Two-Phase Pressure Drop by the Homogeneous Model

Frictional pressure drop of a gas–liquid flow in a pipe by the homogeneous model with McAdams viscosity and Colebrook friction, and mixture density and velocity.

Method: Homogeneous equilibrium model

Input parameters

Unit system: SI

Parameter	Value	Unit
Total mass flow	18,000	kg/h
Pipe inside diameter	100.00	mm
Vapour (gas) mass quality	10.000	%
Liquid density	900.00	kg/m³
Gas density	5.0000	kg/m³
Liquid viscosity	0.15000	mPa·s
Gas viscosity	0.015000	mPa·s
Pipe roughness	0.045000	mm
Pipe length	50.000	m

Calculated results

Parameter	Value	Unit
Homogeneous mixture density	47.619	kg/m³
Mixture viscosity (McAdams)	0.078947	mPa·s
Mixture velocity	13.369	m/s
Reynolds number	806,385	
Darcy friction factor	0.016980	
Frictional pressure drop	36.129	kPa

Notes for this case

• Homogeneous model: phases move at the same velocity, ρ_m = 1/(x/ρ_g + (1 − x)/ρ_l), 1/μ_m = x/μ_g + (1 − x)/μ_l; Δp = f(L/D)G²/(2ρ_m). Good at high mass flux and for bubbly or mist flow; separated-flow correlations are better for stratified and annular flow. Acceleration and static head are not included.

Formula and method

$$\rho_m = \left(\frac{x}{\rho_g} + \frac{1-x}{\rho_l} \right)^{-1}, \quad \Delta p_f = f \frac{L}{D} \frac{G^2}{2\rho_m}$$

Variables

$\dot{m}$	Total mass flow	kg/s
D	Pipe inside diameter	m
x	Vapour (gas) mass quality	-
ρ_l	Liquid density	kg/m³
ρ_g	Gas density	kg/m³
μ_l	Liquid viscosity	Pa·s
μ_g	Gas viscosity	Pa·s
ε	Pipe roughness	m

L	Pipe length	m
ρ_m	Homogeneous mixture density	kg/m³
μ_m	Mixture viscosity (McAdams)	Pa·s
v_m	Mixture velocity	m/s
Re	Reynolds number	-
f	Darcy friction factor	-
Δp_f	Frictional pressure drop	Pa

Method and standards

Homogeneous model.

Assumptions and limits

- Equal phase velocities; adiabatic; constant quality.

References

Homogeneous equilibrium model

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

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Reopens the calculator with the inputs of this report.