IC Engine Heat Balance Sheet

Heat balance of an engine per unit time: fuel heat, brake power, heat to cooling water, heat in the exhaust and the unaccounted remainder, with each share.

Method: First-law heat balance on the engine

Input parameters

Unit system: SI

Parameter	Value	Unit
Fuel flow	12.500	kg/h
Fuel calorific value (net, NCV)	42.500	MJ/kg
Brake power	50.000	kW
Cooling water flow	1,800.0	kg/h
Cooling water temperature rise	18.000	K
Exhaust gas flow	432.00	kg/h
Exhaust specific heat	1.0500	kJ/(kg·K)
Exhaust temperature	450.00	°C
Ambient (reference) temperature	30.000	°C

Calculated results

Parameter	Value	Unit
Fuel heat	147.57	kW
Heat to cooling water	37.681	kW
Heat in the exhaust	52.920	kW
Unaccounted (radiation and other)	6.9682	kW
Brake power share	33.882	%

Notes for this case

- Cooling water specific heat 4.1868 kJ/(kg·K). Fuel heat on net calorific value: with a gross value the exhaust latent heat falls into the unaccounted term.

Formula and method

$$\dot{Q}_f = \dot{m}_f CV$$

$$\dot{Q}_w = \dot{m}_w c_w \Delta T_w \qquad \dot{Q}_g = \dot{m}_g c_{p,g} (T_g - T_a)$$

$$\dot{Q}_u = \dot{Q}_f - BP - \dot{Q}_w - \dot{Q}_g \qquad x_b = BP / \dot{Q}_f$$

Variables

$\dot{m}_f$	Fuel flow	kg/s
CV	Fuel calorific value, net (NCV)	J/kg
c_w	Cooling water specific heat, 4186.8	J/(kg·K)
BP	Brake power	W
$\dot{m}_w$	Cooling water flow	kg/s
ΔT_w	Cooling water temperature rise	K
$\dot{m}_g$	Exhaust gas flow	kg/s
$c_{p,g}$	Exhaust specific heat	J/(kg·K)

T_g	Exhaust temperature	K
T_a	Ambient (reference) temperature	K
$\dot{Q}_f$	Fuel heat	W
$\dot{Q}_w$	Heat to cooling water	W
$\dot{Q}_g$	Heat in the exhaust	W
$\dot{Q}_u$	Unaccounted (radiation and other)	W
x_b	Brake power share	-

Method and standards

First law.

Assumptions and limits

- Steady test.
- Net calorific value: with a gross value the latent heat of the water vapour in the exhaust ends up in the unaccounted term.
- Exhaust heat measured above the ambient (reference) temperature.

References

- First-law heat balance on the engine

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/ic-engine-heat-balance

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Reopens the calculator with the inputs of this report.