Gas Pipeline Flow: Weymouth, Panhandle, IGT and Others

Gas flow through a pipeline from inlet and outlet pressures by the Weymouth, Panhandle A or B, IGT, Spitzglass, Mueller or Fritzsche equation, with elevation.

Method: Menon; Gas Pipeline Hydraulics (CRC Press, 2005); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow equation	Weymouth	
Inlet pressure (absolute)	7,101.0	kPa
Outlet pressure (absolute)	5,601.0	kPa
Pipe inside diameter	388.00	mm
Pipe length	24.000	km
Inlet elevation	0	m
Outlet elevation	0	m
Gas gravity (air = 1)	0.60000	
Average gas temperature	20.000	°C
Compressibility factor	0.90000	
Pipeline efficiency	95.000	%
Gas viscosity (IGT and Mueller only)	0.011900	cP
Base temperature	15.000	°C
Base pressure	101.33	kPa

Calculated results

Parameter	Value	Unit
Gas flow at base conditions	5,747,142	m^3/d
Average pressure	6,380.5	kPa
Equivalent length for elevation	24.000	km
Gas velocity at the inlet	7.3501	m/s
Gas velocity at the outlet	9.3186	m/s

Notes for this case

- Empirical equations with a pipeline efficiency E in place of roughness; Z is taken at the average pressure (Menon eq. 2.14). Velocities assume Z = 1 at base conditions.

Formula and method

$$Q_b = C\,E\left(\frac{T_b}{P_b}\right)^a \left(\frac{P_1^2 - e^s P_2^2}{G^b T_f L_e Z}\right)^c D^n$$

$$s = 0.0684\,G\frac{H_2 - H_1}{T_f Z}, \quad L_e = L\frac{e^s - 1}{s}, \quad P_{avg} = \frac{2}{3}\left(P_1 + P_2 - \frac{P_1 P_2}{P_1 + P_2}\right)$$

Variables

eq.	Flow equation	-

P_1	Inlet pressure (absolute)	Pa
P_2	Outlet pressure (absolute)	Pa
D	Pipe inside diameter	m
L	Pipe length	m
H_1	Inlet elevation	m
H_2	Outlet elevation	m
G	Gas gravity (air = 1)	-
T_f	Average gas temperature	K
Z	Compressibility factor	-
E	Pipeline efficiency	-
μ	Gas viscosity (IGT and Mueller only)	Pa·s
T_b	Base temperature	K
P_b	Base pressure	Pa
Q_b	Gas flow at base conditions	m^3/s
P_{avg}	Average pressure	Pa
L_e	Equivalent length for elevation	m
u_1	Gas velocity at the inlet	m/s
u_2	Gas velocity at the outlet	m/s

Method and standards

The constants and exponents are those of Menon's SI forms (Q in m^3/day at base conditions, P in kPa, D in mm, L in km, T in K): Weymouth C = 3.7435×10^{-3}, n = 2.667; Panhandle A C = 4.5965×10^{-3}, a = 1.0788, b = 0.8539, c = 0.5394, n = 2.6182; Panhandle B C = 1.002×10^{-2}, a = 1.02, b = 0.961, c = 0.51, n = 2.53; IGT C = 1.2822×10^{-3}, b = 0.8, c = 0.555, n = 2.667 with μ^0.2 (poise) in place of Z; Spitzglass C = 1.0815×10^{-2}, with (1 + 91.44/D + 0.0012D) beside Z; Mueller (b = 0.7391, c = 0.575, n = 2.725, with μ^0.2609 in place of Z) and Fritzsche (b = 0.8587, c = 0.538, n = 2.69, no Z) use Menon's US-unit forms, eqs. 2.69 and 2.71 (C = 85.7368 and 410.1688; SCFD, psia, inch, mile, °R, μ in lb/(ft·s)), because his SI constants for these two do not agree with the US forms (by a factor of about 22 and 1,000). The elevation term e^s is applied to all seven.

Assumptions and limits

- Steady, isothermal flow; constant Z at the average pressure.
- Single slope between inlet and outlet for the elevation correction.

References

• Menon
• Gas Pipeline Hydraulics (CRC Press, 2005)
• ch. 2
• eqs. 2.9–2.14
• 2.29
• 2.54
• 2.56
• 2.60
• 2.64
• 2.68
• 2.69
• 2.71

Report details

Report reference	FCC-DKVE-9M7C (the same inputs always give the same reference)
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Release checks	7 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/oil-gas/gas-pipeline-flow-equations

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Reopens the calculator with the inputs of this report.