Progress Supply Inc. THE INSIDE STORY

Helpful Information for HVAC Contractors from Progress Supply

This is one of a series of technical bulletins from your friends at Progress Supply

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CAPACITY REDUCTION CONTINUED

In the last issue of the Inside Story, we discussed the ***'why's'*** and ***'how's'*** of capacity reduction. We also discussed how the different types of compressors can have their capacity reduced. Let's do a quick review and then get into a discussion of various systems that need and/or use capacity reduction. In this article, we will also look at another means of reducing the **system's** capacity.

In review, Copeland models 9, 3D, 4R, 4D, 6R, 6D and 8D can have their capacity reduced by cylinder unloading. The screw compressor uses either a slide vane or entrance port unloading. Currently, the scroll compressor uses entrance port unloading.

Typically, in a residential air-conditioning system, there is no need for unloading. They use on/off operation, 100% unloading. The cooling load in these systems is relatively constant, changing only as the outside ambient temperature changes.

Large building air-conditioning systems, however, have changing load conditions as a result of both the outdoor ambient and internal load changes. The internal load changes are due to lighting loads, people loads and equipment loads. The people load change is the result of people entering and leaving the building. This internal load change can not only be large, but can happen over a short period of time. First thing in the morning, a large number of people enter the building, turn on lights and pieces of equipment such as computers. The load on the system has increased, calling for more cooling capacity. In addition, these changes may not occur all at once. If these changes occur at the same time, on/off control might be acceptable. *Then, how do we keep the cooling system operating properly with these changing loads?*

The cooling media for the many buildings is chilled water supplied by a chiller or chillers. The chilled water is circulated to the individual terminal units or to large air handlers located in equipment rooms throughout the building. As the cooling loads at these terminal units change, the amount of chilled water needed is changing. This change results in the return water temperature to the chiller(s) changing. As the return water temperature falls, the amount of cooling provided by the compressor(s) must be reduced. If the compressor's capacity is not reduced, the suction pressure will fall, causing the refrigerant's temperature to fall. At some point, the refrigerant temperature can drop below 32°F, ultimately freezing the water in the chiller barrel. The control system should turn the compressor off before a freeze up occurs. This results in on/off control and a water temperature change that may be unacceptable to the occupants of the building. In this type of system, it is important to keep the suction pressure up and to keep a relatively constant water temperature flowing to the cooling systems. To do this, the compressor(s) capacity must be reduced, unloaded. The compressor and the number of compressors on the chiller will determine the unloading method.

If the system has multiple compressors, system unloading can start by turning off compressors in sequence. Additional intermediate steps of unloading can be accomplished by unloading each compressor. This provides even closer control of the suction pressure and water temperature.

Depending on the needs of the space(s) being cooled, it may not be feasible to turn off all of the compressors. In this type of system, when the last compressor is at its last step of unloading, turning off the compressor may cause compressor short cycling or too wide of a temperature change of the water, therefore, too wide of a space temperature change. If this is the case, then hot gas by-pass may be used.

What is Hot Gas Bypass? This is a process that allows the hot gas in the compressor discharge line to go into the suction line. This keeps the suction pressure up in the normal range for which the system has been designed. If the system is an air-conditioning application, the normal suction pressure should be in the range of 70 to 76 psig. Now the question is, *"Why do I want to keep an air-conditioning system running when the suction pressure is indicating that the load has fallen off? Why not just shut the compressor off?"* Yes, shutting the system off is an option and, if your system can tolerate it, this is the way to go. However, if your system depends on relatively close temperature control, this may not be acceptable.

