Open Thermal Lab: geothermal heat balance

Estimate the thermal power removed from a hypothetical geothermal water stream as it cools through a heat exchanger. The calculation is illustrative, not a field-performance forecast.

FICTIONAL TEACHING EXAMPLE · NO MEASURED FINDINGS

System boundary and model

For a steady, single-phase liquid stream, use P = m_dot × cp × (Tin − Tout). Mass-flow rate m_dot is in kg/s; the chosen constant cp is 4.18 kJ/(kg·K). Temperature differences have the same numerical value in K and °C. The result is thermal power in kW.

Worked example and sensitivity

At 5 kg/s, Tin = 120 °C and Tout = 50 °C: P = 5 × 4.18 × 70 = 1463 kW. Increasing flow to 5.5 kg/s at the same temperatures gives 1609.3 kW, a 10% increase. This proportional response follows from fixed cp and temperature drop.

Assumptions that matter

Assume sufficient pressure to keep the water liquid throughout. Hold cp and outlet temperature fixed; neglect heat loss, kinetic and potential energy changes. The model does not resolve exchanger capacity, pressure loss, pumping power, phase change or reservoir cooling.

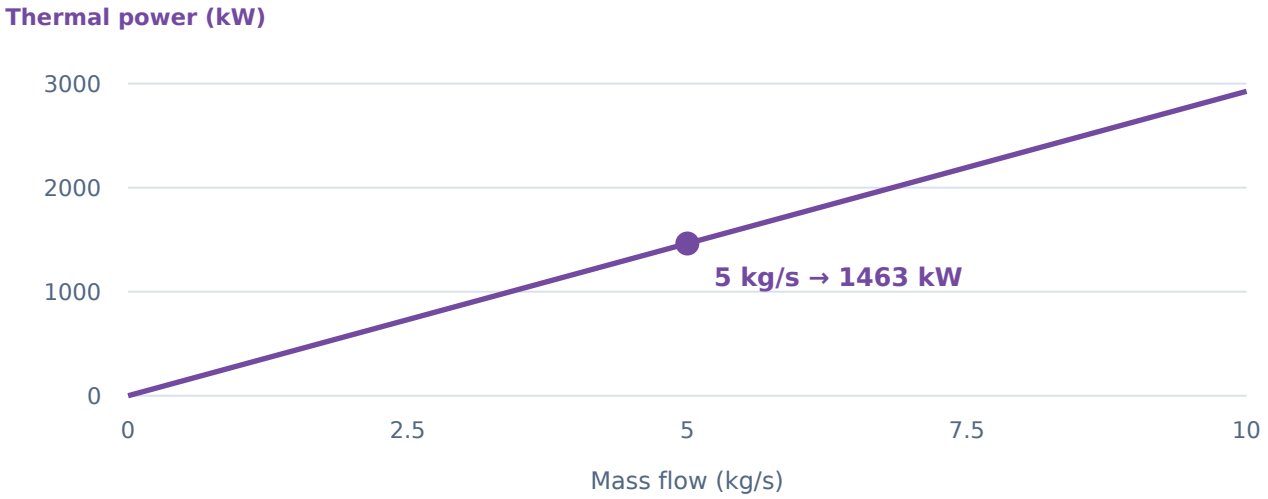
What would validate this model?

Measure inlet/outlet temperature, mass flow, pressure and heat losses; select properties for the actual fluid and conditions. Compare calculated heat with an independent heat balance. Thermal kW is not electrical kW, annual energy or a guarantee of usable plant output.

Data and reproducibility

Thermal power at a fixed 70 K temperature drop

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Values used in the example

Flow (kg/s)	Inlet (°C)	Outlet (°C)	Thermal kW
1	120	50	292.6
2.5	120	50	731.5
5	120	50	1463
5.5	120	50	1609.3
10	120	50	2926

5.5 × 4.18 × (120 - 50) = 1609.3 kW thermal (+10%)

Linear sensitivity follows from the imposed temperatures and constant cp. The outlet is an input, not a prediction of exchanger capacity. Assumes pressure sufficient to retain liquid water.

Background reading · not the source of the example values

U.S. Department of Energy · Geothermal Direct Use

www.energy.gov/hgeo/geothermal/geothermal-direct-use