Tube-Side Heat Transfer Coefficient (Gnielinski, Sieder–Tate)

Film coefficient for flow inside a tube or annulus: Hausen and Sieder–Tate for laminar, Gnielinski for transition and turbulent flow (Perry's sec. 5).

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Geometry	Round tube	
Tube inside diameter or annulus outer diameter	20.000	mm
Annulus inner diameter (annulus only)	10.000	mm
Heated length	3.0000	m
Mean velocity	1.2000	m/s
Density	988.00	kg/m³
Viscosity at bulk temperature	0.54700	cP
Thermal conductivity	0.64000	W/(m·K)
Specific heat	4.1810	kJ/(kg·K)
Fluid	Liquid	
Viscosity at wall temperature (liquids)	0.35500	cP
Bulk temperature (gases)	50.000	°C
Wall temperature (gases)	80.000	°C
Entrance correction (gases, Pr ≈ 1)	None (fully developed)	

Calculated results

Parameter	Value	Unit
Hydraulic diameter	20.000	mm
Reynolds number	43,349	
Prandtl number	3.5734	
Nusselt number (Hausen laminar; Gnielinski turbulent)	228.09	
Film coefficient	7,299.0	W/(m²·K)
Nusselt number, Sieder–Tate (for comparison)	224.70	

Formula and method

$$Nu = \frac{(f/2)(Re - 1000)Pr}{1 + 12.7(f/2)^{1/2}(Pr^{2/3} - 1)} K, \quad f = 0.25(0.790 \ln Re - 1.64)^{-2}$$

$$Nu = 3.66 + \frac{0.0668\,Gz}{1 + 0.04\,Gz^{2/3}}, \quad Gz = \frac{D}{L} RePr, \quad Nu_{ST} = 0.027 Re^{0.8} Pr^{1/3} \left(\frac{\mu_b}{\mu_s}\right)^{0.14}$$

$$K = \left(\frac{Pr_b}{Pr_s}\right)^{0.11} \text{(liquids)}, \quad \left(\frac{T_b}{T_s}\right)^{0.45} \text{(gases)}, \quad \frac{\overline{Nu}}{Nu} = 1 + \frac{C}{(L/D)^n}$$

Variables

$\mathrm{geometry}$	Geometry	-
D	Tube inside diameter or annulus outer diameter	m
D_i	Annulus inner diameter (annulus only)	m
L	Heated length	m
V	Mean velocity	m/s
ρ	Density	kg/m³
μ_b	Viscosity at bulk temperature	Pa·s
k	Thermal conductivity	W/(m·K)
c_p	Specific heat	J/(kg·K)
fluid	Fluid	-
μ_s	Viscosity at wall temperature (liquids)	Pa·s
T_b	Bulk temperature (gases)	K
T_s	Wall temperature (gases)	K
$\mathrm{entrance}$	Entrance correction (gases, Pr ≈ 1)	-
D_h	Hydraulic diameter	m
Re	Reynolds number	-
Pr	Prandtl number	-
Nu	Nusselt number (Hausen laminar; Gnielinski turbulent)	-
h	Film coefficient	W/(m²·K)
Nu_{ST}	Nusselt number, Sieder–Tate (for comparison)	-

Method and standards

Gnielinski, Hausen and Sieder–Tate with Perry's corrections; Pr_s taken as Pr·μ_s/μ_b for liquids.

Assumptions and limits

- The gas property correction K = (T_b/T_s)^0.45 applies to heating and cooling alike over 0.5 < T_b/T_s < 1.5, as Perry's gives it; the liquid correction (Pr_b/Pr_s)^0.11 over 0.05–20. The page warns outside these ranges.
- Entrance-configuration constants (Perry's Table 5-3) are for Pr ≈ 1; the page warns when they are applied to a fluid with Pr far from 1.
- The Petukhov–Roizen annulus factors multiply the turbulent (Gnielinski) result only, as in Perry's; the laminar annulus uses the round-tube equations with D_h.
- Smooth tubes; single phase.

References

• Perry's Chemical Engineers' Handbook
• 9th ed. (McGraw-Hill, 2019)
• sec. 5
• Eqs. (5-52)
• (5-54) to (5-57) and (5-60)
• Table 5-3 and the Petukhov–Roizen annulus factors
• with Example 5-6

Report details

Report reference	FCC-58J5-HMVG (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Tube-Side Heat Transfer Coefficient (Gnielinski, Sieder–Tate)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	4 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-side-heat-transfer-coefficient

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Reopens the calculator with the inputs of this report.