Bulk Milk Cooling Load and Time

Refrigeration to cool milk in a bulk tank or plate cooler from collection to storage temperature within a set time, with the pre-cooling by well water.

Method: Mass and energy balances (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Milk	5,000.0	kg
Milk specific heat	3.9300	kJ/(kg·K)
Milk in	35.000	°C
Milk after pre-cooling	20.000	°C
Storage temperature	4.0000	°C
Cooling time	3.0000	h

Calculated results

Parameter	Value	Unit
Heat removed by pre-cooling	81.875	kWh
Heat removed by refrigeration	87.333	kWh
Refrigeration capacity for the milk alone (average)	29.111	kW

Notes for this case

- This is the average product load only: add tank and agitator heat gains and a margin to size the compressor.

Formula and method

$$Q_{pc} = Mc_p(T_1 - T_{pc}), \quad Q_r = Mc_p(T_{pc} - T_2), \quad \dot{Q}_r = \frac{Q_r}{t}$$

Variables

M	Milk	kg
c_p	Milk specific heat	J/(kg·K)
T_1	Milk in	K
T_{pc}	Milk after pre-cooling	K
T_2	Storage temperature	K
t	Cooling time	s
Q_{pc}	Heat removed by pre-cooling	J
Q_r	Heat removed by refrigeration	J
$\dot{Q}_r$	Refrigeration capacity	W

Method and standards

Sensible heat balance.

Assumptions and limits

- Uniform cooling of one batch. The capacity is the average product load: tank and agitator gains and a margin are extra. Bulk tanks filled over several milkings, where warm milk is added to cold (blend temperature limits), are not modelled.

References

- Mass and energy balances (definitions)

Report details

Report reference	FCC-RV3B-9YR4 (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/food-dairy/milk-chilling-load

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.