Massecuite Head and Boiling Temperature in a Pan

Rise of boiling temperature with depth of massecuite in a vacuum pan from the pan pressure, head and density (IF97), with the liquor's boiling-point elevation.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Absolute pressure in the pan	16.000	kPa
Depth of massecuite above the point	1.5000	m
Massecuite density Hugot: about 1.47 hot; 0.15 kg/cm² of head per metre.	1,470.0	kg/m³
Brix of the mother liquor	80.000	%
Barometric pressure	101.33	kPa

Calculated results

Parameter	Value	Unit
Pressure at that depth	37.624	kPa
Water saturation temperature at the surface	55.314	°C
Water saturation temperature at depth	74.392	°C
Rise due to the head	19.078	K
Boiling-point elevation of the liquor	7.9948	K
Boiling temperature at that depth	82.387	°C

Notes for this case

- Hugot keeps massecuite no more than about 1.5 m above the top tube plate with natural circulation: below that depth it hardly boils.
- The elevation e is Hugot's formula for pure sucrose solutions: impure mother liquors of B and C massecuites boil higher, so e is low for them.

Formula and method

$$p_h = p + \rho_m g h, \quad \Delta T_h = T_s(p_h) - T_s(p), \quad T_b = T_s(p_h) + e(B)$$

Variables

p	Absolute pressure in the pan	Pa
h	Depth of massecuite above the point	m
ρ_m	Massecuite density	kg/m³
B	Brix of the mother liquor	-
p_a	Barometric pressure	Pa
p_h	Pressure at that depth	Pa
T_s	Water saturation temperature at the surface	K
T_h	Water saturation temperature at depth	K
ΔT_h	Rise due to the head	K
e	Boiling-point elevation of the liquor	K
T_b	Boiling temperature at that depth	K

Method and standards

Hydrostatics with IF97 and Hugot's boiling-point elevation.

Assumptions and limits

- Liquid column without vapour (conservative).
- The boiling-point elevation is Hugot's formula for pure sucrose solutions, with no purity input: for low-purity mother liquors (B and C massecuites) the true elevation is higher.
- The vacuum in the elevation formula is the barometric pressure entered less the pressure at depth, in cmHg.

References

- Hugot
- Handbook of Cane Sugar Engineering
- 3rd ed. (Elsevier, 1986)
- ch. 33
- hydrostatic pressure in pans
- p. 647
- and boiling-point elevation
- ch. 32
- Saturation temperatures from IAPWS-IF97

Report details

Report reference	FCC-YRBS-SYA1 (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/sugar-ethanol/pan-boiling/pan-hydrostatic-boiling

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.