Fluid-Elastic Instability Critical Velocity (Connors)

Critical gap velocity for fluid-elastic instability of a tube array by Connors' equation, from natural frequency, mass, damping and fluid density.

Method: Connors (1970) v_c/(f_n d) = K [m δ/(ρ d²)]^½ (Blevins, Flow-Induced Vibration); K by array pattern (user input)

Input parameters

Unit system: SI

Parameter	Value	Unit
Tube natural frequency	60.000	Hz
Tube outside diameter	50.800	mm
Mass per metre (with added mass)	4.0000	kg/m
Damping ratio	1.0000	%
Fluid density	0.60000	kg/m³
Connors constant	3.3000	
Actual gap velocity	12.000	m/s

Calculated results

Parameter	Value	Unit
Log decrement 2πζ	0.062832	
Critical gap velocity	128.15	m/s
Velocity ratio	9.3642	%

Formula and method

$$v_c = K f_n d \sqrt{\frac{m\,\delta}{\rho d^2}}, \quad \delta = 2\pi\zeta$$

Variables

f_n	Tube natural frequency	1/s
d	Tube outside diameter	m
m	Mass per metre (with added mass)	kg/m
ζ	Damping ratio	-
ρ	Fluid density	kg/m³
K	Connors constant	-
v_g	Actual gap velocity	m/s
δ	Log decrement 2πζ	-
v_c	Critical gap velocity	m/s
v_g/v_c	Velocity ratio	-

Method and standards

Connors' equation for the critical gap velocity of fluid-elastic instability (Connors 1970, as given by Blevins), with the log decrement $\delta = 2\pi\zeta$. The constant K depends on the array pattern and is your input (about 2.4–4; 3.3 is common for design). A note appears when the gap velocity exceeds half the critical value, a FireCAD screening margin; at or above the critical value instability is predicted.

Assumptions and limits

- Uniform cross-flow; the mass per metre must include the added mass of the fluid and the tube contents.

References

• Connors (1970) v_c/(f_n d) = K [m δ/(ρ d²)]^½ (Blevins, Flow-Induced Vibration); K by array pattern (user input)

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/boilers-power-plant/boiler-pressure-parts/fluid-elastic-instability-connors

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Reopens the calculator with the inputs of this report.