# 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 | 1.0000 | mg/L |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Hydroxide | 0.025002 | mmol/L |
| pH at 25 °C | 9.3930 | |
| Hydroxide alkalinity as $CaCO_3$ | 1.2512 | 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

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|---|---|
| Report reference | FCC-E072-CVDH (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/boilers-power-plant/water-treatment/free-caustic-ph

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.