Alcoholic Strength: % vol ↔ % mass ↔ Mole Fraction (OIML)

Converts alcoholic strength by volume at 20 °C to strength by mass, mole fraction, density at 20 °C and ethanol g/L on the OIML R 22 basis (Tables III and IV).

Method: OIML R 22 (1973); Alcoholometry; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Strength entered as	% mass (by mass)	
Alcoholic strength	40.000	%

Calculated results

Parameter	Value	Unit
Strength by mass	40.000	%
Strength by volume at 20 °C	47.395	%
Density at 20 °C	935.15	kg/m³
Ethanol content	374.06	g/L
Mole fraction of ethanol	20.679	%

Formula and method

$$q = p\,\frac{\rho_{20}(p)}{\rho_{20}(1)}, \quad \rho_{20}(1) \approx 789.24\ \mathrm{kg/m^3}$$

$$c_e = p\,\rho_{20}, \quad x_e = \frac{p/M_e}{p/M_e + (1-p)/M_w}$$

Variables

basis	Strength entered as	-
S	Alcoholic strength	-
p	Strength by mass	-
q	Strength by volume at 20 °C	-
ρ_{20}	Density at 20 °C	kg/m³
c_e	Ethanol content	kg/m³
x_e	Mole fraction of ethanol	-
M_e, M_w	Molar masses of ethanol and water	kg/kmol

Method and standards

R 22 definitions with the R 22 density formula.

Assumptions and limits

- Binary ethanol–water.

References

- OIML R 22 (1973)
- Alcoholometry
- and International Alcoholometric Tables (1975): formula of Wagenbreth and Blanke
- pp. 12–13
- Mole fraction from IUPAC molar masses (ethanol 46.07, water 18.015 kg/kmol)

Report details

Report reference	FCC-7A2C-4NQB (the same inputs always give the same reference)
Generated	17 November 2026, 19:50 UTC
Calculator	Alcoholic Strength: % vol ↔ % mass ↔ Mole Fraction (OIML)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 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/sugar-ethanol/alcoholometry/alcohol-strength-mass-volume-oiml

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.