Nitrification: Oxygen, Alkalinity and Chemical Make-Up

Oxygen used and alkalinity destroyed by nitrifying ammonia (4.57 g O_2 and 7.14 g $CaCO_3$ per g N), the alkalinity left, and the lime or soda needed to keep a minimum.

Method: Metcalf & Eddy; Wastewater Engineering: Treatment and Resource Recovery; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow	10,000	m^3/d
Ammonia nitrogen nitrified	30.000	mg/L
Influent alkalinity (as $CaCO_3$)	200.00	mg/L
Alkalinity to keep (as $CaCO_3$)	70.000	mg/L
Nitrate denitrified (returns alkalinity)	0	mg/L

Calculated results

Parameter	Value	Unit
Oxygen for nitrification	1,371.0	kg/d
Alkalinity consumed (as $CaCO_3$)	214.20	mg/L
Alkalinity remaining	-14.200	mg/L
Hydrated lime $Ca(OH)_2$ to add	623.32	kg/d
Or sodium bicarbonate to add	1,413.4	kg/d

Notes for this case

- Alkalinity remaining is negative: the influent cannot supply this much nitrification; pH would fall and nitrification stall before this point. The chemical dose shown restores the minimum.
- Chemical doses are for 100 % pure $Ca(OH)_2$ or $NaHCO_3$: divide by the purity of the product used.
- Stoichiometric values for complete nitrification; cell synthesis lowers them slightly (Metcalf & Eddy quote 4.25 g O_2 and 7.07 g $CaCO_3$ per g N with growth). Keep 50–80 mg/L alkalinity for stable nitrification.

Formula and method

$$O_2 = 4.57\,\Delta NQ, \quad Alk_c = 7.14\,\Delta NH_4 - N - 3.57\,\Delta NO_3 - N, \quad m_{Ca(OH)_2} = (Alk_{min} - Alk_r)Q\frac{74.09}{100.09}$$

Variables

Q	Flow	m^3/s
$\Delta NH_4 - N$	Ammonia nitrogen nitrified	kg/m^3
Alk	Influent alkalinity (as $CaCO_3$)	kg/m^3
Alk_{min}	Alkalinity to keep (as $CaCO_3$)	kg/m^3
$\Delta NO_3 - N$	Nitrate denitrified (returns alkalinity)	kg/m^3
$\dot{m}_{O_2}$	Oxygen for nitrification	kg/s
Alk_c	Alkalinity consumed (as $CaCO_3$)	kg/m^3
Alk_r	Alkalinity remaining	kg/m^3
$\dot{m}_{lime}$	Hydrated lime $Ca(OH)_2$ to add	kg/s
$\dot{m}_{NaHCO_3}$	Or sodium bicarbonate to add	kg/s

Method and standards

Stoichiometry.

Assumptions and limits

- Complete nitrification.
- Lime and sodium bicarbonate doses are for 100 % pure chemicals; divide by the product purity.

References

• Metcalf & Eddy
• Wastewater Engineering: Treatment and Resource Recovery
• 5th ed. (McGraw-Hill, 2014)
• ch. 7 (nitrification stoichiometry: 4.57 g O_2 and 7.14 g $CaCO_3$ per g NH_4-N; denitrification returns 3.57 g $CaCO_3$ per g NO_3-N)

Report details

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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/environmental/wastewater/nitrification-oxygen-alkalinity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.