Bulletin No. 218

External Valves, Gages and Fittings

What options are available when stainless steel is not suitable for external parts.

Unless otherwise specified, the external valves, gages, fittings and magnetic drives are furnished in stainless steel. In this tech note, we address some options available when stainless steel is not suitable for these external parts. Before dismissing stainless steel as a suitable material for the external components, several factors should be considered that make the corrosive conditions of these vapor phase components significantly less severe than those encountered by the wetted parts.

A. Generally, these parts are not exposed to liquids; only the vapors.
B. These components are air cooled and are at much lower temperatures than those encountered in the heart of the reactor. Lower temperatures equal less corrosion.
C. We suspect, but cannot prove, that non-condensable gases get Compressed into the dead-end spaces leading to these fittings. This blocks the refluxing of corrosive vapors into these parts.

Besides being able to operate in less severe corrosive conditions, another advantage of stainless steel is its low cost. Components in custom alloys can cost two to ten times more than stainless steel. In some cases, it is possible to endure some corrosion and replacement if safety is not a consideration. Sometimes stainless components, especially valves, may be better quality than one-of-a-kind items made of special alloys.

Valves

Monel Alloy 400 is readily available in a wide range of sizes and designs. In addition, it is at the lower end of the cost spectrum with a cost of twice that of the stainless valve. The price and availability also makes them cost effective alternatives for **Inconel Alloy 600** and other high nickel alloys.

Hastelloy Alloy C-276 valves are generally available for most of our reactors. Swagelok, a valve manufacturer, assumes if you want this material of construction, you should not be buying an inexpensive valve in the first place. So you generally end up with not only the more expensive material, but with a more expensive valve design. We

will also have a limited choice of connections in this alloy. However, we would expect to be able to fill most needs with high quality Hast C-276 valves.

Titanium valves are available in some models but are not recommended. When used with oxygen, they can catch fire and burn. Users can be severely injured when unaware of, or they ignore this danger. In addition, Titanium is a very soft material and makes a poor performing valve. We have made some of our A238VB Valves with the Kel-F soft valve seats out of titanium, but you will have to work hard to get us to furnish this material.

Hastelloy Alloy B-2, Inconel Alloy 600, and Carpenter 20Cb-3 are alloys that are very difficult to get purchased valves. We build our A238VB Valve from these alloys to fill this need. This is a 1/8" NPT Valve. We use a Kel-F soft seat which restricts the operating temperature when compared to metal-to-metal seals. We make it in an angle pattern instead of a straight pattern. It is easier to make this style and we need all the help we can get. We also make **Hastelloy C-276** valves this way when we can make them cheaper than buying them from Swagelok. Like titanium, zirconium is a soft material that makes generally poor valves. We have found some of these materials in the past, but this will not always be the case. Sometimes valve manufactures use long delivery times instead of high prices to discourage ordering custom alloy valves.

Parr stocks and can install a wide variety of valves and fittings for use with reactors and pressure vessels. These valves include:

- Needle Valves with NPT or tube connection.
- Regulating Valves with NPT or tube connection.
- Ball Valves with NPT or tube connection.
- High Pressure Valves
- Severe Service Valves
- Remote Operating Valves
- Tube Connectors
- Pipe Connectors
- Plugs
- Union Coupling Adapters

Please contact our customer service department for details at 1-800-872-7720 or parr@parrinst.com.

Safety Check Valves

Whenever gases or liquids are introduced into a vessel under pressure, the supply pressure must be greater than the pressure in the vessel to prevent reverse flow back into the supply system. Protection against reverse flow can be obtained by installing a check valve in the supply line. With a check valve in the line, the valve will snap shut if the supply pressure is too low, or if the pressure in the vessel should rise above the supply pressure. This protection is particularly important on stirred reactors where gas

enters through a dip tube. With liquids in the vessel, any back pressure will force liquid back into the gas tank or into the gas supply system.

Parr stocks check valves for incorporation into the user's supply lines. These valves have a 10PSI normal cracking pressure and are rated for 3000PSI maximum working pressures. Check valves with other specifications can be furnished on special order.

