Beverage Carbonation: CO_2 Volumes from Pressure and Temperature

Dissolved CO_2 in water at equilibrium as volumes (at 0 °C, 1 atm) and g/L from the CO_2 partial pressure and temperature, with Henry's constant from IAPWS G7-04.

Method: IAPWS G7-04 (2004): Henry's constant of CO_2 in water; Volumes at 0 °C and 101.325 kPa (22.414 L/mol); water density taken as 1 kg/L

Input parameters

Unit system: SI

Parameter	Value	Unit
CO_2 partial pressure (absolute) Absolute: add the atmospheric pressure (about 1.01 bar) to a gauge headspace reading.	3.5000	bar
Temperature	4.0000	°C

Calculated results

Parameter	Value	Unit
Henry's constant	87.812	MPa
Mole fraction of CO_2 in the liquid	3,985.8	ppm
CO_2 volumes (0 °C, 1 atm, per volume of water)	4.9448	
CO_2 concentration	9.7758	g/L

Notes for this case

• IAPWS notes G7-04 is not meant for precise work near ambient temperature; treat results as ±5 %. Water only: sugar and alcohol lower solubility.

Formula and method

$$x = \frac{p_{CO_2}}{k_H(T)}, \quad c = \frac{x}{1-x} \cdot \frac{\rho_w}{M_w} \cdot M_{CO_2}, \quad V_{CO_2} = \frac{c}{\rho_{CO_2,0}}$$

Variables

p_{CO_2}	CO_2 partial pressure (absolute)	Pa
T	Temperature	K
k_H	Henry's constant	Pa
x	Mole fraction of CO_2 in the liquid	-
V_{CO_2}	CO_2 volumes (0 °C, 1 atm, per volume of water)	-
c	CO_2 concentration	kg/m³
ρ_w	Water density, taken as 1 kg/L	kg/m³
$M_w$$, $$M_{CO_2}$	Molar masses of water (18.015) and CO_2 (44.009)	kg/kmol
$\rho_{CO_2,0}$	Density of CO_2 gas at 0 °C and 1 atm, 1.977	kg/m³

Method and standards

Henry's law with IAPWS G7-04.

Assumptions and limits

- Pure water; equilibrium.
- The CO_2 pressure is absolute: a gauge headspace reading needs the atmospheric pressure added (otherwise the volumes are about 1.4 low at 4 °C).
- Volumes are on the real-gas basis the brewing and soft-drink industries use: CO_2 at 0 °C and 1 atm weighs 1.977 g/L (about 22.26 L/mol, against 22.414 for an ideal gas), so 1 volume = 1.977 g/L.

References

- IAPWS G7-04 (2004): Henry's constant of CO_2 in water
- Volumes at 0 °C and 101.325 kPa (22.414 L/mol); water density taken as 1 kg/L

Report details

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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/food-dairy/beverage-co2-volumes

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Reopens the calculator with the inputs of this report.