TRANE® AIR CONDITIONING

FILE INFORMATION:
DIVISION TAB-TRANE REFRIGERATION PRODUCTS
PRODUCT TAB-MISCELLANEOUS
LITERATURE ITEM-GENERAL SERVICE BULLETIN

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GENERAL SERVICE BULLETIN

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SUBJECT: CORRECT MEASUREMENT OF SUCTION SUPERHEAT

INTRODUCTION

The importance of proper suction gas superheat cannot be overemphasized. The well-being of the compressor is dependent on proper adjustment of the expansion valve. This bulletin provides information that will help in understanding the function of suction gas superheat, and the proper method for adjusting the expansion valve to secure proper superheat.

Definitions: The following definitions can be best understood by studying the pressure-enthalpy (Ph) charts for Refrigerant 22.

1. Saturated Vapor -- A saturated vapor condition can occur at many different pressure and temperature conditions.

   Definition:

   A refrigerant vapor is saturated when at constant pressure, the removal of any heat will cause condensation of the gas. In practice, refrigerant in this state is said to be "wet". If a clear glass tube in the suction line were carrying saturated vapor, it would appear as fog.

2. Superheated Vapor -- When additional heat is added to saturated vapor at the same pressure, it is superheated vapor. In practice, when the refrigerant has been superheated 12 F or more, it is said to be "dry".

   If a clear glass tube were carrying superheated vapor, it would appear clear.

DISCUSSION

The refrigeration system, unlike some mechanical systems, is completely sealed. There is no way to see what is occuring within the system.

A working knowledge of refrigeration, electricity, and controls, along with some specific measurements, is needed to "feel the heartbeat" of the equipment.

For example, a voltage reading, current reading, and a visual inspection of sound and vibration levels are used to determine the condition and loading of

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electric motor. One of the three does not provide sufficient information for a good evaluation of the motor's condition.

Similarly, discharge and suction pressure readings are not sufficient to determine how the refrigeration system is operating.

The addition of an accurate suction superheat reading will tell you:

1. How well the expansion valve is controlling the refrigerant flow.
2. The efficiency of the evaporator coil.
3. The protection the compressor is receiving against flooding or overheating.
4. If sufficient charge is in the system.

Factors Affecting Suction Superheat

1. REFRIGERANT CHARGE - The expansion valve controls the refrigerant superheat leaving evaporator coil by metering liquid refrigerant entering the coil.

   When the refrigerant charge is low, a mixture of liquid and vapor will enter the expansion valve. The volume of a given weight of refrigerant increases as the vapor content increases. At a constant differential pressure across the expansion valve, the weight of refrigerant flow will decrease due to the increased volume. This will result in excessive superheat. This may overheat the compressor motor, reduce evaporator capacity and cause coil freeze-up.

   Over charge does not affect the expansion valve operation appreciably.

2. LOW AIR VOLUME OR LOW TEMPERATURE AIR - Decreases the evaporator load. Single ported expansion valves lose control below 25-35% of their rated capacity. Erratic operating (hunting) will result, alternately starving and flooding the compressor.

3. EXPANSION VALVE SIZE - Distributor size and circuiting in the evaporator are parameters to be considered in the design of the system. However, when servicing the unit, the design normally is considered proper except where there is strong evidence to the contrary.

4. EXPANSION VALVE REMOTE BULB LOCATION AND INSULATION - The expansion valve reacts to a signal received from the remote bulb. If the signal is false, the valve will control improperly.

Measuring Suction Gas Superheat

If the best possible field procedures were followed to measure suction gas superheat, the work would result in an error of 2-5 F. The error will nearly always be on the unsafe side.

For example, if the superheat were 10 F, field measurements would indicate a higher value: perhaps 12-15 F.

Laboratory tests are made using low mass thermocouples inserted into wells located in the gas stream. Field tests use surface pyrometers attached to the outside of the line.

