SUCTION PRESSURE: HOW IMPORTANT IS IT ?

Understand that low compressor capacity problems are reallv a lack of load. Low load causes higher compression ratios and causes low capacitv. Therefore, check everv possible cause of low load.

When a service technician is called to a job, and the complaint is lack of cooling the technician looks for a few obvious things. Failing to find anything, one must decide where to start the system diagnosis. This usually involves installing a service manifold and gauges at the compressor and observing operating pressures, a judgment must be made about the suction pressure.

A few pounds of suction pressure below the desired operating pressure can cause significant losses of capacity in a perfectly performing compressor. While most service technicians grow concerned about high head pressures in summertime, they sometimes forget that increases in head pressure of a few pounds cause an insignificant loss of capacity.

Conversely, a small drop in suction pressure at the compressor can reduce its capacity by a significant amount. Compressors operating on R-22 suffer capacity losses of 2% to 4% for pressure drops of only 2 PSIG, and losses of 10% or more for pressure drops of 6 to 7 PSIG. The situation gets worse as the operating pressures go down into the medium and low temperature range. The capacity of a compressor with R-22 is reduced less than 1/2% to 1% for each 5 PSI increase in head pressure. Power increases about 1%.

It is clear that every effort should be made to keep suction pressure at the highest pressure possible, with the correct charge and air flow and less time spent worrying about head pressure.

Every reciprocating compressor must have head clearance above the piston in the cylinder. Otherwise the piston would strike the valve plate. At the end of the compression stroke, this high-temperature and pressure gas never gets discharged.

Instead, as the piston goes down on the intake or suction stroke, the gas re-expands into the cylinder. The lower the suction pressure, the farther the piston must go down in the cylinder before any suction gas can enter the cylinder.

There are other losses of capacity due to temperature interchange in the cylinder, but re-expansion remains the major cause of low capacity and efficiency.

The amount of gas that a compressor actually pumps at any particular suction and discharge pressure, compared to the theoretical volume of the cylinder, is called volumetric efficiency. The volumetric efficiency of a reciprocating compressor varies with suction and discharge pressure. When you determine these two pressures, they must be converted from PSIG to pounds per square inch absolute (PSIA) by adding 14.7 lbs. atmospheric pressure.

Then the discharge pressure must be divided by the suction pressure stated as PSIA. Example:

Suction Pressure = 5 PSIG + 14.7 = 19.7 PSIA
Discharge Pressure = 185 PSIG + 14.7 = 199.7 PSIA
200 PSIA / 20 PSIA = 10:1 Compression Ratio

If the suction pressure is reduced 9 lbs. to 11 PSIA, the result is a higher compression ratio. Example:

200 PSIA / 11 PSIA = 18:1 Compression Ratio

To arrive at 18:1 compression ratio by a change in head pressure, you would need to increase the head pressure to 361 PSIA. Example:

361 PSIA / 20 PSIA = 18:1 Compression Ratio

In these examples a 1 lb. reduction in the suction pressure has the same effect as a 16.1 lb. increase in the discharge pressure.

Where does this leave the service technician with a low-capacity problem?

First, find causes of low suction pressure at the compressor. Understand that low compressor capacity problems are really a lack of load. Low load causes higher compression ratios and causes low capacity. Therefore, check every possible cause of low load.

What should the suction pressure be on any particular type of system?

There are many rules of thumb, but none work under all conditions. What are the varying conditions?

* Air volume through the indoor coil
* Ambient air temperature to the outdoor condenser
* Entering air wetbulb temperature to the indoor coil
* Fixed orifice metering, such as capillary tubes
* Mismatched coils and condensing units
* Suction line sizing and piping

Air volume through indoor coil:

Most manufacturers claim to allow +/- 10% design air volume across the indoor coil. The nominal volume of air required is 400 cfm/ton of capacity. In other words, a 3-ton unit should have 3 x 400 = 1,200 cfm. A 5-ton unit should have 5 x 400 = 2,000 cfm.

If air volume is 10 % low, the load on the unit will be 10% low.

Low load causes low compressor suction pressure and low capacities. Therefore, setting fan speed for the correct airflow is mandatory before any judgment of pressures can be made.

Ambient air temperature to condenser:

Residential units often run between 60 degree outdoor ambient and in some climates as high as 95 degree or even 105 degree. While high head pressure doesn't kill capacity like low suction pressures do, it does have an effect.

As head pressure rises, compressor capacities drop and suction pressures rise. As suction pressure rises, the ability to remove moisture from the air deteriorates. Moisture removal is usually a large part of the load. So, outdoor air temperature is significant.

Entering air wetbulb temperature:

Entering wetbulb temperature can represent a large percentage of the load on a coil. Low wetbulb temps mean low loads and low suction pressures; high wetbulbs mean high loads and high suction pressures.

