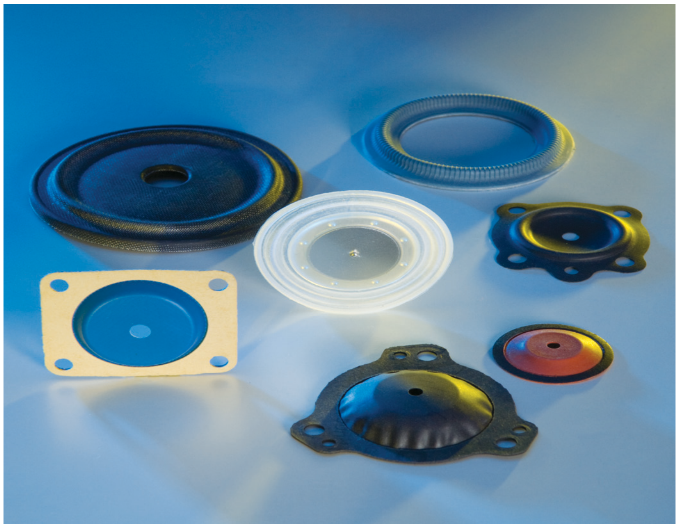
Tolerances of Fabric Reinforced Diaphragms

One of the most misunderstood areas in development of a fabric-reinforced diaphragm is dimensional tolerance. In regard to rigid objects or assemblies, such as metals or plastics, the dimensional tolerances may be relatively straightforward. Since these materials are homogeneous, it is a matter of applying a certain value for shrinkage when designing the tooling for these objects. This is a time-tested method and works very well for those particular industries, providing reliability and consistency in product dimensions.

Many times, design engineers apply similar tolerance methods to diaphragm designs, assuming it is like any other rubber part. Fabric-reinforced diaphragms are a unique product, incorporating both a seal and reinforcement in one structure. Plastic or metal shrinkage techniques do not apply directly to the manufacture of fabric-reinforced diaphragms. If this point is considered throughout the product design process, a better understanding of the diaphragm's role and its capabilities within the hardware will be achieved.

It is important to note that fabric-reinforced diaphragms which are designed with round or circular convolutions are neither round nor circular in the finished product. Given that a reinforced diaphragm is produced from a woven or knit fabric with elastomer coating on one or both sides, there is an intricate interplay of shrinkages and stresses between the fabric and elastomer when a reinforced diaphragm is molded. The elastomer tends to have a uniform shrinkage, while the fabric does not. The fabric is an anisotropic material; it stretches more on the bias of the weave and shrinks more in the direction of the weave. Additionally, the fabric may impart a residual stress that may affect a reinforced diaphragm's dimensional stability.

Add some other features, such as a molded-in fiberboard gasket on the flange, PTFE cladding, or metal insets, and soon there is an even greater amount of interplay between the stresses. Additionally, reinforced diaphragms tend to relax over time. The convolution height may decrease and hole sizes may also change. This phenomenon is directly related to the type of elastomer and fabric used, molded-in inserts (if any), the geometry of the part, and the style of manufacture (coated fabric versus single coat, see Simrit's Design Manual for more information on these styles). Although Simrit's team of engineers is uniquely qualified to design processes matched to each customer's product to minimize the effects of these stresses and shrinkages, it is impossible to completely eliminate them.



Measuring Diaphragms

Elastomer often comprises the majority of the raw material in many diaphragm designs. This presents a challenge when measuring dimensions on a diaphragm. For this reason, one of the most important things to consider when measuring a diaphragm's dimensions is the measurement technique. Generally, it is a good idea to agree upon a measurement technique prior to the introduction of a part for regular production. This way a correlation can be made between the customer and Simrit for part inspections. Simrit recommends documenting inspection procedures for all parts, including methods, as well as the equipment used for conducting the measurements. Will digital or analog gages be used? Are the gages contact or non-contact? Are there specific instructions for measuring the part? There is a lot of potential variation and subjectivity that should be addressed when developing an incoming inspection plan. One type of gauge that Simrit recommends is a Go/No-Go gauge as it takes a significant portion of subjectivity and variation out of the measurement.

Recognizing that there is a significant amount of interaction between the design of a reinforced diaphragm and the subjectivity in measurement, it is easy to see that standard tolerance techniques are not suited to dimensioning reinforced diaphragms. There are certain areas of a diaphragm that can be produced to tighter tolerances, such as mold closure related dimensions like thickness, while other areas require larger tolerances. Simrit's team of engineers has developed tolerance guidelines specific to fabric-reinforced diaphragms. These tolerance guidelines are illustrated in the table below:

Diaphragm Tolerances		
Feature	**Range**	**Required Tolerance**
ID/OD Trim Diameters and Hole Sizes		
	.50" and below	± .005"
	.50 to 1.00"	± .010"
	1.01 to 3.00"	± .015"
	over 3.01"	± .020"
Concentricity		
	1.00" and below	.007" True Position
	1.01 to 2.00"	.010" True Position
	2.01 to 4.00"	.015" True Position
	over 4.01"	.020" True Position
Convolution Height		
		± .015" per inch of height (not to be less than ± .015")
Angular Dimensions		
		± 1/2°
Thickness		
	.005 to .011"	± .002"
	.012 to .018"	± .003"
	.019 to .025"	±. 004"
	.026 to .032"	± .005"
	.033 to .039"	± .006"
	over .039	± .007"
Piston and Bore Diameters		
		± .010" per inch of diameter (not to be less than ± .010" or greater than ±.060")
Bead Width		
	.062 to .187"	± .003"
	.188 to .250"	± .004"
	over .250"	± .006"
Bead Height		
	.062 to .187"	± .005"
	.188 to .250"	± .006"
	over .250"	± .008"
Trim Flash (where applicable)		
		.025" x .025" maximum

For more information on tolerances, please contact Simrit at 866-274-6748. We would be glad to provide guidance on tolerances, dimensioning or any other technical aspect during your product's development.

