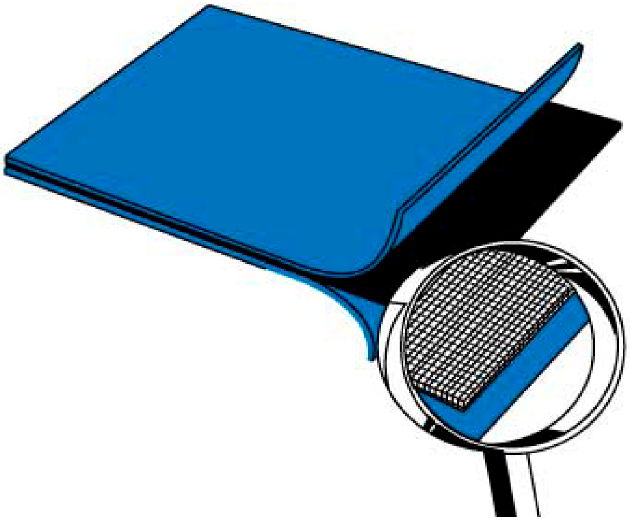
Fabric Reinforcement in Diaphragms



One of the most common questions in diaphragm design is at what pressure is fabric reinforcement required? The most common answer is that 5 to 10 PSI in differential pressure is the threshold for requiring fabric in a diaphragm. In fact, the answer is not that simple. There are many areas of the application that must be considered before a true determination can be made.

First, we need to consider the role of the diaphragm in the proposed system. The diaphragm converts one type of energy into another. It will take pneumatic or hydraulic pressure and convert it into a mechanical force to perform a task or, conversely, take a mechanical force and convert it into either a pneumatic or a hydraulic force. The pneumatic or hydraulic force will react with the weakest link in the system. If the diaphragm's ability to resist stretching is the weakest link, the diaphragm will simply blow up like a balloon, absorbing all the energy put into the system instead of transferring it onto the piston.

Preventing streching with fabric

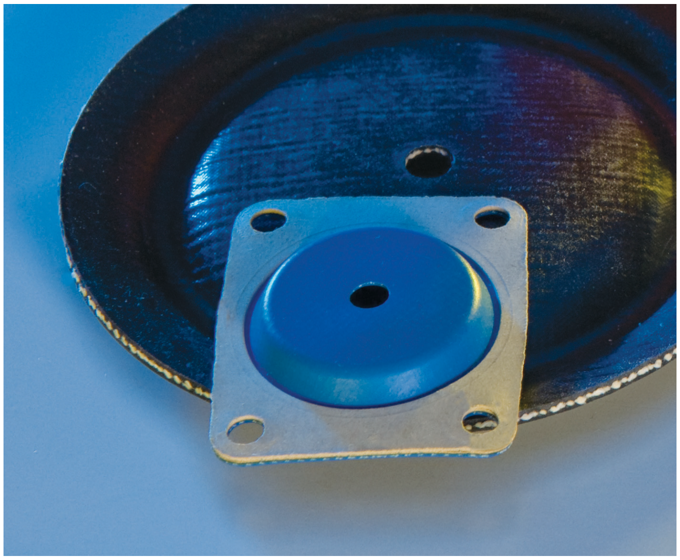
The elastomer's ability to resist stretching varies from compound to compound. It will also vary in the same formula from batch to batch due to mixing variations as well as thickness variations. A homogeneous diaphragm will also become stretched out over time due to pressure being applied repeatedly much like a balloon that has been blown up and deflated many times. To inhibit this stretching, fabric is molded into the diaphragm with a layer of elastomer between it and the high pressure. When pressure is applied to the diaphragm, the elastomer pushes against the fabric, which resists stretching, resulting in the force being transferred onto the piston and on down the line to the work to be done. Once fabric is introduced into a diaphragm, the role of the elastomer is reduced to plugging the holes in the fabric and sealing the flange. The fabric becomes the skeletal system for the diaphragm supplying all the strength to resist stretching and transferring the energy to the piston.

Fabric reinforced diaphragms come in two types: single coat and double coat. The single coat diaphragm has the elastomer on the high-pressure side of the diaphragm and the fabric on the low-pressure side. The double coat has elastomer coating on both sides of the fabric. The reasons to select one type of construction over the other merit their own paper later.

Fabric, like elastomer, has to be in the correct environment with regard to heat, chemical resistance and strength. However, it also has to be able to be formed correctly into the geometry of the diaphragm. With research, an engineer will develop the criteria requiring the selection of a particular fabric for the application's environment. The ability to form a fabric, however, is a product of its weave.

The selection of the fabric's weave is a balancing act

A fabric's ability to be formed is determined by the spacing of the threads on the fabric. As the fabric is formed, the threads in the fabric are pulled to fit the new geometry. Since the threads do not stretch, they must change their orientation at some point to keep from folding on themselves, resulting in a pleat. This change in orientation takes place along the axis that runs 45 degrees to the plane of the threads or the bias area of the fabric. As the fabric is pulled, the open squares (interstices) formed by the threads in the bias area collapse to a point where the threads hit one another. At this point, the fabric can no longer be pulled without forming a pleat. The conclusion here is that the more open the weave the deeper it can be drawn.



As mentioned earlier in this article, once fabric is introduced then the elastomer's job is only for sealing the flange and plugging the interstices in the fabric. The key point is that fabric has holes in it formed by the spacing between threads. It also stands to reason that the lower the thread count (threads per inch) the larger the interstices formed between threads. When the elastomer is introduced, the interstices are closed forming the seal. However, in between the threads there is only elastomer holding onto fabric preventing a leak. If the cross section of elastomer is too thin in relation to the openings in the fabric, blow-through will occur. This is when the pressure in the application actually blows a piece of rubber through the fabric resulting in a small pinhole leak.

Conclusion

The final design of any diaphragm is equally critical to its application and the manufacturing process. Whether your application requires a single-coated or double-coated diaphragm, it is important that you involve a Simrit engineer for optimized materials design, for both elastomer and fabric. For additional information or questions please contact your local Simrit sales person or call our toll-free number below.

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Publication No. 3502