Batch Cooling Time with a Jacket or Coil

Time to cool a stirred batch from one temperature to another with coolant of constant inlet temperature through a jacket or coil, from U, area and coolant flow.

Method: Energy balance on a stirred batch with coolant leaving at $t_2 = T - (T - t_1)/K$; K = e^(UA/wc) (Kern, Process Heat Transfer, batch cooling)

Input parameters

Unit system: SI

Parameter	Value	Unit
Batch mass	8,000.0	kg
Batch specific heat	3.2000	kJ/(kg·K)
Batch start temperature	120.00	°C
Batch end temperature	50.000	°C
Coolant inlet temperature	30.000	°C
Coolant flow	14,400	kg/h
Coolant specific heat	4.1800	kJ/(kg·K)
Overall coefficient	400.00	W/(m²·K)
Heat transfer area	15.000	m²

Calculated results

Parameter	Value	Unit
e^(UA/wc)	1.4317	
Cooling time	2.1215	h
Coolant outlet at the start	57.137	°C

Notes for this case

- Well-mixed batch, constant U and coolant flow; agitator heat and reaction heat are ignored.

Formula and method

$$t = \frac{MC_p}{wc} \cdot \frac{K}{K-1} \ln \frac{T_1 - t_1}{T_2 - t_1}, \quad K = e^{UA/(wc)}$$

Variables

M	Batch mass	kg
C_p	Batch specific heat	J/(kg·K)
T_1	Batch start temperature	K
T_2	Batch end temperature	K
t_1	Coolant inlet temperature	K
w	Coolant flow	kg/s
c	Coolant specific heat	J/(kg·K)
U	Overall coefficient	W/(m²·K)
A	Heat transfer area	m²
K	e^(UA/wc)	-
t	Cooling time	s
$t_{2,0}$	Coolant outlet at the start	K

Method and standards

Batch energy balance.

Assumptions and limits

- Constant U, coolant flow and inlet temperature.

References

- Energy balance on a stirred batch with coolant leaving at $t_2 = T - (T - t_1)/K$
- K = e^(UA/wc) (Kern, Process Heat Transfer, batch cooling)

Report details

Report reference	FCC-D41G-456D (the same inputs always give the same reference)
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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/batch-cooling-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.