Fuel Saving from Lower Flue Gas Temperature

Efficiency gain and fuel saved when the boiler exit gas temperature is lowered, from the fuel analysis, excess air and flue gas enthalpies.

Method: ASME PTC 4-2013 §5.14 (dry gas and water vapour losses); NIST Chemistry WebBook Shomate equations

Input parameters

Unit system: SI

Parameter	Value	Unit
Carbon	45.000	%
Hydrogen	3.5000	%
Oxygen	5.0000	%
Nitrogen	1.0000	%
Sulphur	0.50000	%
Ash	35.000	%
Moisture	10.000	%
Excess air	20.000	%
Air humidity (kg water per kg dry air)	0.013000	kg/kg
Gross calorific value of the fuel, as fired	18,600	kJ/kg
Flue gas temperature now	180.00	°C
Flue gas temperature after the improvement Keep it above the acid dew point (acid dew point calculator).	140.00	°C
Boiler efficiency now (on GCV)	78.000	%
Fuel firing rate	12,000	kg/h

Calculated results

Parameter	Value	Unit
Efficiency gain (points)	1.8886	%
Efficiency after	79.889	%
Fuel saved, share of present fuel	2.3640	%
Fuel saved	283.68	kg/h
Wet flue gas per kg of fuel	8.1695	kg/kg

Formula and method

$$\Delta\eta = \frac{m_g\,\left[h_g(T_1) - h_g(T_2)\right]}{GCV} \qquad \eta_2 = \eta_1 + \Delta\eta$$

$$s = 1 - \frac{\eta_1}{\eta_2} \qquad \Delta\dot{m}_f = s\,\dot{m}_f$$

Variables

$C\$, H\$, O\$, N\$, S\$, A\$, M$	ultimate analysis as fired, mass fractions	–
EA	excess air	–
ω	air humidity, kg water per kg dry air	kg/kg
GCV	gross calorific value	J/kg

T_1	flue gas temperature now	K
T_2	flue gas temperature after the improvement	K
η_1	boiler efficiency now, on GCV	–
$\dot{m}_f$	fuel firing rate now	kg/s
$\Delta\eta$	efficiency gain	–
η_2	efficiency after	–
S	fuel saved, share of present fuel	–
$\Delta\dot{m}_f$	fuel saved	kg/s
m_g	wet flue gas per kg of fuel	kg/kg
h_g	enthalpy of the wet flue gas (Shomate integration)	J/kg

Method and standards

Wet flue gas quantity and composition from FireCAD's exact-ratio combustion balance; gas enthalpy by integrating the NIST Shomate heat capacities of CO_2, H_2O, N_2, O_2, Ar and SO_2. The efficiency gain equals the drop in the flue gas loss (dry gas plus water vapour sensible heat), as in ASME PTC 4. Fuel saved for the same output is $1 - \eta_1/\eta_2$.

Assumptions and limits

- Same excess air and fuel before and after; only the exit gas temperature changes.
- No condensation of water vapour (the gas stays above its water dew point); a warning appears below it.
- The flue gas quantity is for the excess air entered, not a measured O_2; the GCV is checked against the Channiwala–Parikh estimate of the analysis (warning above 15 %).
- A higher temperature after gives a negative gain, with a note.

References

• ASME PTC 4-2013 §5.14 (dry gas and water vapour losses)
• NIST Chemistry WebBook Shomate equations

Report details

Report reference	FCC-HD0S-BJN3 (the same inputs always give the same reference)
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Calculator	Fuel Saving from Lower Flue Gas Temperature
Method last reviewed	10 November 2026
Software release	FireCAD Calc, release of 17 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/boilers-power-plant/boilers/flue-gas-temperature-saving

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.