Gas Engine Heat Recovery: Exhaust Steam and Jacket Hot Water

Steam from a gas engine's exhaust (IF97) and hot water from its jacket cooling, with total heat recovered and CHP efficiency from power and fuel input.

Method: Energy balances (definitions); Steam and water properties from IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Engine electrical output	2,000.0	kW
Electrical efficiency (on LHV)	42.000	%
Exhaust flow	11,000	kg/h
Exhaust temperature	430.00	°C
Exhaust leaving the boiler	180.00	°C
Exhaust specific heat	1.1200	kJ/(kg·K)
Jacket and oil cooler heat	1,100.0	kW
Steam pressure (absolute)	9.0000	bar
Feedwater temperature	90.000	°C

Calculated results

Parameter	Value	Unit
Fuel input	4,761.9	kW
Exhaust heat recovered	855.56	kW
Steam from the exhaust	1,285.4	kg/h
Total heat recovered	1,955.6	kW
Overall CHP efficiency	83.067	%

Notes for this case

- Jacket heat is at 80–90 °C: use it for hot water, absorption chilling or boiler feed preheating.
- The exhaust leaves at 180 °C, less than 10 K above the steam saturation temperature (175 °C): an evaporator alone cannot cool it that far, so this needs an economiser section; for an evaporator-only boiler the steam is overstated.

Formula and method

$$Q_f = \frac{P_e}{\eta_e}, \quad Q_{ex} = \dot{m}_g c_p (T_g - T_s), \quad \eta_{CHP} = \frac{P_e + Q_{ex} + Q_j}{Q_f}$$

$$\dot{m}_s = \frac{Q_{ex}}{h_g(p_s) - h_f(T_{fw})}, \quad Q_{th} = Q_{ex} + Q_j$$

Variables

P_e	Engine electrical output	W
η_e	Electrical efficiency	-
$\dot{m}_g$	Exhaust flow	kg/s
T_g	Exhaust temperature	K
T_s	Exhaust leaving the boiler	K

c_p	Exhaust specific heat	J/(kg·K)
Q_j	Jacket and oil cooler heat	W
p_s	Steam pressure (absolute)	Pa
T_{fw}	Feedwater temperature	K
Q_f	Fuel input	W
Q_{ex}	Exhaust heat recovered	W
$\dot{m}_s$	Steam from the exhaust	kg/s
Q_{th}	Total heat recovered	W
η_{CHP}	Overall CHP efficiency	-
$h_g\$, \$h_f$	saturated steam enthalpy at p_s and saturated liquid enthalpy at T_{fw} (IF97)	J/kg

Method and standards

Energy balance on the exhaust and the jacket circuit; steam and feedwater enthalpies from FireCAD's IAPWS-IF97.

Assumptions and limits

- LHV basis throughout (electrical efficiency and fuel input).
- Saturated steam; feedwater enthalpy as saturated liquid at its temperature; no blowdown. Small effects.
- An evaporator alone can cool the exhaust only to about 10 K above the steam saturation temperature; a lower exit needs an economiser section (a warning appears).
- A warning appears when power plus recovered heat exceeds the fuel input.

References

- Energy balances (definitions)
- Steam and water properties from IAPWS-IF97

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/hrsg-waste-heat/engine-exhaust-jacket-recovery

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.