6.4 Pumps

Introduction

The information set out in the following identified sections provides general guidelines relevant to the specification and design of the pumping system for pure phosgene. Please reference Sections 6.2 *Materials of Construction*; 6.3 *Piping Items and Valves*; and 6.5 *Instruments*. Additional information is included in the References Section [1,2].

Several common options available to pump phosgene are addressed here.
As with other sections of the Guidelines, users have an independent obligation to conduct their own analysis for their specific circumstances as alternative or additional considerations may be required for the design of pumping equipment.

This information is for pumping pure phosgene. Mixtures containing phosgene are not considered in this section as mixtures can present additional safety issues and other process issues including electrical classification, fluid characteristics and metallurgy considerations.

The information provided in this section should not be considered as a directive or as an industry standard that readers must adopt or follow. Instead, the information is intended to provide helpful ideas and guidance that users may wish to consider in a general sense (See Section1.1 P*reface and Legal Notice*). Also included is a reference list of useful resources.

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6.4.1 Mechanically Sealed Pumps

Where mechanical seals are employed for containment, consider a double seal with some type of pressurized non-reactive barrier fluid. By way of reference, refer to API 610 Plan 53 and Plan 54 for considerations on pressurized barrier fluid systems.[3] The use of protective systems helps ensure that the seal and pump function correctly. Local and remote indications can be more useful than no monitoring or local monitoring only.

Consider solid shafts because a full shaft sleeve can help reduce the stiffness of the seal supports system that could lead to premature failure of the mechanical seal. A “stub” sleeve can be used with a cartridge seal as an alternative. This is not a recommendation, and each company makes this determination based on its own policies.

Evaluate whether all gasket and O-ring materials are compatible with phosgene. Carefully evaluate permeability of gasket materials. Fugitive emissions or leakage from the mechanical seal could result in concentrations of phosgene vapor around the pump seal. Consider developing phosgene detection in that localized area. Over time, permeation of phosgene, combined with moisture can cause corrosion to take place on bolts where it is difficult to observe and monitor.

One Example of a Mechanical Seal Arrangement:

1. API Plan 53 or 54 with double mechanical seals.

2. Barrier fluids contain no water. The water can mix with the phosgene and create acids that accelerate corrosion in piping systems. The barrier fluid is compatible with the process.

3. Barrier fluid reservoir sight glasses are designed to contain phosgene in the event one of the seals leaks and allows phosgene to enter the barrier fluid system. Magnetic type or integral glass type level indicators have been used. Indicators of the exposed glass tube type may be less desirable. For more information, see Section 6.5, *Instrumentation*.

4. Barrier fluid reservoir designs can allow the addition of fluid without disturbing the pressure on the fluid.

   Threaded connections in phosgene service may be undesirable. For more information see Section 6.3, *Piping-Items and Valves*.

   Casing drains can reduce or eliminate trapped phosgene in equipment that must be serviced. Installing a sufficient quantity at the proper location can allow draining of the pump prior to decontamination and maintenance.

Many manufacturers offer hydro testing as a method of testing their casings and pumps to be used in phosgene service can use this service. For example, vessels have been tested to 1.5 times their working pressure and this reference may offer a useful pressure for these pump parts as well. Consider steps to insure adequate drying of the casing to remove any residual water from the hydro test.

Additional inspections to help ensure the integrity of the casing include dye penetrant, x-ray or helium leak tests. Other casting specifications can be added that may require additional testing.

Pumps function most efficiently and reliably if they are operated near their design flow.

Because low net positive suction head (NPSH) can create seal problems and reduce pump reliability, meeting the manufacturer's recommended minimum or a margin added for a safety factor helps prevent such occurrences. One safety factor that has been used previously is the manufacturer's NPSH + 5 additional feet of head.

For pump protection, instruments are available that measure, monitor or indicate some of or all of the following:

- Suction pressure
- Discharge pressure
- Seal fluid pressure
- Seal fluid flow
- Seal fluid level
- Vibration
- Minimum flow protection
- Supply level trip
- Power level

6.4.2 Sealless Pumps

With regard to sealless centrifugal pumps, magnetically driven and canned motor pumps are two common options. The following considerations relate to both types.

Because the inner rotor is cooled and lubricated by the process, failure can occur quickly and without warning. Therefore, sealless pumps with a predictive device supplied by the manufacturer could help prevent such problems. For example, a predictive device would be one which measures rotor position to detect wear.

One feature that may help with difficult pumping applications including phosgene is to have the capability of using external circulation for cooling and lubricating the drive end of the sealless pump. This approach can be helpful with solids, and conditions that may flash or affect the lubrication of the internal pump bearings.

When vapor pressures and temperatures are near boiling in the rotor support area of the pump, a pressure-boosting device has been used in the drive end of the pump to improve bearing life.

This mechanism has been used when the net positive suction head is marginal.

Minimizing penetrations of the process containing parts of the pump reduces the potential for leak paths.

Screwed connections appear weaker in resisting pipe strain and external forces because of concentrated stresses in their thread roots and can leak. Consider minimizing or eliminating any threaded connections in phosgene service. For more information, see Section 6.3*, Piping Items and Valves*.

Casing drains help reduce or eliminate trapped phosgene in equipment that must be serviced. Installing a sufficient quantity at the proper location can allow almost complete draining of the pump prior to decontamination and maintenance.

