Juice Heater Heating Surface (LMTD)

Heating surface of a condensing-steam juice heater from the duty, the overall coefficient and the log-mean temperature difference to steam.

Method: Q = U A ΔT_lm with condensing steam (Incropera); T_sat from IAPWS-IF97; U from Hugot or plant data

Input parameters

Unit system: SI

Parameter	Value	Unit
Heater duty	19,100	kW
Heating steam pressure (absolute)	2.0000	bar
Juice in	35.000	°C
Juice out	103.00	°C
Overall heat-transfer coefficient	1,000.0	W/(m²·K)

Calculated results

Parameter	Value	Unit
Steam saturation temperature	120.21	°C
Log-mean temperature difference	42.512	K
Heating surface	449.29	m²

Notes for this case

- U falls as scale builds: size with a fouled coefficient and clean on a schedule.

Formula and method

$$\Delta T_{lm} = \frac{T_2 - T_1}{\ln \frac{T_s - T_1}{T_s - T_2}}, \quad A = \frac{\dot{Q}}{U \Delta T_{lm}}$$

Variables

$\dot{Q}$	Heater duty	W
p_s	Heating steam pressure (absolute)	Pa
T_1	Juice in	K
T_2	Juice out	K
U	Overall heat-transfer coefficient	W/(m²·K)
T_s	Steam saturation temperature	K
ΔT_{lm}	Log-mean temperature difference	K
A	Heating surface	m²

Method and standards

LMTD with a condensing side.

Assumptions and limits

- Condensing steam at constant temperature.
- U and A must be on the same tube area basis; Hugot uses the inside area of the tubes.
- The steam pressure is absolute: a gauge reading entered as absolute understates T_s by about 20 K at 1 bar(g).

References

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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-surface

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.