Pressure Gages

Gages for Parr pressure vessels can be furnished with either 3-1/2 inch or 4-1/2 inch dials in almost any pressure range. All have stainless steel Bourdon tubes and 1/4 inch NPT male connections. **Alloy 400** gages are available on special order. Accuracy is .5% of full scale for the 4-1/2 inch size and 1 percent for the 3-1/2 inch gages. All are calibrated in both pounds per square inch (PSI) and bars. Gages in Pascal units are available on special order. Compound gages which show vacuum to 30 inches of Mercury and positive pressures to 300 psi/20 bar are also available. When ordering a special gage, specify the gage diameter, the desired range and scale units.

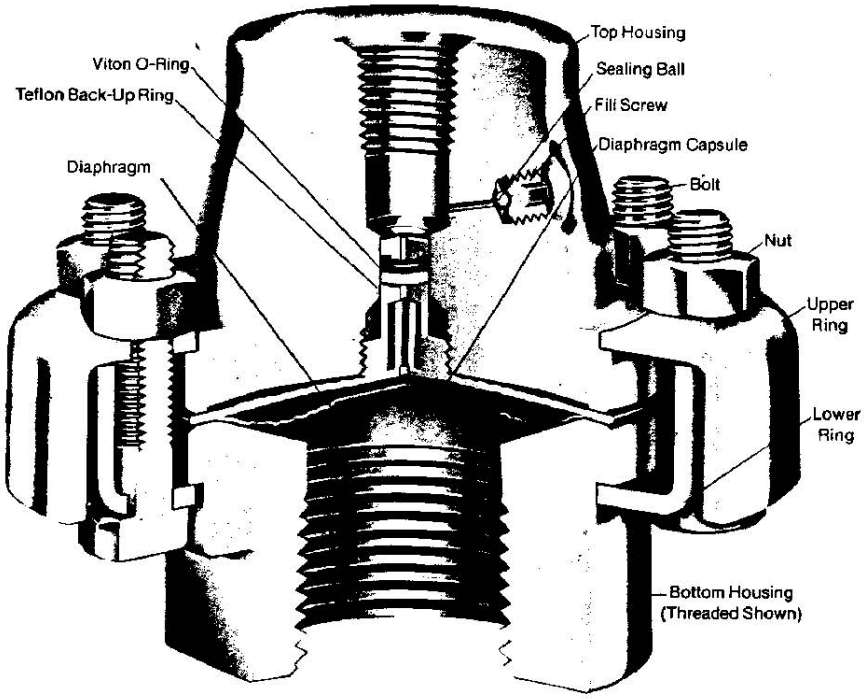
The gage on a pressure vessel should be 150 percent of the maximum operating pressure. This allows the gage to operate in the most accurate pressure range and prevents the gage from being stressed repeatedly to its full range, which will effect the calibration.

If **Stainless** or **Alloy 400** is not adequate, then we have to use a corrosion resistant barrier to protect the gage. This is done in one of two ways: with a flexible diaphragm or with a movable piston. Either method uses a suitable material of construction that will resist the corrosive effects of the process fluids and vapors. The installed gage is on the opposite side from the process connection. The upper portion of the isolator and the bourdon tube of the gage are filled with a suitable hydraulic fluid. The process pressure in the system works on the flexible diaphragm or movable piston which transmits this pressure through the hydraulic fluid to the gage. With either system it is important to get all air out of the hydraulic side of the system since trapped air can produce artificially low readings. Either isolation system requires special filling equipment.

Diaphragm Gage Protectors

Diaphragm protectors are the "standard" industrial method of protecting gages from corrosion. There are no moving seals to be made. Figure 1 shows a typical diaphragm assembly. The bad news about diaphragms is if it is made big enough to flex over the full range of the gage, the assembly ends up being the very large in size. While this could adapt to a one liter and larger reactor, it does not fit on smaller systems because of clearance issues. Also, as you might expect, Hastelloy C-276 or B-2 becomes quite expensive. If the reactor is big enough and the budget is great enough, this is certainly the more conventional method to protect the gage.

