Rolling Diaphragms vs. Flat Diaphragms

The objectives of this bulletin are to examine the advantages of a rolling (molded) diaphragm versus a flat diaphragm. Please assume we are only considering a composite construction, made from fabric and elastomer.

To begin, please consider the following definition:

A diaphragm is a seal that is usually affixed to a moving piston, and is actuated by differential pressure. The diaphragm converts a pneumatic or hydraulic force to a mechanical force by containing this force to one side of the piston. As the diaphragm expands, it pushes on the piston creating the mechanical force.

The diaphragm usually is a barrier, preventing a mixture of fluid and/or gas, or protecting pressure barriers. If the application requires only a separating membrane and a short stroke, a flat cut diaphragm is usually sufficient. Should the application require a long stroke, or a constant effective area, then a rolling diaphragm is the best choice.

A flat cut diaphragm is simply a piece of material cut into the desired shape. Rolling diaphragms are molded diaphragms typically configured in a "top hat" style, or with a molded convolution. The molded diaphragm will allow easier movement of the piston, resulting in low friction, exceptional sensitivity, and provide zero leakage.

If appropriate, flat diaphragms can be economical due to the low manufacturing costs. However, while effective at separating chambers, their application is limited. The maximum stroke for a flat diaphragm ranges from a few thousandths of an inch to just over one inch, depending on the diameter of the part. The best way to increase the stroke for a flat cut is to increase the diameter of the diaphragm, which is not always an option!

Another factor to consider when using a flat diaphragm is the "blousing" that is required. Because the diaphragm will move, some space must be provided across the part to allow for motion. The most common solution to this problem is to cut a larger diaphragm than necessary, and let the diaphragm sit slack in the application. Think of the alternative - a diaphragm stretched tight across the chamber will not allow for any movement. In fact, the energy used to start the stroke will be returned to the system, an effect called the "trampoline syndrome".

This inefficient handling of the system's energy is avoidable with the use of a rolling diaphragm.

Finally, flat diaphragms tend to take a shape when repeatedly cycled. As the cycling increases, the life span of the diaphragm decreases since it has to adjust to the stroke. If the material gathers unevenly when installed, the chances for material wear increases, decreasing the life of the diaphragm as well. Set points could also change through the life of the diaphragm. In control devices, regulators, or other

applications with critical set points, a set point change could lessen the energy required to start the stroke, possibly leading to changes throughout the entire application.

Rolling diaphragms avoid this problem by factoring in the required stroke of the diaphragm in the hardware. A convolution molded into the diaphragm, designed to move in conjunction with the piston, uses less energy to start the stroke, and provides a constant effective pressure area. This guarantees a repeatable displacement each and every time.

Molded diaphragms provide stable set points, low hysteresis, and longer life. Since the molded diaphragm is designed to meet the specific stroke requirements, the resistance to movement is significantly less than the flat diaphragm, resulting in a more efficient system. Additionally, because the diaphragm has already taken the shape of the stroke, the material suffers less wear.

Besides technical advantages, molded diaphragms can also offer assembly advantages too. Since flat diaphragms almost always require some blousing, time must be taken at assembly to incorporate the diaphragm into the application. A molded convoluted diaphragm can be placed into the assembly without any additional work. In most cases, a molded diaphragm offers lower total cost when considering assembly, and life.

In summary, flat diaphragms can be an effective seal in limited applications. However, based on the application requirements, a molded diaphragm is a cost effective sealing solution that will provide significant advantages over a flat diaphragm. The result will be longer life, a constant effective pressure area, low friction, repeatability and yet be sensitive in a broad pressure range.