Industrial Gas Springs Inc.

162 S. Pinnacle Drive Romeoville, IL 60446
PH# 815-553-0253 FX# 815-553-0248
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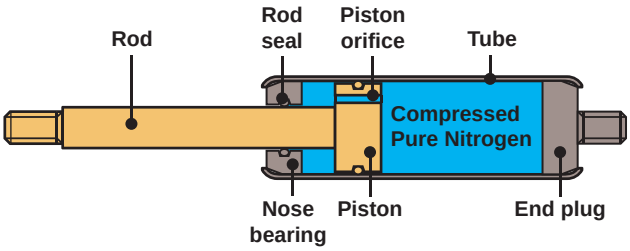
INDUSTRIAL GAS SPRINGS

How do standard gas springs work ?

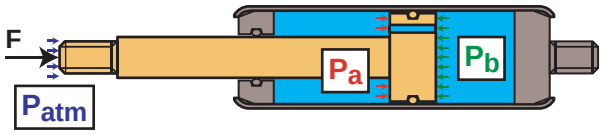


A gas spring is basically a system consisting of a pressure tube, rod and piston. The energy for the spring is provided by gas at high pressure and the whole system is self contained and sealed against loss.

Gas pressure against force

The force F exerted by the spring arises as a result of the out of balance forces acting on the piston which can be calculated as follow:

Where:
F = Force expressed in Newton (N)
P = Gas pressure (N/m^2)
P_a = Gas pressure in chamber a (N/m^2)
P_b = Gas pressure in chamber b (N/m^2)
P_{atm} = External pressure in Pascal (N/m^2)
a = Rod cross section in square metres (m^2)
A = Piston cross section in square metres (m^2)



↳ $F = [P_b \times A] - [P_a \times A] + [P_a \times a] - [P_{atm} \times a]$

on standard gas springs the pressure is the same on both sides of the piston => $P_a = P_b = P$

This equation can be reduced to:

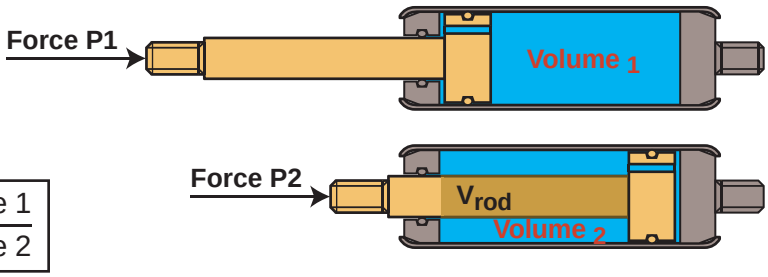
$$F = [P - P_{atm}] \times a$$

Progression "K" Factor

Because the gas spring is a closed system, as the rod is pushed into its body, the gas has nowhere to go and therefore the gas in the spring compresses and the pressure increases.

$$\text{K Factor} = \frac{\text{Force } P_2}{\text{Force } P_1} = \frac{\text{Volume 1}}{\text{Volume 2}}$$

Where:
P1 is the force of a fully extended gas spring
P2 the force of the same spring when compressed



$\text{Volume}_2 = \text{Volume}_1 - V_{rod}$

The importance of Nitrogen

As we will see later, all gas springs need oil to last longer.
One of the disadvantages of a mix of oil and oxygen is that under very high pressure and heat it can create an explosion. Some gas springs can be charged at up to 250 bars (3650 psi). A mix of oxygen, oil and heat at this pressure, can be a major concern for safety.

In order to avoid any danger, a gas spring must always be charged with a neutral gas. Nitrogen (Ni) is a commonly used neutral gas because it is found naturally in the atmosphere in very large quantities. For this reason, it is also the most economical neutral gas.

Under no circumstances you should attempt to regas a spring. This is an extremely hazardous operation.

