

SEALING MATERIAL SELECTION STRATEGY

ENSURING APPLICATION PERFORMANCE & LONGEVITY

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Fluid sealing devices play a critical role in a wide range of processing industries, including chemicals, refining, pulp and paper and many others. In this role they keep pumps from leaking, valves from releasing emissions, flanges from spraying fluids and other undesirable and often dangerous conditions. Yet, because these devices account for a tiny fraction of the cost of the systems in which they are installed, they often do not receive the attention they warrant.

Fluid sealing devices come in many different materials and configurations, primarily as gaskets for flanged joints and compression packing for pumps and valves. The process of selecting the right device for any given application begins with defining the expected level of performance and identifying service conditions. Ultimately, whatever sealing solution is selected must be able to withstand the service conditions to which it will be exposed and, ideally, remain maintenance-free over the course of its anticipated useful life. To eliminate unscheduled outages, it is important to make sure the service life of the sealing device corresponds to the maintenance cycle. Sealing devices also should be cost-effective, capable of saving more than they cost within budgetary constraints. Another important selection criterion may be compliance with regulations and standards. Most sealing manufacturers can provide certificates of conformance for their products, but compliance with standards often calls for documentation of performance based on regulated test and measurement methods. In addition, sealing devices often serve to protect equipment and components, minimizing the need for replacement parts. In many applications, particularly refineries, they also must be fire-safe. This means that during a fire the seal will maintain its integrity and not further fuel the fire. In the absence of a universal sealing solution, consolidating



Figure 1: *this compressed fiber gasket contains a proprietary rubber binder, allowing it to swell and create a compressive load in both oil and water service.*

different sealing devices to the fewest number can minimize stocking and inventory requirements. Fortunately, most fluid sealing applications do not involve all of these requirements. However, they serve as a useful starting point in formulating your sealing material selection strategy. Taking that strategy to the next level is done by establishing the operating parameters of the service for which the sealing solution is intended.



Figure 2: *PTFE gaskets are used extensively in the chemical processing, food and beverage and pharmaceutical industries.*

TAMPSS

A simple acronym, TAMPSS (temperature, application, media, pressure, size and speed) provides a general guide to assuring selection of the correct sealing device for your application.

Temperature. The first consideration should be the temperature of the fluid contacting the seal, which in rotating equipment will increase due to frictional heat. Knowing this temperature will immediately reduce the number of viable materials.

Application. How is the seal component to be used — rotating pump shaft, raised face flange, valve stem, etc.? Defining the parameters of the application itself requires what is often difficult-to-obtain, but necessary, information about the equipment in which the seal will be installed. This information also helps determine installation procedures to optimize seal performance.

For gaskets, you need to know the type of flanges on which they will be installed, as well as material and bolting information to determine the amount of compressive force available. These are extremely important factors, since more than 70 percent of gasket failures can be attributed to insufficient load.

Choice of compression packing for pumps and valve stems can depend on whether the motion is reciprocating, helical or rotating.

Media. Either the common or chemical name of the gas, liquid or solid that will come into contact with the seal can be used to determine its compatibility with the seal material. Also considered should be any secondary media to which the seal may be exposed, such as fluids that are intermittently present during chemical or steam/hot-water flushing. Sometimes the sensitivity of the media to color contamination or extracted materials that may leach from the seal must also be considered.

Pressure. Most systems operate at fairly consistent pressure, but it is important to take into account any severe spikes or surges that may occur.

Size. ASME B16.5, B16.20, B16.21 and B16.47 provide standard dimensions for flanges and gaskets. Required information includes nominal pipe size and flange class. Most pumps and valves conform to API/ANSI standards. Otherwise they must be field measured.

Speed. Surface speed in FPM at the seal-shaft interface is crucial in selecting pump packing. Note, the surface speed of two pumps operating at the same RPM with different shaft diameters will differ. Surface speed indicates how much frictional heat will be generated; high speeds call for materials that can withstand and effectively dissipate heat.

