process HEATING

FOR MANUFACTURING ENGINEERS WHO USE HEAT PROCESSING EQUIPMENT AND SUPPLIES.

A bnp PUBLICATION

June 2014 • Volume 21, Number 6

PROCESS HEATING 20th 1994 – 2014 ANNIVERSARY

Design and Operation

THERMAL EXPANSION TANKS

Heat Processing Technologies for these 9 Industries

- Chemicals/Petrochemicals
- Food Processing
- Finishing
- Plastics/Rubber
- Pharmaceuticals
- Pulp/Paper/Wood/Converting
- Ethanol/Biodiesel
- Packaging/Printing
- Electronics

Watch a video and learn how to use these tabs!

Follow us on:

www.process-heating.com

THERMAL EXPANSION TANK

Design and Operation

A low maintenance heat transfer fluid system can be provided via a properly designed and operated thermal expansion tank.

By Ken Devore,
Eastman Chemical Co.

Heat transfer fluid systems are used around the globe to provide indirect heating and cooling to process users. Because all heat transfer fluids will change in volume when heated or cooled – with a potential increase of 30 percent or more when heated from ambient temperatures to normal operating temperatures – an expansion tank is an essential and necessary component in a liquid-phase heat transfer fluid system.

A well-designed and properly operated expansion tank is more than just a wide spot in the system to allow for fluid expansion and contraction. It also can:

- Serve as the main venting point of the system for removal of moisture and low boiling components.
- Provide positive head pressure to the suction of the circulating pump.
- Act as a reservoir for fluid that is maintained at a lower temperature than the fluid that is circulating through the system.

The expansion tank also provides a location in a heat transfer system to apply an inert gas blanket and a good spot in the system to add makeup fluid.

What are the important considerations for a well-designed expansion tank? First, it must be sized correctly. The expansion tank should be sized to hold about a 25 percent level when the fluid is cool and have no more than a 75 percent level when the system is at its maximum operating temperature. Different fluids have different coefficients of expansion, so a design consideration should include the possibility of changing fluids in the future. This may result in an additional safety factor when sizing the expansion tank to accommodate a change to a fluid with a higher coefficient of expansion than that of the fluid initially used in the system.

The 25 percent "cold" minimum level should be maintained to ensure that there is always sufficient fluid in the system to provide the necessary head pressure at the circulating pump suction, and to provide good visibility of the liquid inventory level. The 75 percent "hot" maximum level should provide adequate free space in the tank for any vapor disengagement. Using these guidelines for sizing will usually result in an expansion tank sized to hold about 30 to 50 percent of the total system fluid volume.

Ideally, the expansion tank should be located at the highest point in the system to allow for the most effective collection and purge of noncondensable gases and to provide the most suction head to the circulation pumps. Pump suction head also is optimized when the tank is connected to the main circulation loop, close to the suction of the circulating pump. There are several different expansion tank designs, but a preferred design is a tank with a double-drop-leg arrangement, where the diameter of the drop-leg piping is as close to the same size as the return header as possible. This design allows for full fluid flow through the expansion tank during startups and during times when moisture or low boilers must be vented from the system. It also allows for pass-by flow during normal operations. A simple schematic of an expansion tank design is shown in figure 1.

Because it is critical that the expansion tank not be overfilled or emptied, the system design must include instrumentation to provide accurate level measurement. The instruments should provide both high and low level alarming capability as well as a low level switch to shut down the heater if the fluid level is lost. A high temperature sight glass can be installed to serve as a visual backup for the level sensors. Magnetic level sight glasses can provide a more visible indication of the liquid levels than traditional sight glasses, which can darken with time and often be difficult to read. It also is desirable to have an indication of the temperature of the liquid in the expansion tank and a measurement of the pressure in the tank.

The expansion tank will need overpressure-relief protection with discharge directed away from potential ignition sources and areas where personnel are likely to be. The tank also needs a vent line for removal of noncondensables, moisture and any low boiling components that may form in the fluid. The design should provide a small vessel for the collection of condensed liquids and to capture any overflow if the system is inadvertently overfilled.

The expansion tank should be equipped with an inert gas blanketing system:

- To prevent introduction of atmospheric moisture into the system.
- To eliminate a reactive atmosphere in the expansion tank.
- To prevent oxidation of the fluid at elevated temperature.

Nitrogen is the most commonly used blanketing gas, but carbon dioxide or natural gas also can be used with the appropriate design considerations. The inert gas should be introduced into a nozzle on the opposite end of the expansion tank from the vent line. This configuration allows the gas to sweep across the vapor space of the tank when controlled venting is desired and aids in the removal of moisture or low boiling materials. Normally, there will not be a continuous flow of inert gas through the expansion tank. The design should incorporate a low-pressure regulator for the inert gas supply and a pressure control valve on the discharge vent line, so that a "pad" of inert gas is maintained on the tank.