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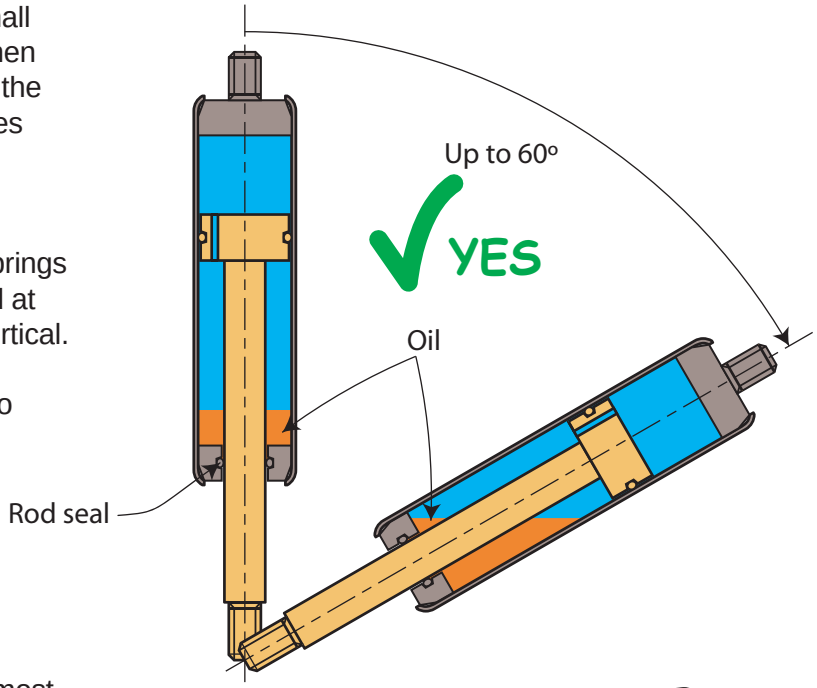
Why should springs be used rod down ?

In order to keep the rod seal lubricated, a small amount of oil is used in every gas spring. When used rod down, the oil is kept in contact with the rod seal which improves the sealing properties and ensure the seal itself will never dry.

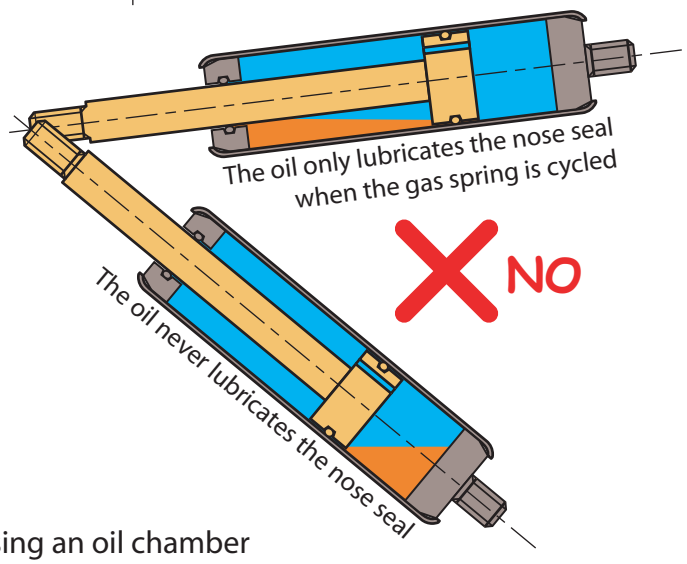
For this reason, one of the basic recommendations when incorporating gas springs in your design, is to make sure they are used at an angle of less than 60 degrees from the vertical.

The oil used in the gas spring is also useful to obtain a high damping effect on the last few millimeters of the stroke.



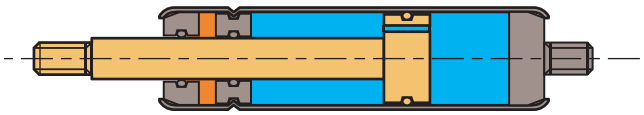
When a standard gas spring is used in an almost horizontal position, the oil lubricates a tiny part of the nose seal. While this may not be a problem on applications which are cycled regularly, when the gas spring is not cycled for a long time, the nose seal dries and allow the gas to escape.

When the gas spring is used with the rod up, the piston is almost never in contact with the oil, which means that regardless of usage, the nose seal will eventually dry and the gas spring loose all its force.
Also, in this position the gas spring may provide damping at the beginning of the extension or at the end of the compression.



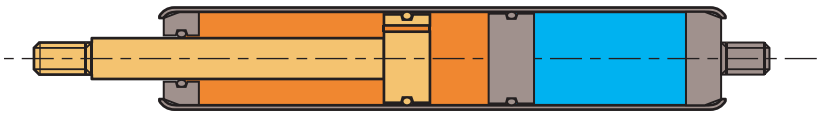
When there is no alternative solution and the gas spring can only be used either rod up or near horizontal, we specify an oil chamber or a fully damped gas spring.

