Diaphragm Seal Design Guide

This catalog is provided as a reference tool to assist our customer's in the specification and selection of diaphragm seals and systems. We have built our business by servicing our customers with immediate application and technical support. Our commitment to continuing this level of support will always be our first priority.
If you have an application or technical question, or just want RJ Global to take the hassle out of the quotation process, please contact our sales group. You will have the security of knowing the best people in the industry are helping to ensure you don't forget a single detail, and you will have an answer fast. Let our experience work for you!

RJ Global is Your Link To Total Process Control

When to use Diaphragm Seals

Diaphragm seals are traditionally used when, for one reason or another, a standard measuring instrument should not be exposed to the process pressure directly. The most common measuring instruments which utilize diaphragm seals include pressure transmitters, transducers, gauges, and pressure switches. Diaphragm seals typically protect the measuring instrument from one or more damaging aspects of the process media. Consideration for using a diaphragm seal should be made in the following circumstances:

High Process Temperature

A diaphragm seal should be considered when the process temperature exceeds the temperature capabilities of the measuring instrument and an impulse line is not an acceptable alternative. An impulse line is used to lower the process temperature of the media being measured by moving the instrument a distance from the process piping and allowing the heat to dissapate to the atmosphere through the impulse line. While an impulse line provides an economical solution to high temperatures applications, it also has many limitations. Impulse lines are subject to clogging and should never be used when the process media may solidify in the line once it has cooled. Thermal expansion and response time can also be problems. A diaphragm seal provides a much more accurate solution by using a low volume, sealed system to provide precise pressure measurement.

Process Media is Viscous or Contains Suspended Solids

A diaphragm seal should be considered if the process media is very viscous or contains suspended solids which may block the pressure ports of the measuring instrument and prevent an accurate pressure measurement.

Process Media is Subject to Solidifying

A diaphragm seal should be considered if the process media has the potential to solidify and block the pressure ports or distort the diaphragm of the measuring instrument. This is a particular problem with processes that can freeze, set up and solidify over time, solidify if the process stops flowing, or solidify due to crystallization or polymerization.

Process Media is Corrosive

A diaphragm seal should be considered if the process media is corrosive and would chemically attack the measuring instrument causing premature or catastrophic instrument failure. This may require frequent instrument replacement or instrument materials of construction which are not readily available. A diaphragm seal can utilize a variety of exotic materials and coatings which eliminate or dramatically reduce problems caused by corrosive media.

Process Application Requires Sanitary Connections

A diaphragm seal should be considered if the process application requires sanitary connections. Most measuring instruments cannot meet 3A sanitary requirements due to crevices inherent to their design. Another problem is the ability of the measuring instrument to withstand the temperature requirements of steam cleaning which is utilized in many sanitary applications. A diaphragm seal provides a sanitary connection and allows easy cleaning between batches.

Process Application Subjects the Measuring Instrument to Hydrogen Permeation

A diaphragm seal should be considered in applications where the generation of atomic hydrogen could permeate the thin metal diaphragm of the measuring instrument. Care should be taken when dissimilar metals are in close proximity of an electrolyte such as water. When hydrogen atoms permeate through the diaphragm, they can unite to form hydrogen molecules in the fill fluid of the measuring instrument. The hydrogen molecules are too large to diffuse back through the dia-

phragm and are trapped as hydrogen bubbles on the fill fluid side. The buildup of hydrogen can severely impact instrument performance. A diaphragm seal can easily be gold plated to help prevent this problem. It may be difficult, if not impossible, to gold plate the diaphragm of the measuring instrument.

Tank Level Applications with Maintenance Intensive Wet Legs

A diaphragm seal can reduce maintenance time and effort on tank level applications with maintenance intensive wet legs. The wet leg provides a reference pressure for the differential pressure measurement used to determine tank level in a closed tank application and ensures accurate level measurement. Accuracy cannot easily be assured if the level of the reference fluid in the wet leg is not always full. This can be a problem in wet leg applications where the wet leg fluid is unstable or must constantly be refilled. A diaphragm seal provides a highly accurate and maintenance free method for tank level measurement.

Tank Application with Density or Interface Measurements

A diaphragm seal provides an easy solution for density and interface measurements in tank applications where impulse piping is not acceptable.

Measuring Instrument Requires Remote Mounting

A diaphragm seal should be considered any time a measuring instrument must be remotely mounted in applications where impulse piping is not acceptable. In many applications, high ambient temperatures, high vibration, unfavorable environments, or ease of access require the instrument to be mounted in a remote location. A diaphragm seal is the most dependable method for ensuring reliable and accurate pressure measurements.

Design Considerations

Material Compatibility

Determine the materials of construction required for the successful operation of the diaphragm seal within the specific application environment. The proper selection of all wetted parts is required to ensure the application compatibility of the diaphragm seal. This includes ensuring the chemical compatibility of the diaphragm seal materials with all of the various chemicals to which the seal may be exposed while in service and the vulnerability of these materials to corrosion, pitting, stress cracking, embrittlement, and hydrogen permeation. Improper material selection can result in premature or catastrophic instrument failure.

A material compatibility table is provided at the end of this catalog to assist in the proper selection of seal materials. RJ Global cannot guarantee the suitability of suggested materials within any application. It is the end user's responsibility to ensure all selected materials are compatible with the application.

