Evaporator Calandria: Tubes, Pitch and Diameter

Number of tubes for a heating surface, tube pitch and calandria diameter of a short-tube (Robert) evaporator from Hugot's tube-plate ratios (eqns 32.10–32.15).

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Heating surface (inside of tubes)	1,000.0	m²
Tube outside diameter	45.000	mm
Tube wall	1.5000	mm
Tube length	2.2500	m
Tube-plate ratio, outside tube area / plate Hugot: 0.45–0.55.	50.000	%
Inside tube section / calandria section Hugot: 0.33–0.38 overall, allowing for downtake and rim.	36.000	%
Downtake / calandria diameter Hugot: 1/4 to 1/8.	20.000	%

Calculated results

Parameter	Value	Unit
Number of tubes	3,369.0	
Tube pitch	60.585	mm
Calandria diameter	4.0630	m
Downtake diameter	0.81260	m

Notes for this case

- Ligament between tubes 15.6 mm; Hugot's practice is about one third of the tube diameter.
- Hugot's tube lengths fall along the set (about 4 m in the first vessel to 2.25 m in the last); longer tubes need smaller diameters for the same circulation.

Formula and method

$$N = \frac{S}{\pi d_i L}, \quad p = \frac{0.952\, d_e}{\sqrt{k_e}}, \quad D = \sqrt{\frac{4}{\pi}\frac{N\pi d_i^2/4}{k}}, \quad d_d = r_d D$$

Variables

S	Heating surface (inside of tubes)	m²
d_e	Tube outside diameter	m
e	Tube wall	m
L	Tube length	m
k_e	Tube-plate ratio, outside tube area / plate	-
k	Inside tube section / calandria section	-
r_d	Downtake / calandria diameter	-
N	Number of tubes	-
p	Tube pitch	m
D	Calandria diameter	m
d_d	Downtake diameter	m

Method and standards

Hugot's tube-plate relations.

Assumptions and limits

- Triangular pitch; uniform tube field.
- The pitch (from k_e) and the diameter (from k) come from separate ratios. A note checks that the triangular tube field, $N(\sqrt{3}/2)p^2$, fits in the plate outside the downtake, and gives the ligament p − d_e for comparison with Hugot's one third of the diameter.

References

- Hugot
- Handbook of Cane Sugar Engineering
- 3rd ed. (Elsevier, 1986)
- ch. 32
- construction
- eqns 32.10–32.15
- pp. 504–511

Report details

Report reference	FCC-33H9-TAX7 (the same inputs always give the same reference)
Generated	17 November 2026, 19:49 UTC
Calculator	Evaporator Calandria: Tubes, Pitch and Diameter
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/evaporation/evaporator-calandria-size

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Reopens the calculator with the inputs of this report.