Shell-side Coefficient and Pressure Drop by Kern's Method

Shell-side equivalent diameter, cross-flow area, Reynolds number, film coefficient and pressure drop of a baffled shell-and-tube exchanger by Kern's method.

Input parameters

Unit system: SI

Parameter	Value	Unit
Shell inside diameter	0.60000	m
Tube outside diameter	25.000	mm
Tube pitch	31.250	mm
Tube layout	Triangular	
Baffle spacing	0.30000	m
Tube length	4.8800	m
Shell-side flow	72,000	kg/h
Shell fluid density	780.00	kg/m³
Viscosity at the bulk temperature	0.40000	mPa·s
Viscosity at the wall temperature	0.55000	mPa·s
Shell fluid conductivity	0.13000	W/(m·K)
Shell fluid specific heat	2.4700	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Shell-side equivalent diameter	18.073	mm
Clearance between tubes	6.2500	mm
Cross-flow area	0.036000	m²
Shell-side mass velocity	555.56	kg/(m²·s)
Shell-side Reynolds number	25,101	
Shell-side film coefficient	1,280.3	W/(m²·K)
Friction factor	0.25955	
Number of baffles	15.000	
Shell-side pressure drop	28.520	kPa

Notes for this case

- Kern's correlation h_oD_e/k = 0.36 Re^0.55 Pr^1/3 (μ_b/μ_w)^0.14 for 2,000 < Re < 10⁶ with 25 % baffle cut; it ignores leakage and bypass streams, so the Bell–Delaware method is preferred for final design.

Formula and method

$$D_e = \frac{4(P_T^2 - \pi d_o^2/4)}{\pi d_o}\ \text{(square)}, \quad A_s = \frac{D_s C B}{P_T}, \quad Re_s = \frac{G_s D_e}{\mu_b}$$

$$\frac{h_o D_e}{k} = 0.36 Re_s^{0.55} Pr^{1/3} \left(\frac{\mu_b}{\mu_w}\right)^{0.14}, \quad \Delta p_s = \frac{f G_s^2 (N_b + 1) D_s}{2 \rho D_e \phi_s}, \quad f = e^{0.576 - 0.19 \ln Re_s}$$

Variables

D_s	Shell inside diameter	m
d_o	Tube outside diameter	m
P_T	Tube pitch	m
layout	Tube layout	-
B	Baffle spacing	m
L	Tube length	m
$\dot{m}_s$	Shell-side flow	kg/s
ρ	Shell fluid density	kg/m³
μ_b	Viscosity at the bulk temperature	Pa·s
μ_w	Viscosity at the wall temperature	Pa·s
k	Shell fluid conductivity	W/(m·K)
c_p	Shell fluid specific heat	J/(kg·K)
D_e	Shell-side equivalent diameter	m
C	Clearance between tubes	m
A_s	Cross-flow area	m²
G_s	Shell-side mass velocity	kg/(m²·s)
Re_s	Shell-side Reynolds number	-
h_o	Shell-side film coefficient	W/(m²·K)
f	Friction factor	-
N_b	Number of baffles	-
Δp_s	Shell-side pressure drop	Pa

Assumptions and limits

- Segmental baffles with about 25 % cut; no leakage or bypass correction.

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/chemical/process-heat-exchangers/kern-shell-side-method

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Reopens the calculator with the inputs of this report.