Air-Cooled Crystalliser Cooling Curve (Hugot)

Massecuite temperature with time in an air-cooled U-trough crystalliser (Hugot eqns 34.6–34.13), its surface/volume ratio and the time to a target temperature.

Method: Hugot; Handbook of Cane Sugar Engineering; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Massecuite temperature at the start	70.000	°C
Air temperature	30.000	°C
Crystalliser width (diameter)	1.8000	m
Length / width	3.3300	
Heat-transfer coefficient to air	8.1410	W/(m²·K)
Massecuite specific heat	1.8422	kJ/(kg·K)
Massecuite density	1,500.0	kg/m³
Time	24.000	h
Target temperature	45.000	°C

Calculated results

Parameter	Value	Unit
Cooling surface / volume	2.5559	1/m
Massecuite temperature after the time	50.870	°C
Time to the target temperature	36.182	h

Notes for this case

- Hugot's example: 70 °C massecuite in air at 30 °C, D = 1.8 m, m = 3.33 follows T = 30 + 40e^(−0.027t), t in hours.
- The massecuite cools at 1.1 °C/h at the start, faster than the about 1 °C/h Hugot recommends against false grain.

Formula and method

$$\frac{S}{V} = \frac{2(1+2m)}{mD}, \quad T = \theta + (T_0 - \theta)\exp\left(-\frac{k}{d_m c}\frac{S}{V}t\right)$$

Variables

T_0	Massecuite temperature at the start	K
θ	Air temperature	K
D	Crystalliser width (diameter)	m
m	Length / width	-
k	Heat-transfer coefficient to air	W/(m²·K)
c	Massecuite specific heat	J/(kg·K)
d_m	Massecuite density	kg/m³
t	Time	s
T^*	Target temperature	K
S/V	Cooling surface / volume (per m)	1/m
T	Massecuite temperature after the time	K
t^*	Time to the target temperature	s

Method and standards

Hugot's lumped cooling model of a U-trough.

Assumptions and limits

- Well-mixed massecuite; constant coefficient.
- If the target temperature is not between the air and starting temperatures, the time to it is left out with a note; a note also appears when the starting cooling rate exceeds about 1 °C/h.

References

- Hugot
- Handbook of Cane Sugar Engineering
- 3rd ed. (Elsevier, 1986)
- ch. 34
- cooling in air-cooled crystallisers
- eqns 34.6–34.13
- pp. 729–731

Report details

Report reference	FCC-5WXX-ZGP1 (the same inputs always give the same reference)
Generated	17 November 2026, 19:35 UTC
Calculator	Air-Cooled Crystalliser Cooling Curve (Hugot)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/sugar-ethanol/pan-boiling/air-cooled-crystalliser

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.