Sealing Material Selection

Having collected the necessary data, the next step is to match the sealing solution to the application. Most manufacturers will make a number of recommendations, allowing you to consider the advantages and disadvantages of each. Having a choice among

Figure 3: compression packing sets incorporate a combination of carbon, graphite, spacers and flexible graphite braid. They expand radially when the gland is tightened for a positive seal on both the valve stem O.D. and stuffing box I.D.



multiple options also allows you to take into account other factors, such as availability and price. In today's environment of heightened cost-consciousness, price too often trumps quality and performance. Selection of the best sealing solution for a particular application should be governed by the application itself. Price should become secondary, for example, in applications requiring standard or regulatory compliance. When assessing the difference between a high- and low-cost solution, be sure to consider the expense of raw materials used in the seal, life expectancy, reliability, ease of installation and removal, and potential cost of failure. Cost of failure can be assessed in such terms as lost production, labor to repair or replace the failed seal, worker safety and consequences of not complying with environmental regulations.

Gasketing

Gasketing for flanged joints is available in a wide variety of materials, shapes and sizes. Produced using organic or inorganic fibers, fillers and elastomeric binders, compressed sheet gaskets are used in a broad range of industries. Numerous material formulations are available for applications ranging from general service and mild media to high-temperature, high-pressure applications and relatively aggressive media. Also available are specialized gaskets with elastomers that swell in the presence of fluids without losing their integrity and sealing effectiveness. In the process fluid, these gaskets create compressive load in lightweight flanges. More compressible than stand-

ard fiber gaskets, they seal with low load and, unlike more universal gaskets that swell only in oil, these are suitable for water service as well. Capable of sealing flanges in less than perfect condition, these gaskets are ideal for use in compressors, generators, pumps and other equipment (Figure 1). For service in extreme temperatures (-400 F to 1,000 F), high pressure (up to 2,000 PSI) and aggressive media, graphite gaskets resist most non-oxidizing chemicals and provide excellent compressibility and low creep relaxation. For more severe services, the choice is often PTFE gaskets, which offer even better chemical resistance. Use of restructured PTFE in the production of these gaskets improves cold flow and creep resistance compared with conventional PTFE. This improves torque retention, eliminating the need for frequent flange retightening. PTFE gaskets can withstand exposure to a broad spectrum of aggressive media, including strong acids and caustics, solvents, hydrocarbons and cryogenics (Figure 2) Gasket manufacturers provide detailed data about their individual offerings, including material and physical properties, as well as sealing characteristics. When making a final selection based on these data, be sure to also consider gasket geometry. Gasket performance generally decreases as material thickness increases. Thicker gaskets require heavier compressive loads, which may not be obtainable in certain applications, such as those with glass-lined, non-metallic or custom-designed flanges. Thinner gaskets require flatter flanges and will not seal

as many irregularities, but they typically cost less and provide enhanced joint performance by reducing emissions and product loss and increasing blowout resistance. Whenever possible, select ring instead of full-face gaskets, which cover the entire flange surface. By contrast, ring gaskets are seated concentrically inside the bolt circle, significantly reducing the compressive load required for an effective seal.

Compression Packing

Like gasketing, compression packing for sealing valves, pumps, agitators and other rotary equipment comes in different materials and configurations.

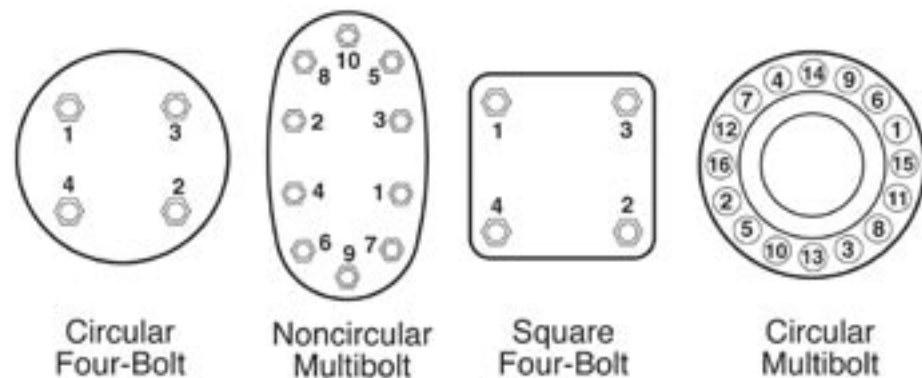


Figure 4: flange bolts should be tightened uniformly, going from side to side around the joint in a star-like crossing pattern.