Hot gas by-pass is a rather common way to keep the suction pressure up in order to keep the compressor operating and not allow the suction pressure, therefore, the suction gas temperature to get so low to cause compressor and system problems. As stated earlier, a hot gas by-pass system allows the hot compressor discharge gas to be metered into the suction line in order to keep the suction pressure up to a predetermined value. A hot gas by-pass valve, such as an **ALCO CPH or CPHE Direct Operated Hot Gas By-pass Regulator,** is installed between the system's discharge line and the suction line. The valve measures its outlet pressure, the suction pressure, and should the suction pressure fall below the valve's set point, the valve will modulate open to let the high discharge pressure refrigerant into the suction line. When the suction pressure is at or above the hot gas by-pass regulator's set point, the valve will close.

Sounds simple. Yes, this will keep the suction pressure up. However, it will also cause the suction gas temperature to rise to an unsatisfactory level. Compressors do not like high return gas temperatures. This can, and will, cause compressor failures. When using hot gas by-pass to keep the suction pressure up and to reduce the systems capacity, some means must also be used to cool the suction gas before it goes into the compressor. OK, now what do we do?

If it has been decided that hot gas by-pass is needed, the next decision is where in the system to install it. There are, typically, two choices — at the evaporator or at the compressor. Although the result is the same, the installation and the accessory items needed are different. The questions that need to be answered are — how many evaporators are there and how far is the evaporator from the compressor?

If there is only one evaporator and it is relatively close to the compressor, the hot gas by-pass valve can be installed at the evaporator location. Before the installation can be made, the type of distributor used with the evaporator must be determined. *There are two types of distributors, the* ***Sporlan type*** *and the* ***venturi type.*** Which one is used will determine how the Hot Gas By-pass valve is installed into the system.

The refrigerant line feeding the hot gas by-pass valve can be taken off of the compressor discharge line anywhere between the compressor and the condenser. At the take off, a solenoid valve MUST be installed in the hot gas line to the valve. The outlet of the valve is piped into a TEE that is installed between the TEV and the coil's distributor. If the distributor is a Sporlan type, the tee must be a Sporlan Auxiliary Side Connector (ASC). DO NOT use a standard tee. If the distributor is the venturi type, a standard tee is used and not the ASC. In this type of installation, the TEV not only provides refrigerant control to the evaporator, but it also acts as a desuperheater valve to cool the hot gas before it returns to the compressor.

A side note. It is important that the solenoid valve be installed at the hot gas take off at the discharge line and not at the hot gas valve location. When the compressor is to be shut down, pumped down, the hot gas solenoid must be deenergized. This will allow the hot gas in the hot gas line to be pumped down also. If it is not pumped down, the gas in that line can condense and will return to the compressor's suction connection as a liquid during the next run cycle.

When there is more than one evaporator, or if the piping run between the compressor and the evaporator is relatively long, then the hot gas by-pass valve is generally installed at the compressor location. In this installation, the hot gas takeoff will generally be several feet away from the compressor's discharge connection. Again, a solenoid valve must be installed near the takeoff in the hot gas line. The outlet of the hot gas valve is connected into the compressor's suction line. This connection should be installed upstream of an accumulator or at last two elbows upstream of the compressor. If neither of these connections is practical, then the connection should be made with the connection pointing upstream of the compressor. In this type of installation, a DeSuperheating TEV, such as an ALCO LA(E) or LCL(E) must be used. The function of this valve is to cool the hot return gas before it enters the compressor. Again, when the compressor is to be shut down, pumped down, the hot gas solenoid must be deenergized so that the compressor can pump down. Without the solenoid valve, or if it is not shut off, the hot gas valve will continue to provide refrigerant to the suction side of the compressor and it will not pump down.

Either reducing the compressor's capacity or effecting the system's capacity can do capacity reduction. In some systems, both techniques must be used. Systems such as computer room systems may require capacity reduction. When the cooling load has fallen off does not mean the need for dehumidification has gone away. Yes, the cooling system may have to continue to operate just for dehumidification. There are other systems that need capacity reduction, such as cooling tunnels, close tolerance laboratories and gage calibration rooms, for example. ***When one runs into such systems, consider the basic application of compressor unloading and/or hot gas by-pass.***