Progress Supply Inc. THE INSIDE STORY

Helpful Information for HVAC Contractors from Progress Supply's George Story

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

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SUCTION PRESSURE REVISITED

Some time ago, Dick Snyder of the Copeland Corporation wrote an article entitled **"Keep the Suction Pressure Up."** As true as that was then, it is still true today. Unfortunately, as time has passed, this truth seems to have been forgotten. Let's look at suction pressure and what happens to the system and the compressor when one "plays" with suction pressure.

What should the suction pressure be? The next question is where? First, one needs to know the temperature of the space being cooled, the refrigerant being used and the coil design. Let's assume that we are air conditioning an office space. The generally accepted air temperature of the air leaving the cooling coil is 55°F. This dictates a 45°F refrigerant temperature in the coil, based on a 10° Delta T (ΔT), the difference between the refrigerant temperature in the evaporator and the leaving air temperature. Being an air conditioning system, R-22 is currently today's most used refrigerant. The Pressure Temperature (P/T) chart shows that for a 45°F refrigerant saturated suction temperature, the pressure should be 76 psig. With this knowledge at hand we can state that the suction pressure should be 76 psig. But where?

By convention, one would say at the compressor. Generally, this is where an access valve is located. It may be the only place in the system that one can read the suction pressure. Not only may this be the only place where an access valve is located; many technicians believe that all suction pressure readings in the system are the same. However, this could be a bad place to read the needed suction pressure at the evaporator coil outlet.

If you want to know the saturated refrigerant temperature at a place in the system, you need to know the pressure at the place it is needed. If you want the coil's saturated refrigerant temperature, you need the pressure at the coil. A basic law of physics is that if there is flow through a pipe there is pressure drop; therefore, the pressure at the compressor will be lower than the pressure at the coil outlet.

As the refrigerant flows from the outlet of the coil to the compressor there will be pressure drop. The amount depends on a number of things. The actual pressure at different places in a system must be measured, it cannot be calculated. If one reads the pressure at the compressor and assumes this is the pressure at the outlet of the coil they may be making a serious mistake.

The problem is that the space temperature is not getting to the desired value. First and foremost, has something changed in the space? Has a load been added that was not taken into consideration in the original design? So you decide that the way to get additional capacity from the unit is to lower the suction pressure. This will get the refrigerant colder. Yes, as the suction pressure is lowered, the refrigerant does get colder. Look at your P.T. chart. However, as the refrigerant gets colder, the unit's capacity does not increase; in fact, it decreases.

When one looks at a compressor curve you will note that the compressor's capacity is a function of the suction and discharge pressures at the compressor (Figure 1). The curve shows that the suction pressure has the greater effect. When the suction pressure goes down and/or the discharge pressure goes up, the compressor's capacity goes down. From the compressor's perspective, its capacity is based on the pressures measured at the compressor and not on the values anywhere else in the system. Why? The compressor cannot consider system pressure drop. First of all, system pressure drop is not a constant. It changes as the load on the system changes. Even though the suction pressure at the coil outlet being correct, it is the suction pressure at the compressor that is a major consideration that determines the system capacity.

With respect to the suction pressure at the compressor, let's look at the question asked earlier. . . . "the suction pressure where?" The suction pressure at the compressor has two basic effects on the compressor. One is its capacity, the second is the discharge temperature. We will examine each of these effects.

Every compressor has a fixed displacement. Displacement is a function of the compressor design. In a reciprocating semi-hermetic or hermetic compressor design for all practical purposes, neither you nor I can change it. The pounds per hour of refrigerant in circulation, LBS/HR, are the displacement, FT^3/HR, times the density, LB/FT^3, of the refrigerant entering the compressor. As the suction pressure is reduced so is the refrigerant's density. Basic math shows that as the suction pressure goes down so does the compressor's capacity.

The compressor is moving a vapor, a superheated vapor. As its pressure is lowered, its density is lowered. With these facts, the BTU/HR capacity of refrigerant goes down as the suction pressure at the compressor goes down. To keep the capacity up, keep the suction pressure up.

Next, as the discharge pressure goes up, the compressor's capacity goes down. This happens primarily because of additional re-expansion. Of the two

Figure 1

conditions, lowered suction pressure or higher discharge pressure, suction pressure has the largest impact on capacity.

Using the curve for a Copeland CR18K6 compressor (Figure 1), let's examine capacities as a function of suction pressure and discharge pressure at the compressor. The curve shows that at a suction pressure of 76 psig, 45°F R-22 and at a discharge pressure of 260 psig, 120°F R-22, Point A, the compressor's capacity is 20,000 BTU/HR, Point B. If the suction pressure is lowered by 7.5 psig, to 68.5 psig, Point C, a reduction of 5°F saturated suction temperature, the compressor's capacity is reduced to 17,600 BTU/HR, Pointy D, a loss of 2400 BTU/HR. It takes a rise in discharge pressure of 37 psig to see a 2400 BTU loss in compressor capacity.

To examine the consequences of discharge temperature, it is necessary to go into a Pressure Enthalpy (PH) diagram. Under ideal conditions, at compressor entering conditions of 65°F return gas, 76 psig suction pressure (45°F saturated suction temperature) and a discharge condition of 120°F saturated discharge temperature, 259.9 psig. The compressor's approximate discharge temperature will be 160°F. Lowering the suction pressure by 7.5 psig to 40° saturated suction temperature, causes the discharge temperature to rise to 180°F.

Keeping the suction pressure at 76 psig and raising the discharge pressure by 37 psig, 296.8 psig, 130°F, saturated discharge temperature will cause the discharge temperature to rise to 180°F. A drop in suction pressure of 7.5 psig has the same effect on compressor discharge temperature as a 37 psig rise in discharge pressure. Like capacity, suction pressure changes have a greater impact on discharge temperature than do changes in discharge pressure.

Let's take a quick look at a medium temperature application. The example will be a walk-in cooler to be maintained at 35°F. The compressor for this example is a Copeland Discus 4DA3-2000. Again, let's use R-22 as the refrigerant. The 35°F space temperature requires a 25°F saturated refrigerant temperature or a suction pressure of 49 psig.

Considering only the compressor again, at 25°F saturated suction, 49 psig, and at 120°F saturated condensing, 260 psig, the approximate discharge temperature will be 175°F. The compressor's capacity will be 140,000 BTUH.

If one makes the decision to lower the saturated suction temperature to 15°F, 38 psig, to get more capacity, the compressor chart shows that the capacity will decrease to 110,000 BTUH, a loss of 30,000 BTUH. The compressor's discharge temperature will rise to 200°F. This is a lowering of suction pressure by only 11 psig, not very much.

Returning to the base pressure consideration, let's change the discharge-saturated temperature to 130°F, 296.8 psig, a rise of 37 psig. The capacity will now be 125,000 BTUH, a loss of 15,000 BTUH. The discharge temperature will be approximately 180°F. Yes, suction pressure still has the greater effect on compressor capacity and discharge temperature. This condition is even more dramatic at 15°F suction temperature. Capacity is 100,000 BTUH and the discharge temperature rises to 215°F. This is getting close to a major problem.

No matter what the application, High Temperature, Medium Temperature, or Low Temperature, suction pressure is the more important.

Yes, KEEP THE SUCTION PRESSURE UP.

SUGGESTIONS

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