Pipe Span Natural Frequency

First natural frequency of a pipe span from its size, wall, contents and insulation, for simply supported or fixed ends, to check against vibration.

Method: Euler–Bernoulli beam natural frequency with standard end constants

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter	168.30	mm
Wall thickness	7.1100	mm
Span length	6.0000	m
Elastic modulus	200.00	GPa
Pipe material density	7,850.0	kg/m³
Contents density	1,000.0	kg/m³
Insulation and cladding mass per metre	8.0000	kg/m
End condition	Simply supported (π²)	

Calculated results

Parameter	Value	Unit
Second moment of area	1,171.6	cm⁴
Mass per metre	54.909	kg/m
First natural frequency	9.0137	Hz
Span for a 4 Hz first frequency	9.0068	m

Notes for this case

• A pipe span vibrates like a beam: $f_1 = (\lambda^2/2\pi L^2)\sqrt{(EI/m)}$, with $\lambda^2 = \pi^2$ for simply supported ends, 22.37 for fixed ends and 15.42 for one fixed and one pinned. The mass includes the pipe, its contents and insulation. Keeping the first frequency well away from pump, compressor and flow-induced excitation (commonly above 4 Hz, and away from running speeds) avoids resonance; shorter spans raise it with the square of the length.

Formula and method

$$f_1 = \frac{\lambda^2}{2\pi L^2}\sqrt{\frac{EI}{m}}, \quad \lambda^2 = \pi^2,\ 15.42,\ 22.37$$

Variables

D	Pipe outside diameter	m
t	Wall thickness	m
L	Span length	m
E	Elastic modulus	Pa
ρ_s	Pipe material density	kg/m³
ρ_f	Contents density	kg/m³
m_i	Insulation and cladding mass per metre	kg/m
ends	End condition	-
I	Second moment of area	m⁴
m	Mass per metre	kg/m
f_n	First natural frequency	1/s

L_{4Hz}	Span for a 4 Hz first frequency	m

Method and standards

Pipe span frequency.

Assumptions and limits

- Uniform straight span; supports rigid vertically.

References

Euler–Bernoulli beam natural frequency with standard end constants

Report details

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Release checks	3 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/piping/pipe-span-natural-frequency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.