Water Hardness and TDS Conversions (ppm, °dH, °fH, gpg)

Total hardness as $CaCO_3$ from calcium and magnesium, in mg/L, German and French degrees, grains per gallon, mmol/L and meq/L, with TDS from conductivity.

Method: Hardness unit definitions (°dH = 10 mg/L CaO, °fH = 10 mg/L CaCO3, grain = 64.79891 mg); IUPAC 2013 atomic weights

Input parameters

Unit system: SI

Parameter	Value	Unit
Calcium, as Ca	60.000	mg/L
Magnesium, as Mg	20.000	mg/L
Electrical conductivity at 25 °C, µS/cm	600.00	
TDS factor, mg/L per µS/cm Depends on the dissolved salts; calibrate against a gravimetric TDS of your water.	0.65000	

Calculated results

Parameter	Value	Unit
Total hardness, as $CaCO_3$	232.20	mg/L
German degrees	13.010	
French degrees	23.220	
Grains per US gallon, as $CaCO_3$	13.564	
Hardness	2.3200	mmol/L
Hardness, meq/L	4.6399	
Total dissolved solids (estimate)	390.00	mg/L

Formula and method

$$TH = Ca\,\frac{M_{CaCO_3}}{M_{Ca}} + Mg\,\frac{M_{CaCO_3}}{M_{Mg}}$$

$$^\circ dH = \frac{TH}{10\ \text{mg/L}\cdot M_{CaCO_3}/M_{CaO}} \qquad ^\circ fH = \frac{TH}{10\ \text{mg/L}} \qquad gpg = \frac{TH}{\text{grain/US gal}} \qquad c = \frac{TH}{M_{CaCO_3}}\ (\text{mmol/L with } TH \text{ in mg/L and } M \text{ in g/mol}),\quad c_{eq} = 2c \qquad TDS = k\cdot EC$$

Variables

Ca	calcium, as Ca	kg/m³
Mg	magnesium, as Mg	kg/m³
EC	electrical conductivity	µS/cm
k	TDS factor	mg/L per µS/cm
TH	total hardness as $CaCO_3$	kg/m³
$^\circ dH$	German degrees	–
$^\circ fH$	French degrees	–
gpg	grains per US gallon	–
c	hardness in mmol/L	–
c_{eq}	hardness in meq/L, $2c$	–
TDS	total dissolved solids estimate	kg/m³
M	molar masses from IUPAC atomic weights	kg/kmol

Method and standards

Equivalent conversion to $CaCO_3$ with IUPAC 2013 atomic weights; unit definitions of the German and French degrees, the grain

(64.79891 mg) and the US gallon (231 in^3).

Assumptions and limits

- Hardness from calcium and magnesium only; TDS is an estimate from conductivity.
- Conductivity is taken as the value at 25 °C (temperature-compensated). The linear TDS factor suits dilute waters; a note appears above 10 000 µS/cm.

References

- Hardness unit definitions (°dH = 10 mg/L CaO, °fH = 10 mg/L CaCO3, grain = 64.79891 mg)
- IUPAC 2013 atomic weights

Report details

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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/boilers-power-plant/water-treatment/hardness-tds-conversions

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.