Air–Fuel Ratio, Excess Air and Equivalence Ratio

Air–fuel ratio from measured air and fuel flows, compared with the stoichiometric ratio, giving lambda (excess air) and the equivalence ratio.

Method: AFR = ṁ_a/ṁ_f; λ = AFR/AFR_s; φ = 1/λ

Input parameters

Unit system: SI

Parameter	Value	Unit
Air flow	648.00	kg/h
Fuel flow	22.000	kg/h
Stoichiometric air–fuel ratio About 14.5 for diesel, 14.7 for petrol, 17.2 for methane.	14.500	

Calculated results

Parameter	Value	Unit
Air–fuel ratio	29.455	
Lambda AFR/AFR_s	2.0313	
Equivalence ratio 1/λ	0.49228	
Excess air (λ − 1)	103.13	%

Formula and method

$$AFR = \frac{\dot{m}_a}{\dot{m}_f}, \quad \lambda = \frac{AFR}{AFR_s}, \quad \phi = \frac{1}{\lambda}$$

Variables

$\dot{m}_a$	Air flow	kg/s
$\dot{m}_f$	Fuel flow	kg/s
AFR_s	Stoichiometric air–fuel ratio	-
AFR	Air–fuel ratio	-
λ	Lambda AFR/AFR_s	-
ϕ	Equivalence ratio 1/λ	-
EA	Excess air (λ − 1)	-

Method and standards

Definitions.

Assumptions and limits

- Steady running.
- A negative excess air (λ < 1, rich) is the air deficiency; with no air flow φ is not shown.

References

- AFR = ṁ_a/ṁ_f; λ = AFR/AFR_s; φ = 1/λ

Report details

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Release checks	2 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/automotive/engine/engine-air-fuel-ratio

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.