Rules of thumb can't adequately judge suction pressure or head on a system with this many variables.

Fixed orifice metering, capillary tubes:

Add to the problem that the amount of refrigerant in this type of refrigerant control can cause significant changes in suction and discharge pressure, and endanger the compressor's life due to flood-back.

Mismatched coils, condensing units:

The common practice of installing a replacement condensing unit on an existing coil of unknown capacity makes every effort to diagnose the unit a big guessing game.

Here is the only way to diagnose a capillary tube system correctly.

1. Using the system manufacturer's installation manual, follow the procedure for charging the system with refrigerant, or use the manual's condensing unit performance/charging curves.

2. It is imperative that the air volume through the evaporator coil be +/- 10% of the nominal 400 cfm/ton of system capacity.

3. The manufacturers data is no good if mismatched condensing units and evaporator coils are involved.

Suction line sizing and piping:

Even with a good load on the coil, large pressure drops in the suction line tube set will cause capacity loss. (Ie: 7/8 " line instead of 1-1/8 ")

Lacking the manufacturers data, the only way to check the refrigerant charge is by:

1. Establishing correct air volume.

2. Measuring the entering wetbulb temperature to the evaporator coil.

3. Measuring compressor superheat entering the unit.

4. Measuring the ambient air temperature entering the condenser.

5. Comparing these readings with superheat charging table:

The best way to charge a system is by the weight method, pre the manufacturers unit name plate. First, remove any refrigerant in the system. Bear in mind EPA requirements and restrictions on venting refrigerant to the atmosphere. The weight method won't work if a mismatched system is involved.

Failure to charge capillary tube systems correctly has always been an industry problem that costs untold dollars in added operating cost or compressor failure. most contractors do not set air volume accurately, and do not read entering wetbulbs and superheats correctly and accurately.

While this is hypothetical it illustrates how much more critical the need to control suction pressure is than head pressure. The one thought ever present in designing, installing or servicing refrigeration systems should be:

" Keep that suction pressure up by keeping the load up."

Note: The above information, though not a direct quote, was taken from article : "

Suction Pressure, How important is it? "
By: Dick Snyder
January 27, 1992 - Air Conditioning, Heating & Refrigeration News.

18 May 1994

GUIDELINES FOR GENERAL OPERATING TEMPERATURES FOR THE FOLLOWING CONDITIONS

1. R22 REFRIGERANT

2. AIR CONDITIONING SYSTEMS

3.DGT = 95 TO 115 DEGREES F.

1. Suction line temperature (at compressor)

10 to 20 degrees above saturated suction gas temperature (hermeitc units)

10 to 25 degrees above saturated suction gat temperature (direct drive units)

2. Motor barrel temperature near crankcase.

80 to 100 degrees F.

Below 80 degrees may indicate flooding

above 100 degrees may indicate hot motor from

1. Too high superheat
2. Inadequate suction return gas to cool motor under low load conditions

Take motor barrel temperatures at at least three locations to find hot spots of stator, which might indicate rotor drag due to loss of motor end bearings often caused by flooding.

3. Underside of cylinder head

90 to 115 degrees F

Below 90 might indicate flooding

Above 115 is possible an indication of

Unloaded cylinder

Broken valves

Blown gaskets

4, Crankcase temperature

Normally between 105 and 135 degrees F.

Below 105 might indicate flooding

Above 135 degrees might indicate hot running compressor, look for

oil level (too high)

high suction superheat (low charge)

high discharge gas temperatures (determine cause)

5. Discharge gas line temperature (6" from compressor body)

160 to 200 degrees

Temperature below 160 degrees after a reasonable run time might indicate flooding (determine cause)

Temperature above 200 degrees is an indication that unit is running too hot (here again determine cause & correct)

6 Rule of thumb

Discharge temperatures that do not exceed

225 degrees Compressor will probably live a long while

250 degrees, Compressor is in trouble needs help

275 degrees, too late to holler for help, disaster is just around the corner.

Date: ____________________

LOCATION ____________________

Compressor Model: ____________________

Compressor Serial #: ____________________

AMB TEMP								
TIME-DATE								
DISC-PRES								
SUCT PRES								
OIL PRES GAGE								
OIL PRES NET								
SUCT LINE TEMP								
SUCT S/H								
COND GAS TEMP								
INLET								
OUTLET								
SUBCOOLING								
C/CASE TEMP								
DX COIL AIR								
ENTER TEMP								
LEAVE TEMP								
CHILLED WATER								
ENTER TEMP								
LEAVE TEMP								
DISCH GAS TEMP								
RLA L-1								
RLA L-2								
RLA L-3								
VOLTS A - B								
VOLTS A - C								
VOLTS B - C								
COMMENTS:								