Pan Calandria: Optimum Downtake and Tube Count (Hugot)

Downtake diameter for best circulation in a calandria pan by Hugot's formula (eqns 33.26–33.27), tube count, heating surface and his working volume rule V = 1.9Δ².

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Pan (calandria) diameter	4.0000	m
Tube inside diameter	97.400	mm
Tube pitch	127.00	mm
Share of the plate filled with tubes Hugot: 0.70–0.80.	75.000	%
Tube length	1.0000	m

Calculated results

Parameter	Value	Unit
Tube-plate coefficient k_1k_2	40.007	%
Optimum downtake / pan diameter	27.201	%
Practical ratio m + (1 − m)/10	34.481	%
Downtake diameter	1.3792	m
Number of tubes	594.00	
Heating surface	181.76	m²
Working volume 1.9Δ² (Δ in m)	30.400	m³
Surface / volume (m²/m³)	5.9789	

Notes for this case

- Hugot's Table 33.4 check: k = 0.5 and d/Δ = 0.03 give m ≈ 0.30. He adds a tenth of (1 − m) for scale and the cone of the bottom.
- The pitch is checked against the inside diameter only: make sure it also leaves a sound ligament over the tube outside diameter.

Formula and method

$$k = \frac{\pi}{2\sqrt{3}}\frac{d^2}{p_t^2}k_2, \quad m = \sqrt[3]{p\sqrt{2k}} - \frac{p\sqrt{2k}}{3} \ (p = d/\Delta), \quad M' = m + \frac{1-m}{10}$$

$$n = \frac{k(1-M'^2)}{p^2}, \quad S = n\pi d\ell, \quad V = 1.9\Delta^2$$

Variables

Δ	Pan (calandria) diameter	m
d	Tube inside diameter	m
p_t	Tube pitch	m
k_2	Share of the plate filled with tubes	-
ℓ	Tube length	m
k	Tube-plate coefficient k_1k_2	-
m	Optimum downtake / pan diameter	-
M'	Practical ratio m + (1 − m)/10	-

D	Downtake diameter	m
n	Number of tubes	-
S	Heating surface	m²
V	Working volume 1.9Δ² (Δ in m)	m³
S/V	Surface / volume (m²/m³)	1/m

Method and standards

Hugot's analysis of natural circulation in pans.

Assumptions and limits

- Natural circulation; vertical tubes.
- The pitch is checked only against the inside diameter; check the ligament over the outside diameter separately.
- V = 1.9Δ² is dimensional: Δ in metres gives V in m³. S/V is in m²/m³ and shown as a plain number.

References

- Hugot
- Handbook of Cane Sugar Engineering
- 3rd ed. (Elsevier, 1986)
- ch. 33
- eqns 33.6–33.15 and 33.24–33.27
- pp. 640–653

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/pan-boiling/pan-calandria-downtake

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.