Also, it is important that an expansion tank be operated properly. To provide for fluid expansion and contraction, a conduit from the system to the expansion tank must be open at all times. During normal operation with a tank that is equipped with double

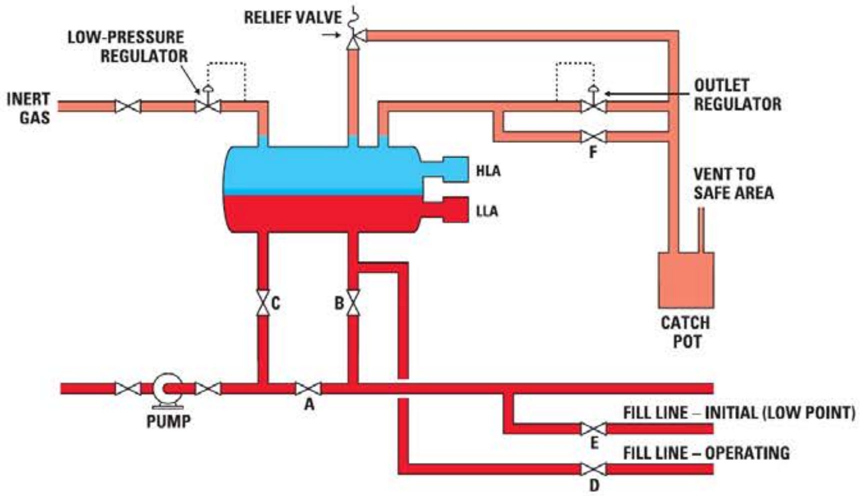
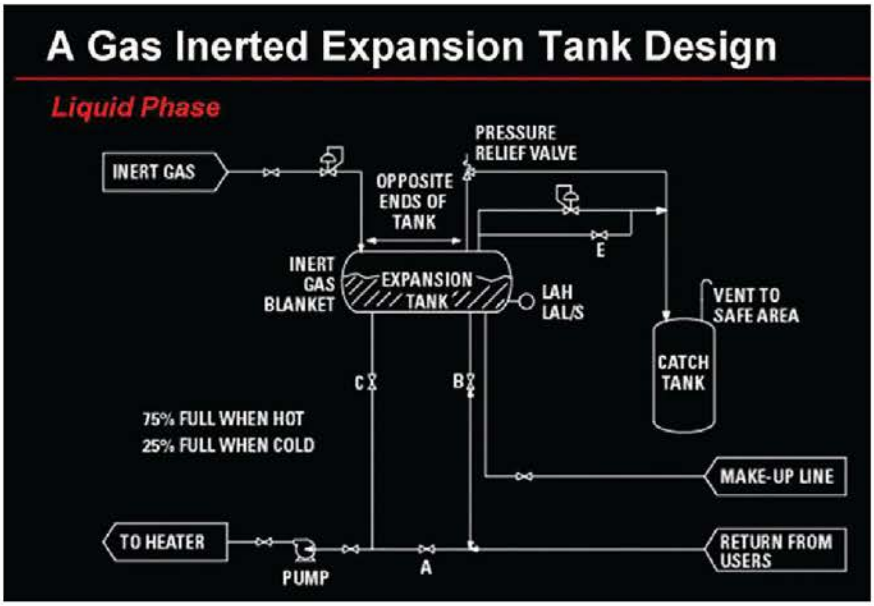


FIGURE 1. Shown here is a basic design for an expansion tank. A preferred design for an expansion tank is one with a double-drop-leg arrangement, where the diameter of the drop-leg piping is as close to the same size as the return header as possible. This design allows for full fluid flow through the expansion tank during startups and during times when moisture or low boilers must be vented from the system.



The expansion tank should be equipped with an inert gas blanketing system to prevent introduction of atmospheric moisture into the system, to eliminate a reactive atmosphere in the expansion tank and to prevent oxidation of the fluid at elevated temperature.

drop legs, only one of the legs (through either Valve B or Valve C, as shown in figure 1) is open to the system and the fluid is passing by the expansion tank (through Valve A). This is important because the nearly static fluid in the expansion tank will be at a lower temperature – typically 150 to 200°F (83 to 111°C) cooler than the fluid circulating through the system – and this can help prolong the operating life of the fluid. It is even more important in systems that do not have an inerted expansion tank. When the fluid flow is directed through an expansion tank in which oxygen is present, the increased temperature and turbulence of the fluid serve to greatly increase the rate of fluid oxidation.

With proper expansion tank operation, you can help ensure that your system runs safely and provides the low maintenance operation that you should expect from a heat transfer fluid system.

The only times that system flow should be directed through the expansion tank of the illustrated design would be during a system startup or when fluid analysis results indicate that either the moisture content or the low boilers content are too high. Under these circumstances, the fluid flow should be directed through the expansion tank: opening both Valve B and Valve C while throttling back on Valve A. The vent valve (Valve F) on the expansion tank should be opened to allow moisture or other low boiling components to be purged from the system. Once the volatile components are adequately purged from the system, the manual vent valve should be closed and the fluid flow should be redirected to pass by the expansion tank by re-opening Valve A and closing either Valve B or Valve C – but not both.

One of the advantages of a heat transfer fluid system is that it can operate for years with only minimal attention. By incorporating the key expansion tank design considerations outlined, you can lay an important cornerstone for a safe, efficient and easy to run system. With proper expansion tank operation, you can help ensure that your system runs safely and provides the low maintenance operation that you should expect from a heat transfer fluid system.

Ken Devore is a senior associate with Therminol Technical Services at Eastman Chemical Co. The Kingsport, Tenn.-based company can be reached at 800-433-6997 or visit www.therminol.com.

WEB EXCLUSIVE

Monitoring Tips for an Expansion Tank

Routine operational monitoring of the expansion tank should include liquid level in the tank, liquid temperature and pressure, among others. Observing your expansion tank will tell you about your heat transfer system.

www.process-heating.com