Gas Composition: Mass % to Volume %

Converts a gas analysis by mass to volume (mole) fractions and gives the mixture molar mass.

Method: IUPAC 2013 standard atomic weights

Input parameters

Unit system: SI

Parameter	Value	Unit
Oxygen (O2) by mass	23.143	%
Nitrogen (N2) by mass	75.514	%
Carbon dioxide (CO2) by mass	0.060773	%
Water vapour (H2O) by mass	0	%
Sulphur dioxide (SO2) by mass	0	%
Carbon monoxide (CO) by mass	0	%
Hydrogen (H2) by mass	0	%
Argon (Ar) by mass	1.2826	%

Calculated results

Parameter	Value	Unit
Oxygen by volume	20.950	%
Nitrogen by volume	78.080	%
Carbon dioxide by volume	0.040000	%
Water vapour by volume	0	%
Sulphur dioxide by volume	0	%
Carbon monoxide by volume	0	%
Hydrogen by volume	0	%
Argon by volume	0.93000	%
Mixture molar mass	28.966	kg/kmol

Formula and method

$$n_i = \frac{w_i}{M_i} \qquad y_i = \frac{n_i}{\sum_j n_j} \qquad M = \frac{\sum_i w_i}{\sum_i w_i / M_i}$$

Variables

w_i	mass fraction of species *i*: $w_{O_2}, w_{N_2}, w_{CO_2}, w_{H_2O}, w_{SO_2}, w_{CO}, w_{H_2}, w_{Ar}$	–
M_i	molar mass of species *i*	kg/kmol
n_i	moles of species *i* per kilogram of mixture	kmol/kg
y_i	mole (volume) fraction of species *i*: $y_{O_2}, y_{N_2}, y_{CO_2}, y_{H_2O}, y_{SO_2}, y_{CO}, y_{H_2}, y_{Ar}$	–
M	molar mass of the mixture	kg/kmol

Method and standards

Molar masses from IUPAC 2013 conventional atomic weights. Exact for ideal-gas mixtures.

Assumptions and limits

- Ideal gas: mole fraction equals volume fraction.
- Fractions that do not sum to 1 are normalised; the page reports the original sum. With Σw = 1 the molar mass is 1/Σ(w_i/M_i).

- Only O_2, N_2, CO_2, H_2O, SO_2, CO, H_2 and Ar can be entered; hydrocarbons and H_2S of a fuel gas are not covered.

References

- IUPAC 2013 standard atomic weights

Report details

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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/weight-to-volume

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.