Critical Heat Flux for a Fire-Tube Boiler Tube Bundle

Critical heat flux of a fire-tube boiler tube bundle: Mostinski pool value corrected by a bundle factor from bundle diameter, tube length and area.

Method: Ganapathy; Industrial Boilers and Heat Recovery Steam Generators (Marcel Dekker, 2003); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Steam pressure (absolute)	27.579	bar
Number of tubes	590.00	
Tube outside diameter	50.800	mm
Tube length	8.9916	m
Bundle diameter	1,981.2	mm
Share of the corrected value allowed in design	75.000	%

Calculated results

Parameter	Value	Unit
Bundle surface area	846.65	m²
Bundle factor D_bL/A	0.021041	
Bundle correction factor	0.15077	
Pool boiling critical heat flux (Mostinski)	3,471.7	kW/m²
Bundle critical heat flux	523.44	kW/m²
Allowable design flux	392.58	kW/m²

Notes for this case

• Vapour from the lower tubes blankets the upper ones, so a bundle reaches its limit at a fraction of the single-tube pool value; designers use 70–80 % of the bundle value (Ganapathy).

Formula and method

$$C = \frac{D_b L}{A}, \quad \log F = 0.8452 + 0.994 \log C, \quad F \leq 1, \quad q_{c,bundle} = F q_{c,pool}, \quad q_{c,pool} = 803\, p_c \left(\frac{p}{p_c}\right)^{0.35} \left(1 - \frac{p}{p_c}\right)^{0.9}$$

Variables

p	Steam pressure (absolute)	Pa
N	Number of tubes	-
d_o	Tube outside diameter	m
L	Tube length	m
D_b	Bundle diameter	m
a	Share of the corrected value allowed in design	-
A	Bundle surface area	m²
C	Bundle factor D_bL/A	-
F	Bundle correction factor	-
$q_{c,pool}$	Pool boiling critical heat flux (Mostinski)	W/m²
$q_{c,bundle}$	Bundle critical heat flux	W/m²
q_{allow}	Allowable design flux	W/m²

Method and standards

Mostinski with Ganapathy's bundle factor.

Assumptions and limits

- Pool boiling of water outside horizontal tubes.
- The bundle factor F is capped at 1.
- US-unit correlation converted: p_c = 22.064 MPa = 3 200.1 psia, q in Btu/(ft²·h) × 3.154591 = W/m².

References

• Ganapathy
• Industrial Boilers and Heat Recovery Steam Generators (Marcel Dekker, 2003)
• Q8.47b–c (Mostinski pool boiling CHF and the bundle correction log F = 0.8452 + 0.994 log C)

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/mechanical/heat-transfer/fire-tube-bundle-critical-heat-flux

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.