Valves and pumps in high-temperature, high-pressure and high-speed chemical applications should be packed with braided carbon filament with graphite lubrication or die-formed flexible graphite to reduce friction, shaft wear and maintenance. Flexible graphite packing, chemically resistant and self-lubricating, is capable of sealing to extremely low levels of leakage for applications subject to PPM limits. Packing made of highly graphitized yarn performs well under extreme temperature and pressure conditions and provides excellent chemical resistance and thermal conductivity. When selecting this type of packing, make sure it will retain its original volume and remain pliable for ease of removal. Braided packing made of PTFE fiber resists chemical attack. Braids of PTFE yarn impregnated with PTFE particles are well suited for use in valves. Pumps in the chemical and food processing industries utilize PTFE braid impregnated and coated with silicone or other lubricants. Also available are sets of

engineered packings designed specifically for use in pumps or valves. For example, a recently developed rotary seal that replaces mechanical seals in industrial pumping applications provides leak-free, no-dilution, outage-to-outage service in slurry applications. Superior heat dissipation enables the seal to be maintained with minimal amounts of water. Valve stem packing is also increasingly taking the form of engineered sets that have simplified the approach to achieving low fugitive emissions (Figure 3).

Proper Installation

Just as important as selecting the right

sealing solution for an application is installing it properly. This begins by adhering to the manufacturer's instructions for handling and installation. Field support may be necessary in some cases, depending upon the criticality of the application and availability of resources. Use of torque wrenches or other controlled tightening methods help to assure that the proper gasket load is achieved and evenly distributed on the flange (Figure 4). However, torque wrenches are rarely used or are limited to use on what are considered critical applications. In many cases, bolt-thread lubricants are applied to gaskets to facilitate removal. If the gaskets contain non-oil-resistant binders, such as SBR or EPDM, petroleum-based lubricants can attack them chemically, softening the binders and reducing their crush strength. These lubricants also reduce friction between the gasket and flange faces, allowing them to extrude and eventually blow out. Metal in the lubricants can bond to flanges and fill in surface serrations

that bite into the gaskets and hold them in place. In addition, the lubricants can degrade or "bake off" at elevated temperatures, leaving a problematic void between the gasket and flange.

Another common practice is to use caulk to affix gaskets to flanges or to compensate for damaged or irregular flange surfaces.

However, some caulks contain acidic cure systems that can attack gaskets containing rubber binders. Because of their lubricity, caulks also can cause gaskets to shift or slide within the flange assembly, leading to the same loss of friction, crush strength and blowout resistance. Gaskets should be installed using only products specified by the manufacturer.

Properly installing valve stem packing requires stem and stuffing box surfaces to be in good condition, with stem finish at 32 micro-inch AARH or better and the stuffing box wall free of burrs. The stuffing box should be cleaned out of any remaining rings or parts of rings, and its depth measured to accommodate a standard five-ring set. If the box is deeper than required, carbon or stainless steel bushings should be used to shorten its depth. If the box is too short, contact the manufacturer.

Installing multiple-ring packing sets begins with inserting the bottom two rings one at a time and tamping them to the bottom of the box. Stagger the ring joints at a 90-degree angle from one another, and use the gland follower to compress them. Repeat this step with the third, fourth and fifth rings. When complete, the gland follower should penetrate the box to approximately half of a ring thickness. Three to five strokes of the valve will distribute the load in the packing set. If the gland loosens after actuation, retighten it to its original level.

Working closely with a sealing solutions provider will contribute to optimizing seal selection and performance. Identifying, troubleshooting and gathering information on problematic issues in advance will inevitably lead to better solutions for your fluid sealing applications, and installing them properly will ensure performance meets expectations. <<



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