Temperature Effects

Temperature induced errors are the primary cause of inaccurate pressure measurements in diaphragm seal systems. Eliminating temperature induced errors is the key to proper system performance. Temperature induced errors occur when the fill fluid expands or contracts due to process or ambient temperature changes. As the fill fluid expands and contracts, the fill fluid volume changes within the diaphragm seal system. The change in fill fluid volume directly affects the pressure measurement of the measuring instrument. If the volume of fill fluid is minimized, the effects of process media or ambient temperature changes are minimized. RJ Global utilizes low volume seal designs, capillary tubing, and fittings to ensure optimum system performance. Temperature errors induced by ambient temperature changes can be reduced through the use of heat tracing to maintain fill fluid temperature greater than the ambient temperature. RJ Global offers pre-engineered heat trace solutions that provide a cost effective alternative to expensive field installation of heat tracing.

High vacuum, high temperature, and cryogenic applications require specialized construction techniques and careful fill fluid selection. Higher temperatures reduce the maximum working pressure of a diaphragm seal. All pressure ratings are specified for a process temperature of 100° F. System response time can dramatically increase at low ambient temperatures. Consult RJ Global for assistance with these applications. We can help minimize temperature induced errors and ensure optimal performance of your diaphragm seal system.

Fill Fluids

Fill fluid selection is critical to the performance of a diaphragm seal system. When selecting a fill fluid, special consideration should be given to process and ambient temperatures, pressure, and compatibility with the process fluid. Inert fill fluids must be specified when oxidizers such as Oxygen, Chlorine, Nitric Acid, Bromine, Hydrogen Peroxide, and Fluorine are present

in the process media. Failure to do so may result in a violent chemical reaction. A sanitary fill fluid must be specified in food processing applications. Neobee M-20 is approved as both a direct and indirect food additive.

High vacuum, high temperature, and cryogenic applications require careful fill fluid selection. Fill fluid temperature limits are dependent upon the system operating pressure and are dramatically reduced at very low operating pressures. Fill fluids become more viscous as temperatures decrease and can dramatically affect system response time. The technical requirements for filled systems can vary significantly depending upon the measuring device, fill fluid type, and connection type, While filling a diaphragm seal attached directly to a gauge may be relatively simple, filling a diaphragm seal connected to a low range differential pressure transmitter can be very complex. Consult RJ Global for assistance with these applications. We can help select the proper fill fluid for optimal performance of your diaphragm seal system. RJ Global also has the ability to cost effectively fill and calibrate any diaphragm seal filled system.

Diaphragm Size

Another primary determining factor in the performance of a diaphragm seal system is the actual size of the diaphragm. The diaphragm size must be properly selected for optimal performance. As the process media exerts pressure on the diaphragm, the diaphragm in turn drives the system fill fluid into exerting force on the measuring instrument. The diaphragm seal may not be capable of driving the measuring instrument if the diaphragm is too small. There may be problems with instrument resolution while measuring small pressure changes and the system may be susceptible to temperature errors caused by contraction and expansion of the fill fluid. Reference page 58 for information on selecting the proper diaphragm.

Time Response

The time response of a diaphragm seal system is affected by a number of factors. These factors include diaphragm size, fill fluid viscosity, process and ambient temperatures, capillary length, the inside diameter of the capillary, and the measuring instrument itself. Determining the overall effect of these factors in combination can be extremely complex. Contact RJ Global for assistance in determining the overall time response of the diaphragm seal system for a specific application. We can assist in specifying the proper diaphragm size, fill fluid, maximum capillary length, capillary ID, and suggest options such as heat tracing to provide optimum system performance in your application.

Common Errors

Failure to use Low Volume Nipples: Always use a low volume nipple with high quality threads when a nipple is required to connect the diaphragm seal to the instrument. This will help eliminate temperature induced errors and reduce the possibility of fill fluid leakage. Always use a high quality thread sealant such as Rectorseal #5.

Fill Fluid Vaporization: The fill fluid can vaporize and destroy the diaphragm seal system if the process or ambient temperatures exceed the capabilities of the fill fluid. The potential for problems increases with high operating temperatures at low pressure ranges. Always ensure the fill fluid will work within the pressure and temperature range of the application.

Improper Filling: Overall performance of a diaphragm seal system can be dramatically affected by improper filling of the system. The diaphragm may bulge outward or the static pressure exerted by the fill fluid on the measuring instrument may induce gross measurement errors if the system is overfilled. The system may experience a lack of response or non-linear reading if the system is underfilled.

Improperly Sized Diaphragm: The diaphragm seal may not be capable of driving the measuring instrument if the diaphragm is too small. There may be problems with instrument resolution while measuring small pressure changes and the system may be susceptible to temperature errors caused by contraction and expansion of the fill fluid.

Slow ResponseTime: Longer capillary lines were used than were necessary for the application, consideration was not given to ambient temperature effects, incorrect fill fluid was specified, or incorrect capillary internal diameter was used. Always consult RJ Global for assistance in determining the response time of a diaphragm seal system in an application.

Unequal Capillary Lines: Unequal capillary lines are not recommended for differential pressure instruments since the system may be susceptable to zero shifts resulting from fill fluid expansion and contraction.

General Information

Use caution when cleaning or flushing a diaphragm seal. High pressure flushing, Clean in Place (CIP), and Steam in Place (SIP) procedures can damage the thin diaphragm material if the diaphragm is subjected to high pressure spray or steam.

Do not press on the diaphragm with fingers or other objects. This will ruin the performance of the seal and possibly puncture the diaphragm. Do not allow gaskets to overlap and touch diaphragms during installation.

Use good welding practices when installing welded in place seal housings and sanitary spuds. This will help avoid gasket and o-ring leakage caused by weld distortion of close tolerance parts.