar Sieder–Tate: Nu = 1.86 (RePrD/L)^1/3 (μ/μ_w)^0.14, not below the fully developed 3.66.

Formula and method

$$Nu = 0.027 Re^{0.8} Pr^{1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \text{(turbulent)}, \quad Nu = 1.86 \left(\frac{RePrD}{L}\right)^{1/3} \left(\frac{\mu}{\mu_w}\right)^{0.14} \text{(laminar)}$$

$$T_2 = T_w - (T_w - T_1) \exp\left(-\frac{h\pi DL}{\dot{m} c_p}\right)$$

Variables

D	Tube inside diameter	m
L	Tube length	m
$\dot{m}$	Flow	kg/s
c_p	Specific heat	J/(kg·K)
μ	Viscosity at the bulk temperature	Pa·s
k	Thermal conductivity	W/(m·K)

μ/μ_w	Viscosity ratio bulk to wall (1 if unknown)	-
T_1	Inlet temperature	K
T_w	Wall temperature	K
Re	Reynolds number	-
Pr	Prandtl number	-
h	Film coefficient	W/(m²·K)
NTU	hπDL/(ṁc_p)	-
T_2	Outlet temperature	K
Q	Heat transferred	W
ΔT_{lm}	Log-mean temperature difference	K

Method and standards

Energy balance of a tube with a uniform wall temperature.

Assumptions and limits

- Constant properties and wall temperature.

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/mechanical/heat-transfer/tube-heating-constant-wall-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.