Causticizing: Lime Requirement and Lime Mud

Burnt lime to causticize green liquor Na_2CO_3 (as Na_2O) to a target efficiency, with lime availability and excess, and the $CaCO_3$ lime mud formed.

Method: Smook; Handbook for Pulp & Paper Technologists; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Green liquor flow	100.00	m³/h
Green liquor Na_2CO_3 (as Na_2O)	90.000	g/L
Causticizing efficiency to reach	82.000	%
Lime availability (CaO content)	88.000	%
Lime excess over stoichiometric	3.0000	%

Calculated results

Parameter	Value	Unit
Pure CaO reacted	160.25	t/d
Burnt lime fed	187.57	t/d
$CaCO_3$ formed (part of the lime mud)	286.02	t/d
NaOH formed (as Na_2O)	177.12	t/d
Lime mud solids ($CaCO_3$ + excess CaO + lime inerts)	313.34	t/d

Notes for this case

- Over-liming makes lime mud hard to filter and wastes kiln fuel; keep excess low and slaker temperature steady.

Formula and method

$$\dot{n} = \frac{\dot{V}_{GL}\, c\, CE}{M_{Na_2O}}, \quad \dot{m}_{CaO} = \dot{n} M_{CaO}, \quad \dot{m}_L = \frac{\dot{m}_{CaO}(1+x)}{a}, \quad \dot{m}_{CaCO_3} = \dot{n} M_{CaCO_3}, \quad \dot{m}_{mud} = \dot{m}_{CaCO_3} + x\,\dot{m}_{CaO} + (1-a)\,\dot{m}_L$$

Variables

$\dot{V}_{GL}$	Green liquor flow	m³/s
Na_2CO_3	Green liquor Na_2CO_3 (as Na_2O)	kg/m³
CE	Causticizing efficiency to reach	-
a	Lime availability (CaO content)	-
x	Lime excess over stoichiometric	-
$\dot{m}_{CaO}$	Pure CaO reacted	kg/s
$\dot{m}_L$	Burnt lime fed	kg/s
$\dot{m}_{CaCO_3}$	$CaCO_3$ formed (part of the lime mud)	kg/s
$\dot{m}_{mud}$	Lime mud solids ($CaCO_3$ + excess CaO + lime inerts)	kg/s
$\dot{m}_{NaOH}$	NaOH formed (as Na_2O)	kg/s

Method and standards

Causticizing stoichiometry.

Assumptions and limits

- Green liquor NaOH ignored; complete slaking. In kraft practice the causticizing efficiency is NaOH/(NaOH + Na_2CO_3) including the NaOH already in the green liquor; here it applies to the Na_2CO_3 only, which overstates the lime when the green liquor carries NaOH.
- The lime mud solids add the excess CaO and the lime's inerts to the $CaCO_3$ formed.

References

- Smook
- Handbook for Pulp & Paper Technologists
- 3rd ed. (Angus Wilde, 2002)
- ch. 10 (causticizing: $CaO + H_2O \rightarrow Ca(OH)_2$; $Ca(OH)_2 + Na_2CO_3 \rightarrow 2\ NaOH + CaCO_3$)
- Molar masses from IUPAC atomic masses

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/chemical/pulp-paper/causticizing-lime-requirement

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Reopens the calculator with the inputs of this report.