Boiler Purge and On-Off Cycling Heat Loss

Heat carried away by the purge air at each burner start of an on–off boiler, and the yearly heat, fuel and cost lost to purging from the number of starts.

Method: NFPA 85 / EN 746-2 purge requirement (air changes before ignition); NIST Shomate air enthalpy (PTC 4 air composition)

Input parameters

Unit system: SI

Parameter	Value	Unit
Purge air flow (normal: 0 °C, 101.325 kPa)	8,000.0	Nm³/h
Purge time per start (pre-purge plus post-purge)	60.000	s
Mean temperature of the air leaving the boiler during purge	200.00	°C
Air temperature at the fan inlet	30.000	°C
Burner starts per day	24.000	
Operating days per year	330.00	
Boiler efficiency (to turn the heat into fuel)	88.000	%
Fuel cost per GJ of fuel heat (your currency)	900.00	

Calculated results

Parameter	Value	Unit
Air mass per purge	172.31	kg
Heat lost per purge	29,671	kJ
Heat lost per year	235.00	GJ
Fuel heat per year to replace it	267.04	GJ
Fuel cost per year	240,337	

Notes for this case

- Dry air with NIST Shomate enthalpy. The leaving temperature falls during a long purge; use the mean you measure. Fewer starts (lower burner turndown limit, modulation) cut this loss.

Formula and method

$$m_a = \dot{V}_N \rho_N t_p$$

$$Q_p = m_a \int_{T_a}^{T_g} c_p \, dT$$

$$Q_y = Q_p \, n \, N_d, \quad Q_F = Q_y / \eta, \quad C_y = Q_F \, c_F$$

Variables

$\dot{V}_N$	Purge air flow at normal conditions (0 °C, 101.325 kPa)	Nm³/s
t_p	Purge time per start (pre-purge plus post-purge)	s
T_g	Mean temperature of the air leaving the boiler during purge	K
T_a	Air temperature at the fan inlet	K
n	Burner starts per day	-
N_d	Operating days per year	-
η	Boiler efficiency (to turn the heat into fuel)	-

c_F	Fuel cost per GJ of fuel heat (your currency)	-
m_a	Air mass per purge	kg
Q_p	Heat lost per purge	J
Q_y	Heat lost per year	J
Q_F	Fuel heat per year to replace it	J
C_y	Fuel cost per year	-
ρ_N	Density of dry air at normal conditions (0 °C, 101.325 kPa)	kg/Nm³
c_p	Specific heat of air	J/(kg·K)

Method and standards

Each start draws a purge volume of fresh air through the furnace and passes, cooling the hot boiler. The heat is the air mass times its enthalpy rise from fan inlet to boiler outlet (NIST Shomate dry-air enthalpy). The yearly loss scales with starts per day and days in service; dividing by efficiency gives the fuel that replaces it. The purge flow and time are inputs: NFPA 85 and EN 746-2 set the purge (air changes before ignition) as applied by the burner maker; this calculator does not compute them.

Assumptions and limits

- Dry air, steady flow during purge. The flow is at normal conditions (0 °C, 101.325 kPa); a US standard flow at 60 °F is about 5.5 % less air for the same number.
- Radiation and standby losses not included.

References

- NFPA 85 / EN 746-2 purge requirement (air changes before ignition)
- NIST Shomate air enthalpy (PTC 4 air composition)

Report details

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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/boilers-power-plant/boilers/boiler-purge-cycling-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.