Oxygen Enrichment of Combustion Air: Available Heat and Fuel Saving

Available heat of a furnace with air and with oxygen-enriched oxidant from flue gas mass and exit temperature, the fuel saving and the oxygen needed per kg of fuel.

Method: Available heat with nitrogen ballast

Input parameters

Unit system: SI

Parameter	Value	Unit
Fuel lower heating value	50.000	MJ/kg
Stoichiometric air per kg fuel	17.200	kg/kg
Oxidant excess ratio	1.1000	
Flue gas exit temperature	1,200.0	°C
Mean flue gas specific heat	1.2500	kJ/(kg·K)
Reference temperature	25.000	°C
Oxygen in the enriched oxidant (volume)	30.000	%

Calculated results

Parameter	Value	Unit
Available heat with air	41.485	%
Available heat enriched	57.785	%
Fuel saving	28.209	%
Oxidant per kg fuel (enriched)	13.371	kg/kg

Notes for this case

• Available heat = 1 − (flue mass × c_p × (T_f − T₀))/LHV per kg fuel; enrichment removes nitrogen ballast, so less flue gas carries heat away. Savings are largest at high flue temperatures (forging, glass, melting). Oxygen mass in the oxidant is the same; nitrogen with it falls. Flame temperature and NOx rise, and burners must suit enriched oxidant.

Formula and method

$$AH = 1 - \frac{(1 + m_{ox}) c_p (T_f - T_0)}{LHV}, \quad m_{ox} = \frac{\lambda A_{st} w_{O_2,air}}{w_{O_2,ox}}$$

Variables

LHV	Fuel lower heating value	J/kg
A_{st}	Stoichiometric air per kg fuel	kg/kg
λ	Oxidant excess ratio	-
T_f	Flue gas exit temperature	K
c_p	Mean flue gas specific heat	J/(kg·K)
T_0	Reference temperature	K
y_{O_2}	Oxygen in the enriched oxidant (volume)	-
AH_{air}	Available heat with air	-
AH_{enr}	Available heat enriched	-
$\Delta F/F$	Fuel saving	-
m_{ox}	Oxidant per kg fuel (enriched)	kg/kg

Method and standards

Oxygen enrichment.

Assumptions and limits

- Constant mean flue c_p; complete combustion; same exit temperature.

References

Available heat with nitrogen ballast

Report details

Report reference	FCC-RBGT-WBYB (the same inputs always give the same reference)
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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/materials/steelmaking-foundry/oxygen-enrichment-fuel-saving

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.