Using an oil chamber



While these solutions are not as economical as standard gas springs, they will ensure your gas springs will last almost as long as standard gas springs used with the rod facing down.

Fulled damped spring using a floating piston



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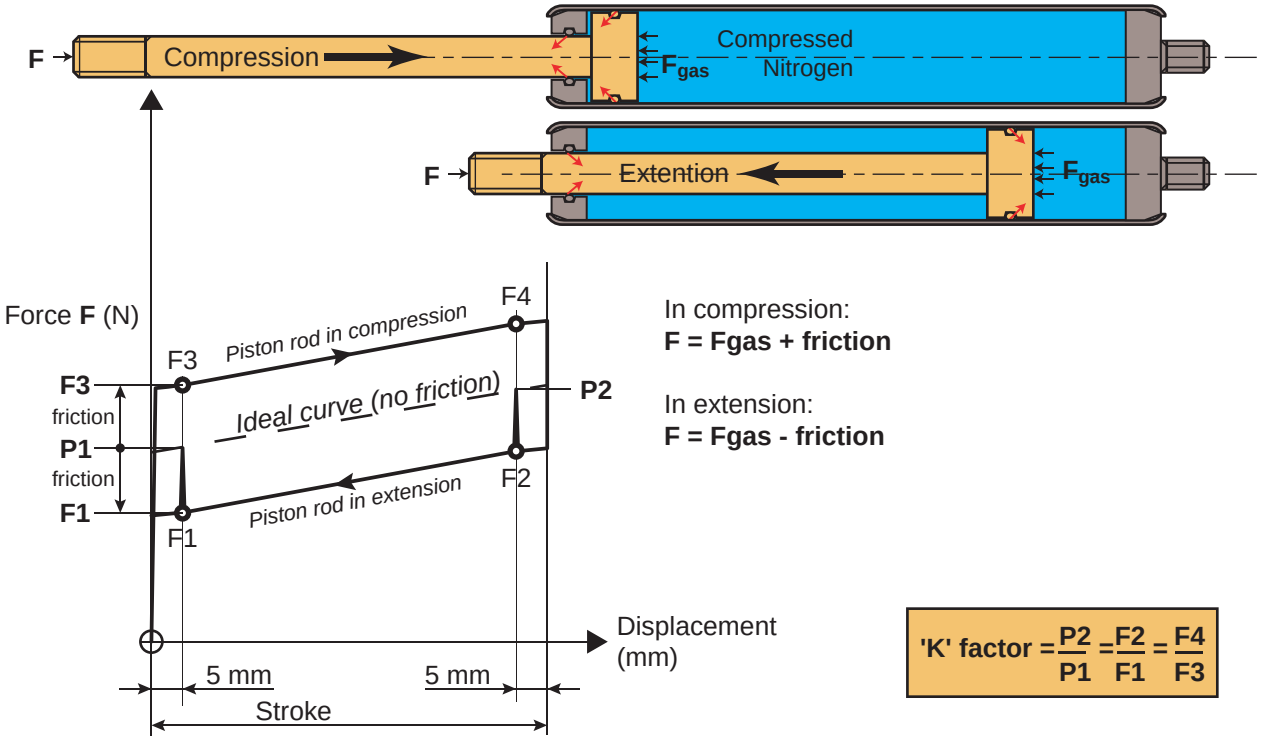
Force P1 and dynamic forces

General definition: P1 is measured when the gas spring is static, F1 is measured when the gas spring is extending. Both forces are measured at 5mm from full extension.
In order to measure the force P1, the gas spring should be placed on a test rig, compressed 10mm, extended 5mm, stopped for 5 seconds, P1 is then measured in this static position.

The graph below represents the force of the gas spring measured dynamically.
Because friction forces appear at the rod seal and on the piston itself, the gas spring will give more or less force depending on the direction it is moving.



In compression:
F = Fgas + friction

In extension:
F = Fgas - friction

'K' factor $= \frac{P2}{P1} = \frac{F2}{F1} = \frac{F4}{F3}$

Typical F1 to F4 values

Depending on the materials used and surface finishes, the friction in a gas spring usually amount for 10% of its force. The dynamic forces can therefore be estimated as follow:

F1 = 0.9 x P1 **F3 = 1.1 x P1** **F2 = 0.9 x K x P1** **F4 = 1.1 x K x P1**

For example, a gas spring with a P1 force of 100 Newtons, will give 110 Newtons when compressing and 90 Newtons when extending (measured at 5mm from full extension).