Lime and Soda Ash Dose for Softening (Stoichiometry)

Lime and soda ash doses for lime–soda softening from free CO_2, alkalinity, magnesium and hardness by stoichiometry (as $CaCO_3$), with daily quantities.

Method: Lime–soda softening stoichiometry in $CaCO_3$ equivalents: lime = CO_2 + HCO_3^- + Mg^{2+} + excess; soda ash = non-carbonate hardness

Input parameters

Unit system: SI

Parameter	Value	Unit
Free CO_2 (mg/L as CO_2)	15.000	
Bicarbonate alkalinity (mg/L as $CaCO_3$)	200.00	
Magnesium hardness (mg/L as $CaCO_3$)	60.000	
Total hardness (mg/L as $CaCO_3$)	280.00	
Excess lime (mg/L as $CaCO_3$)	35.000	
Lime purity as $Ca(OH)_2$	90.000	%
Soda ash purity	98.000	%
Water flow	2,000.0	m^3/d

Calculated results

Parameter	Value	Unit
Lime as $Ca(OH)_2$ (product, mg/L)	270.71	
Soda ash (product, mg/L)	86.446	
Lime per day	541.42	kg/d
Soda ash per day	172.89	kg/d

Notes for this case

- Non-carbonate hardness = total hardness − alkalinity (when hardness exceeds alkalinity). Jar tests set the final doses.

Formula and method

$$L_{CaCO_3} = CO_2 \frac{100}{44} + Alk + Mg + X, \quad S_{CaCO_3} = TH - Alk$$

Variables

CO_2	Free CO_2 (mg/L as CO_2)	-
Alk	Bicarbonate alkalinity (mg/L as $CaCO_3$)	-
Mg	Magnesium hardness (mg/L as $CaCO_3$)	-
TH	Total hardness (mg/L as $CaCO_3$)	-
X	Excess lime (mg/L as $CaCO_3$)	-
p_L	Lime purity as $Ca(OH)_2$	-
p_S	Soda ash purity	-
$\dot{V}$	Water flow	m^3/s
d_L	Lime as $Ca(OH)_2$ (product, mg/L)	-
d_S	Soda ash (product, mg/L)	-
$\dot{m}_L$	Lime per day	kg/s
$\dot{m}_S$	Soda ash per day	kg/s

Method and standards

Stoichiometry in $CaCO_3$ equivalents.

Assumptions and limits

- Complete reactions. Mg above TH is flagged; with alkalinity above total hardness the lime term still takes the full alkalinity (sodium bicarbonate waters) and the soda ash is zero.
- Molar masses $CaCO_3$ 100.0869, CO_2 44.0095, $Ca(OH)_2$ 74.0927, Na_2CO_3 105.9888 g/mol.

References

• Lime–soda softening stoichiometry in $CaCO_3$ equivalents: lime = CO_2 + HCO_3^- + Mg^{2+} + excess; soda ash = non-carbonate hardness

Report details

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This calculator online

https://calc.firecad.com/environmental/wastewater/lime-softening-dose

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Reopens the calculator with the inputs of this report.