



Bellows



Electroforms



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12 Key Factors in Designing a Bellows

The following items are 12 key ingredients in defining a custom bellows. Each must be specified before the design can be established. Be advised that the information provided here is only a guide, not an exhaustive design manual.

[Contact Servometer engineering for a review of your requirements prior to finalizing your design.](#)

1. Stress Modes. Specify extension, compression, bending, swiveling, parallel-end offset, torque, and speed of rotation. Provide a drawing or sketch showing extremes of flexing where possible.

2. Quantify Flexing. Specify the maximum amount of stroke (axial compression or extension) and offset in inches, or bend angle in degrees, or by dimensions on a diagram.

$$S_{comp} = \frac{.001(O-I-t)^2 N}{t} \text{ [in.]} \quad S_{ext} = .75S_{comp}$$

$$Offset = 0.25 \frac{N^2 ns}{O} \text{ [in.]}$$

$$Angle_{bend} = 71.6 \frac{Ns}{O} \text{ [degrees]}$$

3. Pressure Differential. Specify pressure difference between the inside and outside of the bellows, maximum instantaneous pressure, and whether higher pressure is applied inside or outside the bellows.

$$P = \frac{1.25 \times 10^6 t^2}{(O-I-t)} \text{ [psi]}$$

$$P_{proof} = 1.75 P$$

$$P_{burst} = 2.50 P$$

4. Rigid Stops. Specify whether rigid stops will limit the extension or compression of the bellows to its rated stroke, or if the bellows will be required to withstand pressure unrestrained. Note that a restrained bellows usually provides better performance.





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5. Spring Rate. Specify the required spring rate in pounds per inch, or conversely, the amount of force available to flex the bellows the desired amount.

$$R = \frac{4.3E(O+I)t^3}{(O-I)^3N} \text{ [lbs./in]}$$

6. Life Cycles. Specify the required useful life of the bellows, expressed as the number of flexing cycles. Define the flexing cycle.

7. Temperature Extremes. Upper and lower extremes of temperature should be indicated.

8. Exposure. Indicate the media to which the internal end external surfaces of the bellows will be exposed. Identify any potentially corrosive conditions or agents.

9. Assembly Method. The method to be used to join the bellows to end fittings, such as soldering, brazing, welding, cementing, should be specified.

10. Vibration. Specify vibration or shock conditions that the bellows will experience.

11. End Configuration. Specify types and lengths of the bellows ends. Refer to the figure, [Types of Bellows Ends](#). "A" ends are most economical. All Servometer [stock bellows](#) have two "A" ends.

12. Geometric Constraints. Specify restrictions on size of bellows, i.e. maximum O.D., minimum I.D., maximum overall length, etc.

O	bellows outside diameter, in. *
I	bellows inside diameter, in. *
t	bellows nominal wall thickness, in.
N	number of active convolutions in the bellows
E	Young's modulus. Ref. 23.35 x 10 ⁶ for Servometer electro-deposited nickel
S	maximum permissible bellows stroke, in.
s	maximum permissible stroke per convolution, in.
n	length of one convolution (pitch), in. *
L	bellows convolution length
P	pressure (differential) rating, psi
A	angle subtended by bellows bent in circular arc, degrees
R	bellows spring rate, #/in.
r	spring rate per convolution, #/in.

* There are limited ranges of tolerable values for the ID/OD ratio and pitch, based upon production factors and bellows performance. [Contact Servometer engineering for details.](#)

