Feedwater pH from Ammonia Dose (and Dose for a pH)

pH at 25 °C of pure water dosed with ammonia, the share present as free NH_3, and the ammonia needed for a target feedwater pH, from the ammonium equilibrium.

Method: Emerson et al. (1975); J. Fish. Res. Board Can. 32; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Ammonia in the water, as NH_3	0.50000	mg/L
Target pH at 25 °C	9.3000	

Calculated results

Parameter	Value	Unit
pH at 25 °C from the dose	9.1927	
Share of the ammonia present as free NH_3	46.915	%
Ammonia needed for the target pH, as NH_3	0.72427	mg/L
pKa of ammonium at 25 °C	9.2464	

Notes for this case

- Pure water with ammonia only, at 25 °C; carbon dioxide, other amines and salts change the result. pH is measured on a cooled sample at 25 °C.

Formula and method

$$pK_a = 0.09018 + \frac{2729.92}{T}, \quad T = 298.15\ \mathrm{K}$$

$$[\mathrm{H^+}] + \frac{c\,[\mathrm{H^+}]}{[\mathrm{H^+}] + K_a} = \frac{K_w}{[\mathrm{H^+}]}$$

$$c = \frac{c_{NH_3}}{M_{NH_3}}, \quad f_{NH_3} = \frac{K_a}{[\mathrm{H^+}] + K_a}$$

$$c_{req} = \left(\frac{K_w}{[\mathrm{H^+}]_t} - [\mathrm{H^+}]_t \right) \frac{[\mathrm{H^+}]_t + K_a}{[\mathrm{H^+}]_t}\, M_{NH_3}$$

Variables

c_{NH_3}	Ammonia in the water, as NH_3	kg/m³
pH_t	Target pH at 25 °C	-
pH	pH at 25 °C from the dose	-
f_{NH_3}	Share of the ammonia present as free NH_3	-
c_{req}	Ammonia needed for the target pH, as NH_3	kg/m³
pK_a	pKa of ammonium at 25 °C	-
K_a	Dissociation constant of ammonium	mol/L
K_w	Ionic product of water at 25 °C	(mol/L)²
C	Ammonia concentration	mol/L
M_{NH_3}	Molar mass of ammonia	kg/kmol
$[\mathrm{H^+}]_t$	Hydrogen ion concentration at the target pH	mol/L

Method and standards

The ammonium–ammonia equilibrium constant comes from the Emerson et al. (1975) fit to Bates and Pinching's measurements. The charge balance of pure water with ammonia is solved for the hydrogen ion concentration; the dose for a target pH follows from the same balance in closed form.

Assumptions and limits

- Pure water plus ammonia at 25 °C; ideal solution.
- Kw = 1.0×10^{-14} (the shared water-chemistry value; the 25 °C value is nearer 1.008×10^{-14}, a pH difference of about 0.002–0.004).

References

- Emerson et al. (1975)
- J. Fish. Res. Board Can. 32
- ammonium pKa
- Bates and Pinching (1949)
- ammonium dissociation

Report details

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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/ph-from-ammonia

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.