Reactor Heat Removal and Cooling Water Flow

Heat to remove from an exothermic reactor from the reaction rate, volume, heat of reaction and agitator power, and the cooling water flow (IF97).

Method: Heat generation r V (−ΔH_r) plus agitator power; water enthalpies from IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Reaction rate, mol of key reactant per m³ per second	0.050000	
Reacting volume	10.000	m³
Heat of reaction (negative: exothermic)	-120.00	kJ/mol
Agitator power to the liquid	7.5000	kW
Cooling water in	32.000	°C
Cooling water out	40.000	°C

Calculated results

Parameter	Value	Unit
Heat to remove	67.500	kW
Cooling water flow	7.2696	t/h

Notes for this case

- Water enthalpies at 3 bar(a) (IAPWS-IF97). Size for the peak rate, not the average.

Formula and method

$$\dot{Q} = rV(-\Delta H_r) + P_a, \quad \dot{m} = \frac{\dot{Q}}{h(t_2) - h(t_1)}$$

Variables

r	Reaction rate, mol of key reactant per m³ per second	-
V	Reacting volume	m³
ΔH_r	Heat of reaction (negative: exothermic)	J/mol
P_a	Agitator power to the liquid	W
t_1	Cooling water in	K
t_2	Cooling water out	K
$\dot{Q}$	Heat to remove	W
$\dot{m}$	Cooling water flow	kg/s

Method and standards

Energy balance.

Assumptions and limits

- Steady state.
- The rate r is a plain number in mol of key reactant per m³ per second, and ΔH_r must be per mol of the same key reactant.

References

- Heat generation r V (−ΔH_r) plus agitator power; water enthalpies from IAPWS-IF97

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/chemical/process-heat-exchangers/reactor-cooling-water

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.