Two-Phase Pressure Drop: Lockhart–Martinelli, Chisholm, Friedel, MSH

Two-phase frictional pressure gradient in a pipe by Lockhart–Martinelli, Chisholm's B-coefficient method, Friedel and Müller-Steinhagen–Heck correlations.

Input parameters

Unit system: SI

Parameter	Value	Unit
Total mass flow	7,200.0	kg/h
Pipe inside diameter	50.000	mm
Vapour mass fraction (quality)	10.000	%
Liquid density	739.70	kg/m³
Vapour density	36.500	kg/m³
Liquid viscosity	0.091000	mPa·s
Vapour viscosity	0.018900	mPa·s
Surface tension	17.700	mN/m
Friction factor fit	Exchanger tubing: f = 0.4137 Re^−0.2585	

Calculated results

Parameter	Value	Unit
Total mass flux	1,018.6	kg/(m²·s)
Liquid-alone Reynolds number	503,699	
Liquid-alone pressure gradient	157.80	Pa/m
Lockhart–Martinelli parameter	1.8780	
Lockhart–Martinelli multiplier (C = 20)	11.933	
Lockhart–Martinelli gradient	1,883.0	Pa/m
Gradient for the total flow as liquid	189.58	Pa/m
Chisholm parameter	3.6742	
Chisholm coefficient	1.7308	
Chisholm multiplier	3.8846	
Chisholm gradient	736.45	Pa/m
Friedel multiplier	4.0898	
Friedel gradient	775.35	Pa/m
MSH multiplier	3.3926	
MSH gradient	643.17	Pa/m

Notes for this case

- Separated-flow correlations; the Lockhart–Martinelli line uses X_tt and C = 20 (both phases turbulent). Friedel is valid for horizontal and vertical upflow; the MSH correlation is simplest and performed best in recent comparisons.

Formula and method

$$\phi_L^2 = 1 + \frac{20}{X_{tt}} + \frac{1}{X_{tt}^2}, \quad \phi_{LO,Ch}^2 = 1 + (Y^2 - 1)\left\{B[x(1-x)]^{(2-n)/2} + x^{2-n}\right\}$$

$$\phi_{LO,F}^2 = E + \frac{3.24FH}{Fr^{0.045}We^{0.035}}, \quad \phi_{LO,MSH}^2 = Y^2x^3 + [1 + 2x(Y^2 - 1)](1-x)^{1/3}$$

Variables

$\dot{m}$	Total mass flow	kg/s
D_i	Pipe inside diameter	m
x	Vapour mass fraction (quality)	-
ρ_L	Liquid density	kg/m³
ρ_V	Vapour density	kg/m³
μ_L	Liquid viscosity	Pa·s
μ_V	Vapour viscosity	Pa·s
σ	Surface tension	N/m
$f(Re)$	Friction factor fit	-
G	Total mass flux	kg/(m²·s)
Re_L	Liquid-alone Reynolds number	-
$(\Delta P/L)_L$	Liquid-alone pressure gradient	Pa/m
X_{tt}	Lockhart–Martinelli parameter	-
ϕ_L^2	Lockhart–Martinelli multiplier (C = 20)	-
$(\Delta P/L)_{LM}$	Lockhart–Martinelli gradient	Pa/m
$(\Delta P/L)_{LO}$	Gradient for the total flow as liquid	Pa/m
Y	Chisholm parameter	-
B	Chisholm coefficient	-
ϕ_{LO}^2	Chisholm multiplier	-
$(\Delta P/L)_{Ch}$	Chisholm gradient	Pa/m
$\phi_{LO,F}^2$	Friedel multiplier	-
$(\Delta P/L)_F$	Friedel gradient	Pa/m
$\phi_{LO,MSH}^2$	MSH multiplier	-
$(\Delta P/L)_{MSH}$	MSH gradient	Pa/m

Method and standards

Separated-flow two-phase friction multipliers applied to single-phase gradients from a power-law friction factor.

Assumptions and limits

- Adiabatic frictional gradient at a fixed quality; integrate along the pipe when the quality changes.

Report details

Report reference	FCC-N0SJ-4XK2 (the same inputs always give the same reference)
Generated	23 November 2026, 17:51 UTC
Calculator	Two-Phase Pressure Drop: Lockhart–Martinelli, Chisholm, Friedel, MSH
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

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This calculator online

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