CONDENSING PRESSURE BASICS

High condensing pressure is one of the most often misunderstood and misdiagnosed conditions in refrigeration systems. With a good understanding of the basics of condensing, and a few simple diagnostic steps, high condensing pressure can be easily diagnosed and corrected.

If condensing pressure rises above normal levels, the cause must be determined before taking corrective action. A few simple steps can determine the cause. First, it is necessary to understand that if the supply of condensing water is maintained at a steady temperature and flow rate, condensing pressure will fluctuate in direct correspondence to compressor load. It is therefore important to keep diligent log entries, so patterns can be recognized. The study of operating logs will establish predictable condensing temperatures under a variety of operating conditions.

NON-CONDENSABLE GASES

In the event that air or any other non-condensable gas enters the system, it will be evidenced by an increase in condensing, or discharge pressure. This increase in pressure results from two separate but related causes.

(1) The effect of combining two or more different gasses within one pressure vessel, governed by the law of partial pressures (Dalton's Law of Partial Pressures). Simply stated, the total pressure of a gas mixture equals the sum of the partial pressures that make up the mixture. If the pressure at which refrigerant is condensing is 150 PSIG, and there is a quantity of air in the condenser that would create 20 PSIG *with no refrigerant present*, then the resultant pressure will be 170 PSIG. In other words, if the refrigerant was removed and the air left behind, the remaining pressure would be 20 PSIG; or if the air was removed (as with purging), the resultant pressure would be 150 PSIG.

(2) As air accumulates in the condenser, it occupies space that would otherwise be available for refrigerant. This will effectively reduce the amount of surface area available upon which refrigerant vapor can condense. Any condensing surface that is in direct contact with air cannot also be in direct contact with refrigerant. If other factors remain constant, a reduction in condensing surface will always cause an increase in condensing pressure.

Air, or any other non-condensable gas, will always flow to the condenser (and sometimes the receiver as well), regardless of how or where it entered. Once a non-condensable gas enters the condenser and receiver, it will not flow out with liquid to other parts of the system since it cannot condense. It can only be removed by purging to atmosphere. Purging from any point on the low pressure or intermediate pressure sections of a system WILL NOT remove non condensable gases.

PURGING

Halocarbons

Stop the compressor, isolate the condenser from the system, and leave the water running. This will allow any refrigerant to condense. Any non-condensable gas will remain at the top of the condenser, as the refrigerant vapor is heavier. Connect a service hose to the access valve on top of the condenser. Leave a pressure gauge connected, as it will be necessary for determining progress. Carefully open the service valve, allowing the non-condensables to discharge to atmosphere. As non-condensables are purged, the pressure inside the condenser will be reduced. When all non-condensables have been removed, the pressure (saturation temperature) will correspond to the water temperature provided that liquid refrigerant is present. If the condenser contained enough non-condensable gas to displace all of the refrigerant, the resulting pressure will be lower than saturated until the isolation valves are opened to expose the condenser to liquid refrigerant.

It is important to note that air can only enter the refrigeration system from leaks in the suction side when the system is operated in a vacuum, or when some part of the system is open for servicing. It is imperative that equipment or components that have been open for any reason be pressure tested and evacuated prior to the resumption of operation. If air is discovered and no part of the system has been open, it can be assumed that one or more leaks exist in the suction side of the system. If this is the case, then the leak(s) must be identified and repaired to prevent further ingress of air.

Ammonia

Removing air with system stopped

After pumping the system down to obtain a nearly full high pressure receiver, stop the compressor and leave the water running. This will allow any refrigerant to condense. Any air will remain above the liquid ammonia and below the ammonia vapor (which is lighter than air). Connect one end of a service hose to the access valve on top of the receiver and lead the other end to a barrel of water, securing it so it cannot come out of the water. Leave a pressure gauge connected, as it will be necessary for determining progress. Carefully open the service valve, allowing the air to discharge into the water. Air entering the water will form bubbles, while ammonia gas will be absorbed into the water without forming bubbles. As air is purged, the pressure inside the condenser will be reduced. When all air has been removed, the pressure (saturation temperature) will correspond to the water temperature.

Removing other gases lighter than ammonia with system stopped

See procedure for purging from halocarbon systems.

WATER FLOW

At the first sign of abnormally high condensing pressure, check to ensure that there is adequate water flow through the condenser. There are three ways to verify this.

(1) The most obvious is a visual check.

(2) The flow rate can be gauged with fair accuracy by subtracting the water outlet pressure from the inlet pressure. Some condensers are furnished with a capacity chart that will give corresponding flow rates for various pressure drop values.

If a visual check is not practical, indeterminate, or inconclusive, a solid grasp of the following relationship will help rule water flow in or out.

Each pound of water circulating through the condenser has the ability to carry away one b.t.u. of heat per degree Fahrenheit of temperature rise.

For example, if the compressor is rejecting 1,000,000 b.t.u./hour to the condenser, and there is a flow rate of 200 gal./minute of 85°F water, the following relationship can be illustrated.

200 gal./minute X 60 = 12,000 gal./hour X 8.33 lbs./gal. = 99,960 lbs./hour

1,000,000 b.t.u./hour (rejected heat) ÷ 99,960 lbs./hour (water flow) = 10°F (10.004) water temperature rise across the condenser. Therefore 85°F entering water would exit at 95°F.

If the water flow is reduced from 200 gal./minute to 100 gal./minute, the result would be:

1,000,000 b.t.u./hour (rejected heat) ÷ 49,980 lbs./hour (water flow) = 20°F (20.008) water temperature rise across the condenser. Therefore 85°F entering water would exit at 105°F.

Using this formula, any of the three variables can be solved for if the other two are known.

If condensing pressure is higher than normal with adequate water flow, (temperature of the water exiting the condenser lower than normal) it may be assumed the condensing surface is fouled. It must next be determined whether the fouling is on the inside or outside of the tubes. Stop the compressor and maintain water flow through the condenser while observing the refrigerant pressure in the condenser. After allowing temperatures to equalize, if the refrigerant pressure corresponds to a saturation temperature that equals the water temperature, the fouling is on the water side of the tubes, and they will need to be cleaned. If the pressure remains higher than the saturation temperature that equals the water temperature, then the fouling is on the refrigerant side of the tubes, and purging of non-condensables is required. It should be noted that if the symptoms indicate that the water side is fouled, there is a possibility that the tubes are clean but water is short-circuiting. It is possible in a multi-pass configuration, for water to bypass the flow dividers and exit the condenser without flowing through all the tubes. This scenario would be unusual, but this discussion would not complete without addressing that possibility.