Agitated Vessel Inside Film and Overall Coefficient

Vessel-side film coefficient of a jacketed or coiled agitated vessel from agitator Reynolds and Prandtl numbers, and the overall coefficient with wall and jacket.

Input parameters

Unit system: SI

Parameter	Value	Unit
Agitator and surface	Flat-blade turbine, coil, baffled, Re 2,000 to 700,000 (C 1.10)	
Agitator diameter	0.70000	m
Impeller speed	90.000	rpm
Liquid density	1,000.0	kg/m³
Liquid viscosity	1.0000	mPa·s
Liquid thermal conductivity	0.60000	W/(m·K)
Liquid specific heat	4.1800	kJ/(kg·K)
Viscosity ratio bulk to wall (1 to neglect)	1.0000	
Jacket-side coefficient	6,000.0	W/(m²·K)
Wall thickness	12.000	mm
Wall conductivity (stainless 16)	16.000	W/(m·K)
Total fouling resistance	2.0000e-04	m²·K/W

Calculated results

Parameter	Value	Unit
Impeller Reynolds number	735,000	
Prandtl number	6.9667	
Nusselt number on agitator diameter	9,050.8	
Vessel-side coefficient	7,757.9	W/(m²·K)
Overall coefficient	802.85	W/(m²·K)

Notes for this case

• Designers write Nu = h_v d/k_f = C Re^a Pr^0.33 (μ/μ_w)^0.14 with the agitator diameter d in both Nu and Re = ρNd²/μ (eq. 12.85); other texts use the vessel diameter with different constants, so keep each set with its own definition. The wall is treated as flat.

Formula and method

$$\frac{h_v d}{k_f} = C \left(\frac{\rho N d^2}{\mu}\right)^a \left(\frac{c_p \mu}{k_f}\right)^{0.33} \left(\frac{\mu}{\mu_w}\right)^{0.14}$$

$$\frac{1}{U} = \frac{1}{h_v} + \frac{x_w}{k_w} + \frac{1}{h_j} + R_f$$

Variables

case	Agitator and surface	-
d	Agitator diameter	m

N	Impeller speed	rad/s
ρ	Liquid density	kg/m³
μ	Liquid viscosity	Pa·s
k_f	Liquid thermal conductivity	W/(m·K)
c_p	Liquid specific heat	J/(kg·K)
μ/μ_w	Viscosity ratio bulk to wall (1 to neglect)	-
h_j	Jacket-side coefficient	W/(m²·K)
x_w	Wall thickness	m
k_w	Wall conductivity (stainless 16)	W/(m·K)
R_f	Total fouling resistance	m²·K/W
Re	Impeller Reynolds number	-
Pr	Prandtl number	-
Nu	Nusselt number on agitator diameter	-
h_v	Vessel-side coefficient	W/(m²·K)
U	Overall coefficient	W/(m²·K)

Method and standards

Dimensionless correlation for agitated-vessel wall heat transfer.

Assumptions and limits

- Baffled vessel, turbulent agitation; constants depend on agitator and surface.

Report details

Report reference	FCC-V401-NSV0 (the same inputs always give the same reference)
Generated	23 November 2026, 18:00 UTC
Calculator	Agitated Vessel Inside Film and Overall Coefficient
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/chemical/process-heat-exchangers/agitated-vessel-heat-transfer

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.