Lime Kiln: CaO Output, Calcination Heat and Fuel

Burnt lime from lime mud, the calcination heat, and kiln fuel from a specific heat consumption per tonne of CaO, with the CO_2 released by calcination.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Lime mud to the kiln (dry $CaCO_3$)	400.00	t/d
Mud dryness	75.000	%
Kiln heat consumption per tonne CaO	6.5000	MJ/kg
Fuel lower heating value	40.000	MJ/kg

Calculated results

Parameter	Value	Unit
CaO produced	224.12	t/d
CO_2 from calcination	175.88	t/d
Water evaporated from the mud	133.33	t/d
Calcination heat (theoretical)	8.2475	MW
Fuel	36.419	t/d

Notes for this case

- Calcination needs about 3.2 GJ/t CaO in theory; real kilns use 5.5–8 GJ/t because of mud water and exit gas losses.

Formula and method

$$\dot{n} = \frac{\dot{m}_{mud}}{M_{CaCO_3}}, \quad \dot{m}_{CaO} = \dot{n} M_{CaO}, \quad \dot{m}_f = \frac{\dot{m}_{CaO} q}{LHV}$$

Variables

$\dot{m}_{mud}$	Lime mud to the kiln (dry $CaCO_3$)	kg/s
d	Mud dryness	-
q	Kiln heat consumption per tonne CaO	J/kg
LHV	Fuel lower heating value	J/kg
$\dot{m}_{CaO}$	CaO produced	kg/s
$\dot{m}_{CO_2}$	CO_2 from calcination	kg/s
$\dot{m}_w$	Water evaporated from the mud	kg/s
Q_c	Calcination heat (theoretical)	W
$\dot{m}_f$	Fuel	kg/s

Method and standards

Calcination stoichiometry.

Assumptions and limits

- Pure $CaCO_3$ mud: inerts, residual sodium and unreacted CaO in real mud are not counted, so CaO and CO_2 are slightly overstated.
- Fuel = CaO × q / LHV; it does not depend on the mud dryness entered, which only sets the water evaporated.

References

- Smook
- Handbook for Pulp & Paper Technologists

- 3rd ed. (Angus Wilde, 2002)
- ch. 10 (lime kiln: $CaCO_3 \rightarrow CaO + CO_2$)
- Heat of calcination about 178 kJ/mol $CaCO_3$ (standard enthalpy of reaction at 25 °C)

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/lime-kiln-heat

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.