Hydraulic System Heat Load and Oil Cooler Duty

Heat generated in a hydraulic system from input power and efficiency, reservoir heat loss, oil cooler duty and the warm-up rate without cooling.

Method: Energy balance of a hydraulic system (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Pump input power	30.000	kW
Overall system efficiency (useful work/input)	70.000	%
Reservoir heat-losing area	3.0000	m²
Reservoir coefficient to air	12.000	W/(m²·K)
Allowed oil temperature	55.000	°C
Ambient temperature	35.000	°C
Oil density	870.00	kg/m³
Oil specific heat	1.9000	kJ/(kg·K)
Oil volume in the system	400.00	L

Calculated results

Parameter	Value	Unit
Heat generated	9.0000	kW
Heat lost by the reservoir	0.72000	kW
Cooler duty needed	8.2800	kW
Warm-up rate without cooler	0.81670	K/min

Notes for this case

- Every watt not delivered as useful work becomes heat in the oil. Warm-up rate uses the oil ρc_p entered and ignores the steel. Size the cooler at the hottest ambient.

Formula and method

$$Q = P_{in}(1-\eta), \quad Q_r = UA_r(T_{oil} - T_a), \quad Q_c = \max(Q - Q_r,\ 0), \quad \frac{dT}{dt} = \frac{Q}{V\rho_o c_{p,o}}$$

Variables

P_{in}	Pump input power	W
η	Overall system efficiency (useful work/input)	-
A_r	Reservoir heat-losing area	m²
U	Reservoir coefficient to air	W/(m²·K)
T_{oil}	Allowed oil temperature	K
T_a	Ambient temperature	K
ρ_o	Oil density	kg/m³
$c_{p,o}$	Oil specific heat	J/(kg·K)
V	Oil volume in the system	m³
Q	Heat generated	W
Q_r	Heat lost by the reservoir	W
Q_c	Cooler duty needed	W

dT/dt	Warm-up rate without cooler, in K/min	K/min

Method and standards

Energy balance.

Assumptions and limits

- Steady state; the warm-up rate ignores the heat capacity of the steel and is shown in K/min in every unit system.

References

- Energy balance of a hydraulic system (definitions)

Report details

Report reference	FCC-QD1X-9QMZ (the same inputs always give the same reference)
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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/mechanical/hydraulics-pneumatics/hydraulic-heat-generation

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Reopens the calculator with the inputs of this report.