Make gasket and O-ring materials compatible with the phosgene. Carefully evaluate permeability of gasket materials. Fugitive emissions or leakage of phosgene could result in concentrations of phosgene vapor and over time combined with atmospheric moisture can cause corrosion to take place on bolts where it is difficult to observe and monitor. Solid TFE “O” rings appear resistant to phosgene, but may not be as pliable which could reduce the closeness of the seal.

Consider keeping process fluid temperature at the shaft / bearing interface lower than the boiling point of the fluid in the drive end at operating pressures as a means of helping to ensure the bearings are always lubricated.

Because low net positive suction head (NPSH) can create seal problems and reduce pump reliability, meeting the manufacturer’s recommended minimum or a margin added for a safety factor will reduce the potential for such occurrences. One safety factor that has been used previously is the manufacturer’s NPSH + 5 additional feet of head.

Because of the unique nature of sealless pumps, review the design of the control system. Because the process cools and lubricates the bearings, a control system that allows the pump to run at or near its design point generally can help provide for long pump life. This can be addressed by recycling back to the suction supply vessel, not the suction of the pump. If long durations or large flows are involved, consider cooling of this “bypass” stream to prevent the supply vessel from heating up.

Many manufacturers offer hydro testing as a method of testing their casings, and pumps to be used in phosgene service can use this service. For example, vessels have been tested to 1.5 times their working pressure and this reference may be considered for these pump parts as well. Consider steps to insure adequate drying of the casing to remove any residual water from the hydro test.

A refinement on hydro testing is available using a helium and nitrogen gas mixture and a detector to find minute openings in the casing that might allow phosgene to escape when the equipment is put into service. This test can be done on new equipment at the factory or in the plant. Additional inspection options to help ensure the integrity of the casing include dye penetrant, x-ray or underwater air tests. Other casing specifications can be added that will also require additional testing.

Sealless pumps are not well suited to pumping any liquid that is at its boiling point. If this must be done, then cooling of the pump and a pressurized recirculation system can increase pump reliability. An external flush may also be considered.

When applying a sealless pump, several operating points may need to be supplied to the manufacturer. These include normal operation, start-up conditions, and several sets of unusual circumstances that may be encountered. Changing conditions that can be encountered include viscosity changes, fluid make-up changes, specific gravity, pressure and temperature changes. This issue may be especially relevant if one plant uses a pump for more than one service.

To prevent backflow of phosgene into the pump electrical systems, consider isolation methods for electrical conduits.

Thermal expansion can damage sealless pumps if the pumps continue to operate when valved off or deadheaded. The pump motor supplies thermal energy to the fluid for expansion and potential over pressurization. Consider some of the pump protection measures listed below for pump protection, but this is not an exhaustive list. For example, instruments are available that measure, monitor or indicate some of or all of the following:

- Rotor position to detect wear of the thrust bearings
- Bearing wear when using carbon bearings
- Bearing temperatures
- Bearing lubricant temperature
- Direction of rotation
- Thermal cutouts
- Power to detect low flow
- Suction pressure
- Discharge pressure

- Supply level trip
- Flow
- Vibration
- Acoustical energy

6.4.2.1 Magnetically Driven Pumps

Magnetically driven pumps are typically either of the single or the double containment shell design.

Hydro testing containment shells can help ensure that there are no leak paths outside of the containment portion of the pump. For example, consider hydro testing to 1.5 times the maximum operating pressure of the pump. Consider steps to insure adequate drying of the casing to remove any residual water from the hydro test.

If the containment shell is welded, it may also be tested by dye penetrant or x-ray examination.

Installing a replaceable rub ring between the outer magnetic and the containment shell as part of the design can also help protect the containment shell from damage.

Evaluate whether the outer housing is rated for a pressure greater than or equal to the flange ratings of the pump.

Some type of shaft sealing device can be employed to prevent the release of process to atmosphere in the event of a containment shell failure. Consider whether this device can contain pressures greater than or equal to the flange ratings of the pump.

Avoid magnetically driven pumps in applications where ferrous metals can accumulate in the drive mechanism which could result in premature wear.

For pump protection when using magnetically driven pumps, some additional instruments are available that can measure, monitor or indicate some of or all of the following:

- Power level to detect minimum flow
- Bearing flush temperature
- Pressure in the outer housing

- Containment shroud surface temperature (Single shrouded systems)
- Shroud inter-space pressure (Double-shrouded design)
- Liquid in the outer housing

References

[1]Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process; ASME B73.1-2012, The American Society of Mechanical Engineers, New York, N.Y. http://reference.globalspec.com/standard/4053877/b73-1-2012

[2]Specification for Sealless Horizontal End Suction Centrifugal Pumps for Chemical Process; ASME B73.3-2003, The American Society of Mechanical Engineers, New York, N.Y.
http://estore.pumps.org/ASME-B732-2003-Specifications-for-Vertical-In-Line-Centrifugal-Pumps-for-Chemical-Process-Secure-PDF-P109.aspx

[3]API 610 Plan 53 and Plan 54 for considerations on pressurized barrier fluid systems http://www.techstreet.com/products/1741126?product_id=1741126&sid=goog&gclid=COKe-rD46bkCFepZ7AodwUIANg