Air Heater Leakage from O_2 Readings

Air leakage of a regenerative or tubular air heater from the flue gas O_2 before and after it, and the gas outlet temperature corrected for no leakage.

Method: ASME PTC 4.3-2017 Air Heaters (leakage and no-leakage gas temperature)

Input parameters

Unit system: SI

Parameter	Value	Unit
O_2 in dry flue gas entering the air heater	3.5000	%
O_2 in dry flue gas leaving the air heater	5.0000	%
Molar mass of the dry flue gas About 30 kg/kmol for coal and oil.	30.000	kg/kmol
Measured gas temperature leaving the air heater	140.00	°C
Air temperature entering the air heater	30.000	°C
Specific heat of air	1.0100	kJ/(kg·K)
Specific heat of flue gas	1.0500	kJ/(kg·K)
Water vapour in the flue gas entering, by mass Mass share of moisture in the wet gas. Leave 0 to apply the dry-gas leakage ratio directly (the older approximation); 0.05–0.10 is typical for coal.	0	%

Calculated results

Parameter	Value	Unit
Leakage, kg of air per kg of gas entering (approx., dry)	9.0803	%
Leakage, kmol of air per kmol of dry gas entering	9.4044	%
Gas temperature leaving, corrected for no leakage	149.61	°C

Notes for this case

- The no-leakage correction uses the leakage per kg of dry gas; enter the gas moisture to apply it per kg of wet gas (a correction about 5–10 % smaller).

Formula and method

$$L_n = \frac{O_{2,2} - O_{2,1}}{0.2095 - O_{2,2}} \qquad L_m = L_n \frac{M_a}{M_g}$$

$$T_{g,nl} = T_{g,2} + L_m \left(1 - w_g\right) \frac{c_{p,a}}{c_{p,g}} \left(T_{g,2} - T_{a,1}\right)$$

Variables

$O_{2,1}$	O_2 in dry flue gas entering the air heater	–
$O_{2,2}$	O_2 in dry flue gas leaving the air heater	–
M_g	molar mass of dry flue gas	kg/kmol
M_a	molar mass of dry air, 28.96 kg/kmol	kg/kmol
$T_{g,2}$	measured gas temperature leaving	K
$T_{a,1}$	air temperature entering	K
$c_{p,a}$	specific heat of air	J/(kg·K)
$c_{p,g}$	specific heat of flue gas	J/(kg·K)

L_m	leakage, kg of air per kg of dry gas entering	–
w_g	water vapour in the wet flue gas entering, mass fraction	–
L_n	leakage, kmol of air per kmol of dry gas entering	–
$T_{g,nl}$	gas outlet temperature corrected to no leakage	K

Method and standards

Leakage from an oxygen balance on dry flue gas, the approach of ASME PTC 4.3 (Air Heaters), and the gas outlet temperature corrected to no leakage by a mixing balance. The molar leakage is converted to mass with the ratio of the molar masses of dry air and dry flue gas that you enter, rather than a fixed factor.

Assumptions and limits

- All the O_2 rise is air leaking from the air side; no other in-leakage between the probes.
- Mass leakage on a dry basis with a fixed dry gas molar mass. The mixing correction applies per kg of wet gas, so the dry ratio is multiplied by $(1 - w_g)$; with $w_g = 0$ (the default) the correction is the older dry approximation, about 5–10 % too large.

References

ASME PTC 4.3-2017 Air Heaters (leakage and no-leakage gas temperature)

Report details

Report reference	FCC-GJBV-BHE3 (the same inputs always give the same reference)
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Calculator	Air Heater Leakage from O_2 Readings
Method last reviewed	10 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/boilers-power-plant/boiler-auxiliaries/air-heater-leakage

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.