Venturi Scrubber Efficiency and Pressure Drop (Calvert)

Particle collection efficiency of a venturi scrubber by Calvert's equation from throat velocity, liquid-to-gas ratio and factor f, with pressure drop.

Method: Calvert (1977); Chem. Eng. 84(18): 54; Cooper and Alley; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Throat gas velocity	100.00	m/s
Liquid-to-gas ratio	1.0000	L/m³
Particle diameter	1.0000	µm
Particle density	2,000.0	kg/m³
Liquid density	1,000.0	kg/m³
Gas viscosity	0.018500	cP
Calvert empirical factor (0.25 hydrophobic, 0.5 hydrophilic)	0.25000	
Gas temperature	25.000	°C

Calculated results

Parameter	Value	Unit
Cunningham correction	1.1852	
Pressure drop	10.101	kPa
Penetration	6.5900	%
Collection efficiency	93.410	%

Notes for this case

- Calvert's equations in their CGS form (ΔP in cm H_2O, d_p in µm, µ in poise); the calculator converts. Efficiency for a size distribution needs the grade efficiency integrated over it.

Formula and method

$$P_t = \exp\left[-\frac{6.1\times10^{-9}\rho_L\rho_p C_c d_p^2 f^2 \Delta P}{\mu_G^2}\right], \quad \Delta P = 1.03\times10^{-6} v_t^2 \frac{Q_L}{Q_G} \quad (\text{CGS};\ Q_L/Q_G\ \text{L/m}^3)$$

$$C_c = 1 + \frac{6.21\times10^{-4} T}{d_p} \quad (T\ \text{K},\ d_p\ \mu\text{m})$$

Variables

v_t	Throat gas velocity	m/s
Q_L/Q_G	Liquid-to-gas ratio (L/m³)	-
d_p	Particle diameter	m
ρ_p	Particle density	kg/m³
ρ_L	Liquid density	kg/m³
μ_G	Gas viscosity	Pa·s
f	Calvert empirical factor (0.25 hydrophobic, 0.5 hydrophilic)	-
T	Gas temperature	K
C_c	Cunningham correction	-
ΔP	Pressure drop	Pa

P_t	Penetration	-
η	Collection efficiency	-

Method and standards

Calvert's venturi equations.

Assumptions and limits

- Single particle size; Calvert's empirical f.

References

• Calvert (1977)
• Chem. Eng. 84(18): 54; Cooper and Alley
• Air Pollution Control: A Design Approach
• 4th ed. (Waveland, 2011)
• ch. 9 (venturi scrubbers)

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

https://calc.firecad.com/environmental/air-pollution/venturi-scrubber-calvert

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Reopens the calculator with the inputs of this report.