Figure 1



Piston Isolator Gage Protectors

PARR designed its own isolators a number of years ago to overcome the problems of large size and high cost associated with diaphragm style isolators. Figure 2 shows a piston style isolator. In this design, a piston slides in a tube to transmit the process pressure. The piston seals into the tube with a Kalrez O-ring. The water cooling jacket surrounds the entire assembly to protect the O-ring and hydraulic fluid. These are definitely more compact than the diaphragms isolators. We can make them in any material of construction with reasonable lead times, and they cost approximately two-thirds of the diaphragm isolator.

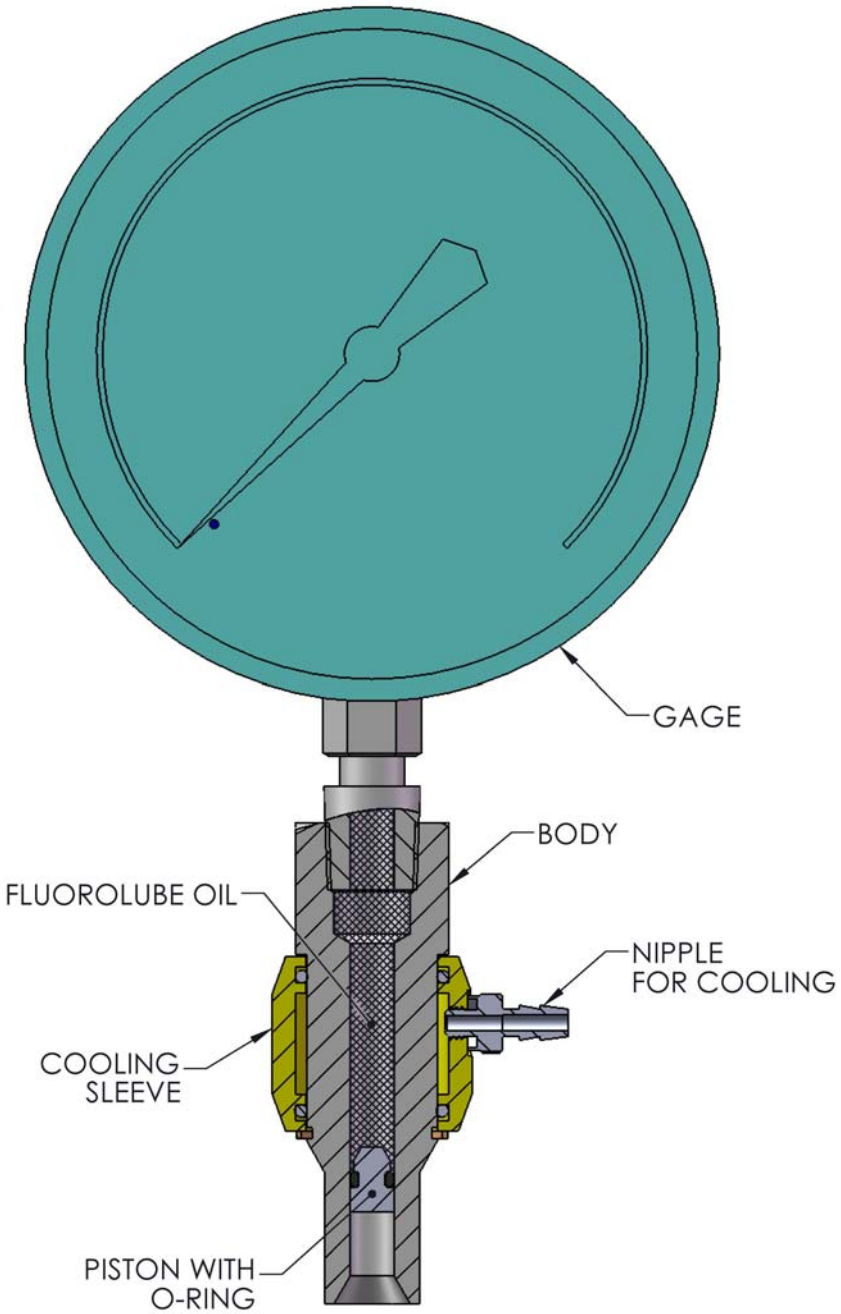
There are two design facts users need to be aware of. First, they depend upon an O-ring seal. Secondly, we use Kalrez for the best corrosion resistance and long life, but this O-ring may need to be replaced. It would probably be more accurate to say it would be improbable for the user to reassemble the gage and isolator without any air trapped on the hydraulic side than to say it would be impossible. Generally, they need to come back to us for this; we have designed special tools for this process. Customers should be cautious not to break any of the threaded seals above the piston or diaphragm.

