Fuel Saving from Reducing Excess Air (O_2)

Efficiency gain and fuel saved by lowering the flue gas O_2 (excess air), from the fuel analysis, the gas and air temperatures and the present efficiency.

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
O_2 in dry flue gas now	6.0000	%
O_2 in dry flue gas after tuning Keep it where CO stays low; the burner maker or a combustion test sets the floor.	4.0000	%
Carbon	45.000	%
Hydrogen	3.5000	%
Oxygen	5.0000	%
Nitrogen	1.0000	%
Sulphur	0.50000	%
Ash	35.000	%
Moisture	10.000	%
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 at the boiler exit	160.00	°C
Combustion air temperature	30.000	°C
Boiler efficiency now (on GCV)	76.000	%
Fuel firing rate	12,000	kg/h

Calculated results

Parameter	Value	Unit
Fuel saved, share of present fuel	0.93392	%
Fuel saved	112.07	kg/h
Efficiency after	76.716	%
Excess air now	38.863	%
Excess air after	22.852	%
Sensible flue gas loss now	6.8861	%
Sensible flue gas loss after	6.1696	%

Formula and method

$$n_{a,0} = \frac{1}{0.2095}\left(\frac{C}{12.011} + \frac{H}{4.032} + \frac{S}{32.06} - \frac{O}{31.998}\right), \quad n_{dg,0} = \frac{C}{12.011} + \frac{S}{32.06} + \frac{N}{28.014} + 0.7905\, n_{a,0}$$

$$EA = \frac{O_2\, n_{dg,0}}{n_{a,0}\,(0.2095 - O_2)} \qquad L = \frac{m_g(EA)\,\left[h_g(T_g) - h_g(T_a)\right]}{GCV}$$

$$\eta_2 = \eta_1 + L_1 - L_2 \qquad s = 1 - \frac{\eta_1}{\eta_2} \qquad \Delta\dot{m}_f = s\,\dot{m}_f$$

Variables

$O_{2,1}$	O_2 in dry flue gas now	–
$O_{2,2}$	O_2 in dry flue gas after tuning	–
$C\$, H\$, O\$, N\$, S\$, A\$, M$	ultimate analysis as fired, mass fractions	–
ω	air humidity, kg water per kg dry air	kg/kg
GCV	gross calorific value	J/kg
T_g	flue gas temperature at the boiler exit	K
T_a	combustion air temperature	K
η_1	boiler efficiency now, on GCV	–
$\dot{m}_f$	fuel firing rate now	kg/s
s	fuel saved, share of present fuel	–
$\Delta\dot{m}_f$	fuel saved	kg/s
η_2	efficiency after	–
EA_1	excess air now	–
EA_2	excess air after	–
L_1	stack loss now	–
L_2	stack loss after	–
$EA\$, \$O_2$	excess air and dry O_2 in general	–
$n_{a,0}$	theoretical dry air per kg fuel	kmol/kg
$n_{dg,0}$	dry flue gas per kg fuel at zero excess air	kmol/kg
m_g	wet flue gas per kg fuel	kg/kg
h_g	enthalpy of the wet flue gas	J/kg

Method and standards

Excess air from the dry O_2 by an exact oxygen balance of the fuel analysis. Stack loss (dry gas plus water vapour sensible heat between the air and gas temperatures) from FireCAD's combustion balance and NIST Shomate enthalpies, as in the ASME PTC 4 losses. The CO loss is not included: keep O_2 above the point where CO rises.

Assumptions and limits

- Exit gas and air temperatures unchanged; complete combustion at both O_2 levels.
- Water vapour leaves as vapour (no condensation).
- Dry-basis analyser and complete combustion: CO, unburned carbon and air in-leakage are not modelled. The fuel enters at the air temperature (no separate fuel sensible heat).
- If the O_2 after is higher than now, the result is an extra fuel use (negative saving), with a note.
- The flue gas losses shown are sensible heat only. The latent heat of the water from hydrogen and moisture does not change with excess air, so it cancels in the saving but is not part of the loss figures.

References

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

Report details

Report reference	FCC-MF18-01NY (the same inputs always give the same reference)
Generated	17 November 2026, 19:36 UTC
Calculator	Fuel Saving from Reducing Excess Air (O_2)
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/combustion/excess-air-fuel-saving

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.