Sorbent Ca/S, Calcination Loss and Sulfation Credit

Ca/S molar ratio of a limestone feed, the heat lost to calcining $CaCO_3$ and $MgCO_3$, and the heat gained by sulfation, as percentages of fuel heat (Basu Eqs. 6.1–6.5).

Method: Basu; Circulating Fluidized Bed Boilers: Design; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Limestone feed	6.0000	t/h
$CaCO_3$ in limestone	90.000	%
$MgCO_3$ in limestone	3.0000	%
Fuel feed	60.000	t/h
Sulphur in fuel (as fired, same basis as the HHV)	2.0000	%
Fuel HHV	20.000	MJ/kg
Sulphur capture	90.000	%

Calculated results

Parameter	Value	Unit
Ca/S molar ratio	1.4415	
Calcination loss ($CaCO_3$ + $MgCO_3$)	0.85099	%
Sulfation credit	1.3627	%
Net loss	-0.51170	%

Notes for this case

- Excess limestone raises the calcination loss and ash; optimise Ca/S against the SO_2 limit.

Formula and method

$$\frac{Ca}{S} = \frac{\dot{m}_{ls} x_{CaCO_3} / M_{CaCO_3}}{\dot{m}_f S / M_S}, \quad L_{calc} = \frac{\dot{m}_{ls}(1830 x_{CaCO_3} + 1833 x_{MgCO_3})}{\dot{m}_f HHV}, \quad G_{sulf} = \frac{E_{sor} S \cdot 15\,141}{HHV}$$

Variables

$\dot{m}_{ls}$	Limestone feed	kg/s
x_{CaCO_3}	$CaCO_3$ in limestone	-
x_{MgCO_3}	$MgCO_3$ in limestone	-
$\dot{m}_f$	Fuel feed	kg/s
S	Sulphur in fuel	-
HHV	Fuel HHV	J/kg
E_{sor}	Sulphur capture	-
Ca/S	Ca/S molar ratio	-
L_{calc}	Calcination loss ($CaCO_3$ + $MgCO_3$)	-
G_{sulf}	Sulfation credit	-
L_{net}	Net loss	-

Method and standards

Basu's Eqs. (6.1)–(6.5) (kJ/kg), with IUPAC molar masses for $CaCO_3$ and S. The net loss is calcination less sulfation; a negative value means the sulfation heat exceeds the calcination heat (a small gain).

Assumptions and limits

- Heats per kg of carbonate and of sulphur as given by Basu.
- The $CaCO_3$ and $MgCO_3$ shares together must not exceed 100 % of the limestone.
- The sensible heat carried away by spent sorbent and extra ash is not included; count it with the ash loss.
- Sulphur as fired, on the same basis as the HHV.

References

• Basu
• Circulating Fluidized Bed Boilers: Design
• Operation and Maintenance (Springer, 2015)
• ch. 6
• Eqs. (6.1)–(6.5): 1 830 and 1 833 kJ/kg for calcining $CaCO_3$ and $MgCO_3$; 15 141 kJ/kg S for sulfation

Report details

Report reference	FCC-TPFH-TSZY (the same inputs always give the same reference)
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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/boilers-power-plant/fluidised-bed/sorbent-calcination-sulfation-heat

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.