Boiler Water pH and Alkalinity from Free Caustic (NaOH)

pH at 25 °C and hydroxide alkalinity as $CaCO_3$ of boiler water from its free caustic (NaOH) content, by ideal dilute-solution equilibrium (pK_w 13.995).

Method: Ideal dilute solution; pK_w = 13.995 at 25 °C (IAPWS R11-07); alkalinity as $CaCO_3$ by equivalents

Input parameters

Unit system: SI

Parameter	Value	Unit
Free caustic as NaOH	4.0000	mg/L

Calculated results

Parameter	Value	Unit
Hydroxide	0.10001	mmol/L
pH at 25 °C	9.9950	
Hydroxide alkalinity as $CaCO_3$	5.0047	mg/L

Notes for this case

- Activity coefficients and other alkalis (phosphate, ammonia) are ignored; at boiler temperature the pH is lower than at 25 °C.

Formula and method

$$[OH^-] = \frac{c_{NaOH}}{M_{NaOH}}, \quad [OH^-]_t = \frac{[OH^-]}{2} + \sqrt{\frac{[OH^-]^2}{4} + K_w}, \quad pH = pK_w + \log_{10}[OH^-]_t$$

Variables

c_{NaOH}	Free caustic as NaOH	kg/m³
$[OH^-]$	Hydroxide	mol/m³
$[OH^-]_t$	Total hydroxide, with water's own ionisation (in mol/L in the formula)	mol/m³
K_w	Ionic product of water, 10^{-pK_w} (mol/L)²	–
pK_w	13.995 at 25 °C	–
pH	pH at 25 °C	-
OH_{CaCO_3}	Hydroxide alkalinity as $CaCO_3$	kg/m³

Method and standards

Ideal equilibrium.

Assumptions and limits

- Dilute; 25 °C.
- In the formulas [OH⁻] is in mol/L: c in kg/m³ divided by M in kg/kmol gives kmol/m³, which is mol/L. The output is shown in mmol/L (= mol/m³).
- pK_w = 13.995 at 25 °C (IAPWS R11-07).
- Water's self-ionisation is included, so very dilute caustic gives a pH that tends to 7.

References

- Ideal dilute solution; pK_w = 13.995 at 25 °C (IAPWS R11-07); alkalinity as $CaCO_3$ by equivalents

Report details

Report reference	FCC-72DJ-Q3NF (the same inputs always give the same reference)
Generated	17 November 2026, 19:51 UTC
Calculator	Boiler Water pH and Alkalinity from Free Caustic (NaOH)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/boilers-power-plant/water-treatment/free-caustic-ph

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.