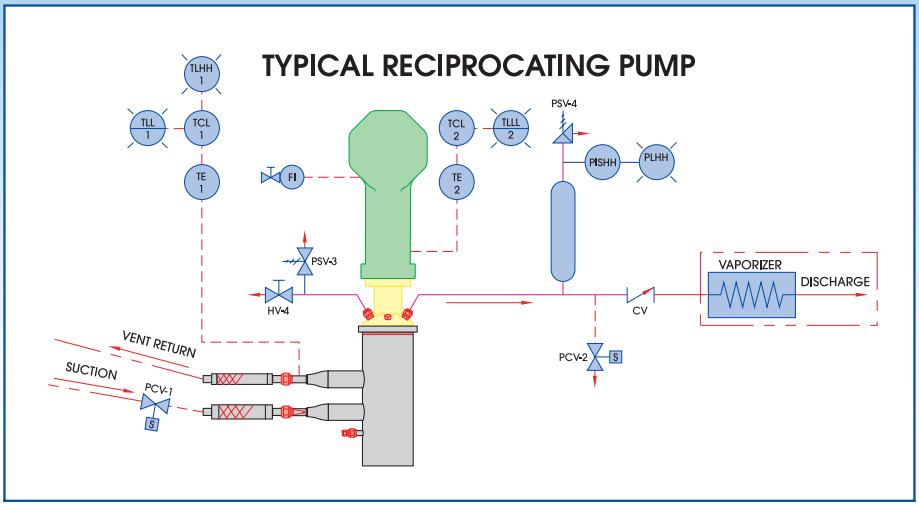
Avoid liquid pump installation problems

Reliable, trouble-free pump operation is the key to low-cost cryogenic liquid pumping. When installing either reciprocating or centrifugal cryogenic liquid pumps, careful up-front planning can mean the difference between long-term reliability or excessive maintenance and consequent downtime. Described below are the general principal issues to be addressed before and during installation of reciprocating and centrifugal pumps. Most topics apply to both types of installations. However, several additional considerations apply only to centrifugal pumps.



All Pumps

The mounting procedures and suction and discharge piping considerations described in the following paragraphs apply equally to reciprocating and centrifugal pumps.

Mounting to Pad

The flex lines connecting the piping to the suction and discharge fittings must be used to take up the stress or shrinkage when the system is cold. To ensure that the flex lines are adequate, the pump should be bolted to the pad after cooldown (not normal practice on reciprocating pumps) as this relieves any stress in the piping and allows the pump to be practically stress-free when in operation.

Therefore, the pump should be mounted in the following sequence:

1. Place pump on pad at desired location, but do not secure in place.
2. Connect suction and discharge piping.
3. Cool down pump.
4. Bolt pump to pad.

Suction Piping

Several suction piping issues should be addressed when planning either a reciprocating or centrifugal pump installation. In general, good piping practices improve the net positive suction head (NPSH) available to the pump. System performance is, therefore, enhanced by careful piping design.

When planning the installation, take into account the location of the pump with respect to the tank and the process so as to minimize piping runs. For the suction connection, the pump should be placed at a location that limits the piping run to less than 5 feet (1.5 meters) from the tank. All pipes in the system should have a pressure rating above system design pressure. Use as few elbows as possible to minimize liquid turbulence in the line and lessen pressure drop. The suction line should have a slight and continuously downward slope to aid in maintaining liquid flow into the suction fitting. At no point should the line rise and then drop (creating a gas trap).

A gate or ball valve, rather than a globe valve, should be used in the suction line. An inlet strainer is needed in suction piping except for most ACD reciprocating pumps, which have a strainer built into the suction fitting. A differential pressure gage should be used across the suction strainer.

Avoid the use of suction piping having a different diameter from the pump inlet fitting. If the diameter is too large product flows too slowly. This permits excessive heat leak into the fluid, which may cause the pump to cavitate. Conversely, small diameter piping increases pressure losses which reduces NPSH and thereby may also cause cavitation.

For reciprocating pumps, connect the suction fitting to a 6- to 8-inch long (15 to 20 cm) (maximum) flex line to compensate for expansion and contraction. Flex lines should not be used to compensate for misalignment or poor piping installations. Also, do not use full-length flex lines, as they add considerably to pressure drop and heat leak.

If the suction piping is relatively long, insulation should be considered. Vacuum-jacketed insulation is preferred because other conventional types of insulation may accumulate moisture, resulting in loss of insulation effectiveness and possibly causing cavitation due to heat leak. For operating cycles that are infrequent and of short duration, conventional insulation might be detrimental because the mass of insulation must be cooled down each time the pump is operated.

Whenever possible, pump suction piping should be separate from other liquid lines. If other pipes must be connected to the pump's suction pipe, a valve must be placed directly adjacent to the connection to prevent a dead-leg. A dead-leg is a void where liquid can vaporize, which adds heat to the fluid and could cause bubbles to flow into the pump and possibly cause cavitation.

Gas Phase Return Piping

To eliminate trapping gas, the gas phase return line for a reciprocating pump should be continuously sloped gently upward toward the tank. Its diameter should match the fitting on the suction adapter, and either a gate valve or ball valve is required.

For centrifugal pumps, a gas phase recirculation line is needed on the discharge side for pump cooldown and startup. A globe valve should be installed in this line to allow throttling during startup. A discharge control valve, downstream of the recirculation valve, must be located as close as possible to the pump to control the flow to be on the "pump's curve." Allowing the pump to start against no restriction, or to fill a large volume before control is established, will cause severe cavitation and likely the inability to "catch prime."

A relief valve must be used to prevent over-pressure from vaporized trapped-liquid when the suction and gas-phase return valves are simultaneously closed. When a relief valve is installed in the gas phase return line, it is not necessary to install a second relief valve in the suction line.

Discharge Piping

Discharge piping should match the discharge fitting size and should be rated higher than the pressure required by the application. A check valve should be installed in the discharge line to prevent backflow. A pressure relief valve must be installed in the discharge piping. Centrifugal pumps must have a discharge control valve as noted above.

Relief Valves

Pressure relief valves must be used to prevent over-pressurization in all pump installations. Their use is even more critical for cryogenic fluids. Ambient heat leak will vaporize trapped liquid, which causes a large pressure increase if the fluid can not expand. Relief valves must be used at all potential trapped-liquid points. Particularly between a reciprocating pump's discharge and a downstream valve, between isolation valves, and between an isolation valve and an upstream check valve.

Centrifugal Pumps Supplied from a Trailer

The following additional issues should be considered when installing a centrifugal pump that is supplied from a trailer:

Minimize length of flex lines, as the trailer's flexible transfer hose adds even further to the overall piping length connected to the suction fitting. This is a heat leak and cavitation issue.

Provision should be made for supporting the trailer transfer hose in the middle of its length to prevent the hose weight from applying unnecessary stress on the suction fitting.

A "witch's hat" strainer should be used in the suction line. Be sure that the open surface area of the strainer is 1.5 times the diameter of the suction piping. A differential pressure gage should be used across the suction strainer.

Instrumentation and Controls

Pumps must be instrumented for proper control and maintenance. As a minimum, a discharge pressure gage must be used to control the operation within the pump's design limits.

For unattended operation, fully automated systems are available to control the operation and shut down the pump if a fault occurs, such as cavitation, seal leak, or over-pressurization.

The issues discussed provide general guidance for pump installations. However, each installation is unique. Always use sound engineering practices for a pump installation. If unsure of the proper criteria, contact ACD, or one of our authorized worldwide service centers (see page 5) to discuss your specific application and installation details.

For more information, visit www.acdllc.com.