Bellows Expansion Joint Pressure Thrust and Anchor Load

Effective area and pressure thrust of an unrestrained bellows expansion joint, its spring force for a displacement and the total main anchor load.

Method: Pressure thrust of unrestrained bellows; Expansion Joint Manufacturers Association; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Design pressure (gauge)	10.000	bar
Bellows inside diameter (corrugation root)	310.00	mm
Bellows outside diameter (corrugation crest)	370.00	mm
Axial spring rate	600.00	N/mm
Axial movement taken up	25.000	mm

Calculated results

Parameter	Value	Unit
Mean diameter	340.00	mm
Effective area	907.92	cm²
Pressure thrust	90.792	kN
Spring force	15.000	kN
Main anchor load	105.79	kN

Notes for this case

• An unrestrained bellows cannot carry the pressure end load of the pipe, so the pressure acting on its effective area, about the area of the mean corrugation diameter, must be taken by main anchors: F_p = p·πD_m²/4. Add the bellows spring force k_a·x for the movement absorbed (and friction of guides, not included). The thrust can be many times the pipe's weight, which is why tied, hinged or pressure-balanced joints are used where anchors are impractical. Use the maker's effective area where available.

Formula and method

$$A_e = \frac{\pi}{4}\left(\frac{D_i + D_o}{2}\right)^2, \quad F_a = pA_e + k_a x$$

Variables

p	Design pressure (gauge)	Pa
D_i	Bellows inside diameter (corrugation root)	m
D_o	Bellows outside diameter (corrugation crest)	m
k_a	Axial spring rate	N/m
x	Axial movement taken up	m
D_m	Mean diameter	m
A_e	Effective area	m²
F_p	Pressure thrust	N
F_s	Spring force	N
F_a	Main anchor load	N

Method and standards

Bellows thrust.

Assumptions and limits

- Unrestrained axial bellows; static pressure; guides frictionless.

References

Pressure thrust of unrestrained bellows, Expansion Joint Manufacturers Association, Standards of the EJMA, 10th ed. (method: effective area from mean diameter)

Report details

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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/bellows-pressure-thrust

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Reopens the calculator with the inputs of this report.