Ice Cream Continuous Freezer Refrigeration Load

Refrigeration load of a continuous ice cream freezer from mix flow, temperatures, water content, ice fraction at draw and dasher heat.

Method: Refrigeration load of continuous ice cream freezing; Tetra Pak; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Mix flow	600.00	kg/h
Mix inlet temperature	4.0000	°C
Initial freezing point of the mix	-2.5000	°C
Draw temperature	-5.5000	°C
Water content of the mix	62.000	%
Share of the water frozen at draw	50.000	%
Specific heat of the unfrozen mix	3.3000	kJ/(kg·K)
Specific heat of the partly frozen mix	2.5000	kJ/(kg·K)
Dasher and friction heat as a share of the product heat	15.000	%

Calculated results

Parameter	Value	Unit
Sensible heat above freezing	21.450	kJ/kg
Latent heat of the ice formed	103.42	kJ/kg
Sensible heat below freezing	7.5000	kJ/kg
Refrigeration load	25.370	kW
Load in tons of refrigeration	7.2139	TR

Notes for this case

• The freezer cools the mix to its initial freezing point, freezes part of its water (about half at a draw temperature of −5 to −6 °C) and cools it further, while the dashers and scraper blades add mechanical heat. The latent heat of the ice formed is the largest part. The rest of the water freezes later in the hardening tunnel, which has its own load.

Formula and method

$$\dot{Q} = \dot{m}\left[c_l(T_{in} - T_{fp}) + x_w f_i L_f + c_f(T_{fp} - T_d)\right](1 + f_d)$$

Variables

$\dot{m}$	Mix flow	kg/s
T_{in}	Mix inlet temperature	K
T_{fp}	Initial freezing point of the mix	K
T_d	Draw temperature	K
x_w	Water content of the mix	-
f_i	Share of the water frozen at draw	-
c_l	Specific heat of the unfrozen mix	J/(kg·K)
c_f	Specific heat of the partly frozen mix	J/(kg·K)
f_d	Dasher and friction heat as a share of the product heat	-
q_s	Sensible heat above freezing	J/kg

q_l	Latent heat of the ice formed	J/kg
q_f	Sensible heat below freezing	J/kg
$\dot{Q}$	Refrigeration load	W
$\dot{Q}_{TR}$	Load in tons of refrigeration	W

Method and standards

Freezer load.

Assumptions and limits

- Steady flow; mean specific heats.

References

Refrigeration load of continuous ice cream freezing, Tetra Pak, Dairy Processing Handbook (Tetra Pak Processing Systems, Lund)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

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Reopens the calculator with the inputs of this report.