Excess Air from Orsat Flue Gas Analysis (Nitrogen Method)

Excess air and air–fuel ratio factor from a dry flue gas analysis by Orsat (CO_2, O_2, CO, with N_2 by difference), by the nitrogen balance for fuels with little nitrogen.

Method: Nitrogen balance on the dry flue gas (textbook); ASME PTC 4-2013 air composition (20.95 % O_2)

Input parameters

Unit system: SI

Parameter	Value	Unit
Carbon dioxide (dry, by volume)	12.000	%
Oxygen (dry, by volume)	7.0000	%
Carbon monoxide (dry, by volume)	0.50000	%

Calculated results

Parameter	Value	Unit
Nitrogen by difference	80.500	%
Free oxygen corrected for CO (O_2 − CO/2)	6.7500	%
Excess air	46.283	%
Air factor (actual / theoretical air)	1.4628	

Notes for this case

• Nitrogen method: all nitrogen comes from the air (N_2 by difference includes argon). Fuels with much nitrogen, such as some gases, need the fuel nitrogen subtracted first.

Formula and method

$$N_2 = 1 - CO_2 - O_2 - CO$$

$$EA = \frac{O_2 - CO/2}{k\,N_2 - (O_2 - CO/2)}, \quad k = \frac{0.2095}{0.7905}$$

$$\lambda = 1 + EA$$

Variables

CO_2	Carbon dioxide (dry, by volume)	-
O_2	Oxygen (dry, by volume)	-
CO	Carbon monoxide (dry, by volume)	-
N_2	Nitrogen by difference	-
$O_{2,x}$	Free oxygen corrected for CO (O_2 − CO/2)	-
EA	Excess air	-
λ	Air factor (actual / theoretical air)	-

Method and standards

All nitrogen in the dry flue gas came from the air; the oxygen supplied is k N_2, where k is the oxygen-to-atmospheric-nitrogen ratio of air (ASME PTC 4 composition).

Assumptions and limits

- Dry flue gas; fuel nitrogen neglected.
- Argon is counted with the nitrogen.
- Unburnt hydrogen and hydrocarbons are not measured by an Orsat and fall into the nitrogen by difference; SO_2 is absorbed with the CO_2. Both slightly distort the result for fuels high in sulphur or with incomplete combustion.
- An analysis with no CO_2 and no CO is rejected as not a flue gas.

References

- Nitrogen balance on the dry flue gas (textbook)
- ASME PTC 4-2013 air composition (20.95 % O_2)

Report details

Report reference	FCC-N6NS-79BS (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

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Reopens the calculator with the inputs of this report.