Juice Heater Outlet Temperature from Surface

Outlet temperature, duty and vapour condensed of a juice heater from surface and coefficient, juice flow and brix (Hugot eqns 30.1 and 30.4, IF97 latent heat).

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Juice flow	100.00	t/h
Juice brix	16.000	%
Heating vapour temperature	92.000	°C
Juice in	30.000	°C
Heat-transfer coefficient	709.43	W/(m²·K)
Heating surface (inside tubes)	150.00	m²

Calculated results

Parameter	Value	Unit
Juice specific heat 1 − 0.006B	3.7849	kJ/(kg·K)
Juice out	69.467	°C
Duty	4,149.4	kW
Vapour condensed	6,559.2	kg/h

Notes for this case

- Hugot's example: 100 t/h juice (pc = 90 000 kcal/h·°C), 150 m², k = 610 kcal/(m²·h·°C) on 92 °C vapour heats juice from 30 to about 70 °C.

Formula and method

$$c = 1 - 0.006B \ [\text{kcal/(kg°C)},\ B \text{ in } \%], \quad t = T - (T - t_0)e^{-kS/(pc)}, \quad \dot{Q} = pc(t - t_0), \quad \dot{m}_v = \frac{\dot{Q}}{h_{fg}(T)}$$

Variables

p	Juice flow	kg/s
B	Juice brix	-
T	Heating vapour temperature	K
t_0	Juice in	K
k	Heat-transfer coefficient	W/(m²·K)
S	Heating surface (inside tubes)	m²
c	Juice specific heat 1 − 0.006B	J/(kg·K)
t	Juice out	K
$\dot{Q}$	Duty	W
$\dot{m}_v$	Vapour condensed	kg/s

Method and standards

Hugot's heater equation for condensing vapour.

Assumptions and limits

- Condensing vapour at constant temperature.
- Hugot's c = 1 − 0.006 B (kcal/(kg·°C), B in %) is a juice approximation; it is converted to J/(kg·K) for the output, and a note appears above 30 brix.

References

- Hugot
- Handbook of Cane Sugar Engineering
- 3rd ed. (Elsevier, 1986)
- ch. 30
- eqns 30.1 and 30.3–30.5 and example
- pp. 449–457
- Latent heat from IAPWS-IF97

Report details

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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/clarification/juice-heater-outlet-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.