The sliding O-ring has a small amount of drag and can create a small amount of hysteresis in the gage readings. These will be more noticeable in lower range pressure gages. We use different pistons for high and low pressure gages to minimize this effect. Our measurements show the hysteresis is normally less than 2% of the full scale range of the gage.

Inert Hydraulic Fluid

Parr uses Flurolube FS-5 for the hydraulic fluid between the piston and the gage. This material is a chlorotrifluro ethylene polymer that is extremely stable and not flammable. This is a lubricant designed for use in applications involving strong acidic and/ or oxidizing environments. It is thermally stable to temperatures to 300°C. It can be used in oxygen atmospheres.

Figure 2



Pressure Transducers

Pressure transducers start out simpler than gages. They are generally available in stainless steel. If you need additional corrosion resistance, you must use either the diaphragm or the piston style isolator. The good news is we can use a tee and install both the gage and the transducer on the hydraulic side of a single isolator. The exception is some pressure transducers are available with; **Hastelloy Alloy C-276** wetted components.

Magnetic Drives

We can manufacture the magnetic drive assembly in any of the alloys we use except nickel because it is magnetic. As you can probably tell, we generally encourage users to go to custom alloys for their external components only when they are sure that stainless will not work. If we were to deviate from that philosophy, the first place we would do so would be the magnetic drive. This is a major component of the reactor (it is a high price component even in stainless steel) and the price premium for it as a percent of the reactor system cost is very low.

All PARR stirred reactors are equipped with a magnetic drive to provide a trouble-free linkage to an internal stirrer, thereby avoiding the leakage problems which can arise with a packed gland stirrer drive. With a PARR magnetic drive there are no rotating seals. The drive turns freely and the system remains gas-tight, permitting long, continuous runs at pressures up to 5000PSI (345BAR) with little or no attention to the seal and drive.

PARR drives are assembled with specially designed permanent magnets which have excellent temperature stability and can be depended upon to operate for long periods with little or no flux degradation. Magnets for the inner rotor to which the stirrer shaft is attached are enclosed in a stainless steel (or other alloy) housing, permanently sealed by laser welding and supported by graphite-filled, PTFE bushings to provide a long life, chemically inert stirring system. Magnets for the outer drive are also fully enclosed and supported by twin; high quality sealed ball bearings for smooth operation and long life. A water cooling sleeve protects the components from excessive heat arising from the reactor. PARR offers a choice of two styles of magnetic drives. They are the general purpose series and the footless series magnetic drives. A separate tech note goes into detail on the various magnetic drives available (see our TechNote on “Stirrer Drives for Parr Reactors”).

Valve and Gage Adapters

Valves and gages are attached to PARR reactors using fittings we call adapters. Adapters can be made in any of the alloys we work with. The only issue here is the added cost it represents.

Rupture Discs

All pressure vessels must be equipped with a primary pressure relief device and in virtually all cases, this is a rupture disc. A separate tech note goes into detail on the various rupture discs available (see our TechNote on “Rupture Discs”).

Pressure Relief Valves

Spring-loaded relief valves should be viewed as supplements and not substitutes for a safety rupture disc as the primary means protecting the vessel and the operator in case of accidental over-pressure. Spring loaded relief valves can be added to a reactor or vessel to:

- Relieve pressures near the operating pressure.
- Reseal once excess pressure has been relieved.
- Protect low pressure components at pressures below available rupture disc ranges.

Relief valves can be installed on any PARR vessel. These relief valves are stainless steel and have FKM O-rings. Other valve and O-ring materials are available on special order.

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