Gas Temperature Along a Buried Pipeline

Outlet gas temperature and heat lost to the soil over a buried pipeline length, from the overall heat transfer coefficient, gas flow and specific heat.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas flow at base conditions	5,000,000	m³/d
Gas gravity (air = 1)	0.60000	
Gas specific heat	2.2000	kJ/(kg·K)
Overall heat transfer coefficient to the soil	2.0000	W/(m²·K)
Pipe diameter	400.00	mm
Pipe length	30.000	km
Inlet gas temperature	50.000	°C
Soil temperature	20.000	°C
Base temperature	15.000	°C
Base pressure	101.33	kPa

Calculated results

Parameter	Value	Unit
Gas mass flow	153,124	kg/h
Exponent UπDL/(ṁc_p)	0.80575	
Outlet gas temperature	33.403	°C
Length-average gas temperature	40.599	°C
Heat lost to the soil	1,553.1	kW

Notes for this case

- Heat transfer only: the Joule–Thomson cooling as pressure falls is not included, so a long line can end slightly below the soil temperature. U is based on the pipe diameter D.

Formula and method

$$T_2 = T_s + (T_1 - T_s)e^{-\theta}, \quad \theta = \frac{U\pi DL}{\dot{m}c_p}$$

Variables

Q_b	Gas flow at base conditions	m³/s
G	Gas gravity (air = 1)	-
c_p	Gas specific heat	J/(kg·K)
U	Overall heat transfer coefficient to the soil	W/(m²·K)
D	Pipe diameter	m
L	Pipe length	m
T_1	Inlet gas temperature	K
T_s	Soil temperature	K
T_b	Base temperature	K

P_b	Base pressure	Pa
$\dot{m}$	Gas mass flow	kg/s
θ	Exponent UπDL/(ṁc_p)	-
T_2	Outlet gas temperature	K
$\bar{T}$	Length-average gas temperature	K
H	Heat lost to the soil	W

Method and standards

Steady heat balance on the gas.

Assumptions and limits

- Constant soil temperature and U.

References

- Menon
- Gas Pipeline Hydraulics (CRC Press, 2005)
- ch. 3.11
- eqs. 3.23–3.29

Report details

Report reference	FCC-HNJD-55H2 (the same inputs always give the same reference)
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Release checks	2 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-buried-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.