Clinker Cooler Heat Recuperation Efficiency

Heat returned to the kiln by secondary and tertiary air as a share of the heat in hot clinker entering a grate cooler, with the heat left in cooled clinker.

Method: Cooler heat balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Clinker temperature into the cooler	1,400.0	°C
Clinker temperature out	110.00	°C
Clinker mean specific heat	1.0500	kJ/(kg·K)
Secondary air per kg clinker	0.35000	Nm³/kg
Secondary air temperature	1,100.0	°C
Tertiary air per kg clinker	0.45000	Nm³/kg
Tertiary air temperature	850.00	°C
Air mean volumetric heat capacity	1.4000	
Reference temperature	20.000	°C

Calculated results

Parameter	Value	Unit
Heat in hot clinker	1,449.0	kJ/kg
Heat recuperated to kiln and calciner	1,052.1	kJ/kg
Heat leaving with clinker	94.500	kJ/kg
Recuperation efficiency	72.609	%
Remainder (vent air and losses)	302.40	kJ/kg

Notes for this case

• η = heat in secondary + tertiary air / heat in clinker entering, relative to T_0. Modern grate coolers recuperate about 70–78 %; the rest leaves in vent air (often used for coal drying or power), cooled clinker and shell losses. c_v,a in kJ/(Nm³·K) is the mean value from T_0 to the air temperature (about 1.38–1.43).

Formula and method

$$\eta_r = \frac{c_{v,a}\left[v_{sa}(T_{sa} - T_0) + v_{ta}(T_{ta} - T_0)\right]}{c_{cl}(T_{cl,in} - T_0)}$$

Variables

$T_{cl,in}$	Clinker temperature into the cooler	K
$T_{cl,out}$	Clinker temperature out	K
c_{cl}	Clinker mean specific heat	J/(kg·K)
v_{sa}	Secondary air per kg clinker	m³/kg
T_{sa}	Secondary air temperature	K
v_{ta}	Tertiary air per kg clinker	m³/kg
T_{ta}	Tertiary air temperature	K
$c_{v,a}$	Air mean volumetric heat capacity	-
T_0	Reference temperature	K

q_{in}	Heat in hot clinker	J/kg
q_r	Heat recuperated to kiln and calciner	J/kg
q_{cl}	Heat leaving with clinker	J/kg
η_r	Recuperation efficiency	-
q_{vent}	Remainder (vent air and losses)	J/kg

Method and standards

Cooler balance.

Assumptions and limits

- Mean heat capacities; steady state.

References

Cooler heat balance

Report details

Report reference	FCC-JFSN-740Q (the same inputs always give the same reference)
Generated	23 November 2026, 17:51 UTC
Calculator	Clinker Cooler Heat Recuperation Efficiency
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 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/chemical/cement/clinker-cooler-recuperation

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Reopens the calculator with the inputs of this report.