Ethanol–Water Density by OIML R 22 (−20 to +40 °C)

Density of an ethanol–water mixture from its alcoholic strength by mass or volume and temperature by the OIML R 22 formula, as in Tables I and II.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Strength entered as	% vol (by volume at 20 °C)	
Alcoholic strength	40.000	%
Temperature of the liquid R 22 formula range −20 to +40 °C.	20.000	°C

Calculated results

Parameter	Value	Unit
Strength by mass	33.300	%
Strength by volume at 20 °C	40.000	%
Density at the temperature t	948.05	kg/m³
Density at 20 °C	948.05	kg/m³

Formula and method

$$\rho = A_1 + \sum_{k=2}^{12} A_k p^{k-1} + \sum_{k=1}^{6} B_k (t-20)^k + \sum_{i=1}^{5} \sum_{k=1}^{m_i} C_{i,k}\, p^k (t-20)^i$$

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

Variables

basis	Strength entered as	-
S	Alcoholic strength	-
t	Temperature of the liquid	K
p	Strength by mass	-
q	Strength by volume at 20 °C	-
ρ_t	Density at the temperature t	kg/m³
ρ_{20}	Density at 20 °C	kg/m³
$A_k, B_k, C_{i,k}$	Coefficients of the R 22 formula (p. 13)	-

Method and standards

The OIML R 22 (Wagenbreth–Blanke) polynomial with the published coefficients; strength by volume by the R 22 definition (introduction §4).

Assumptions and limits

- Pure ethanol–water mixtures; other congeners shift the density slightly.
- Below 0 °C weak mixtures freeze. No freezing check is made: the formula returns a density for a mixture that would be frozen, and a note reminds you below 0 °C.
- Temperature on IPTS-68; the difference from ITS-90 is far below the table resolution.

References

• OIML R 22 (1973)
• Alcoholometry

- and International Alcoholometric Tables (1975): formula of Wagenbreth and Blanke
- pp. 12–13

Report details

Report reference	FCC-ZKZJ-6CHG (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/sugar-ethanol/alcoholometry/ethanol-water-density-oiml

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Reopens the calculator with the inputs of this report.