Van der Waals Equation: Pressure and Compressibility

Pressure of a real gas from temperature and molar volume by the van der Waals equation with a and b from the critical constants, against the ideal gas.

Method: Van der Waals (1873) equation with a and b from the critical point

Input parameters

Unit system: SI

Parameter	Value	Unit
Temperature	26.850	°C
Molar volume	0.50000	L/mol
Critical temperature	30.980	°C
Critical pressure	73.770	bar

Calculated results

Parameter	Value	Unit
a = 27R²T_c²/(64p_c) (Pa·m⁶/mol²)	0.36567	
b = RT_c/(8p_c)	0.042847	L/mol
Pressure	39.936	bar
Ideal gas pressure	49.887	bar
Compressibility pv/RT	0.80053	

Notes for this case

- Van der Waals is qualitative; use Peng–Robinson for design.

Formula and method

$$p = \frac{RT}{v-b} - \frac{a}{v^2}, \quad a = \frac{27R^2T_c^2}{64p_c}, \quad b = \frac{RT_c}{8p_c}$$

Variables

T	Temperature	K
v	Molar volume	m³/mol
T_c	Critical temperature	K
p_c	Critical pressure	Pa
a	a = 27R²T_c²/(64p_c) (Pa·m⁶/mol²)	-
b	b = RT_c/(8p_c)	m³/mol
p	Pressure	Pa
p_{ideal}	Ideal gas pressure	Pa
Z	Compressibility pv/RT	-

Method and standards

Van der Waals.

Assumptions and limits

- Pure gas.

References

- Van der Waals (1873) equation with a and b from the critical point

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/chemical/gas-mixtures/van-der-waals-pressure

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.