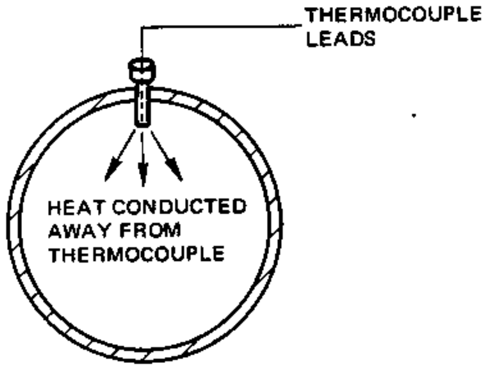

FIGURE 1

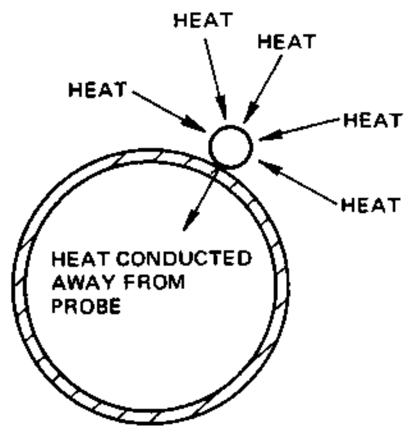

FIGURE 2

From Figure 1, it is evident that the thermocouple junction is sensing temperatures inside the line with little or no outside influence.

From Figure 2, heat is lost from the pyrometer probe to the suction line through a line contact with the tube. However, external heat is added to the probe through the balance of its surface. Therein lies the cause of the error.

To determine suction gas superheat:

Needed: 1. Saturated vapor temperature
2. Actual suction temperature

<u>Where to measure</u> - Take all measurements as close to the expansion valve bulb as possible. If a pressure tap is not available, secure the best suction pressure reading possible. If necessary, correct for the pressure loss in the suction line between the expansion valve bulb location and the point where the pressure is read.

<u>Instruments to Use</u>

1. Gauges - The gauge used to measure suction pressure should be of the best quality available to you. It should be checked for accuracy. Gauges permanently installed on the equipment should not be used.

2. An inexpensive pyrometer is well suited to measure the suction line temperature (Figure 3). There are several manufacturers of these instruments. They are battery powered and usually have two or more inputs with the necessary switches to take input signals from multiple sources.

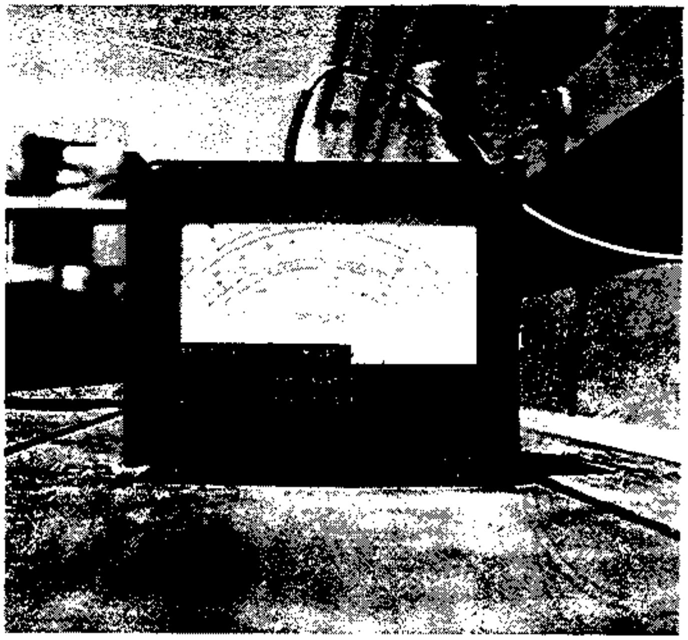

FIGURE 3 - Simpson Surface Pyrometer

Procedure

1. Cut the suction line insulation to gain access to the suction line. If Armaflex is used, it is best to cut around the circumference of the tubing.

2. Clean the line carefully, and attach the sensor. Usually, black plastic electrical tape works well. (Make sure the sensor is in good contact with the tube.)

FIGURE 4

3. Rejoin the Armaflex and seal with the black plastic tape, to prevent sensor contact with the ambient air.

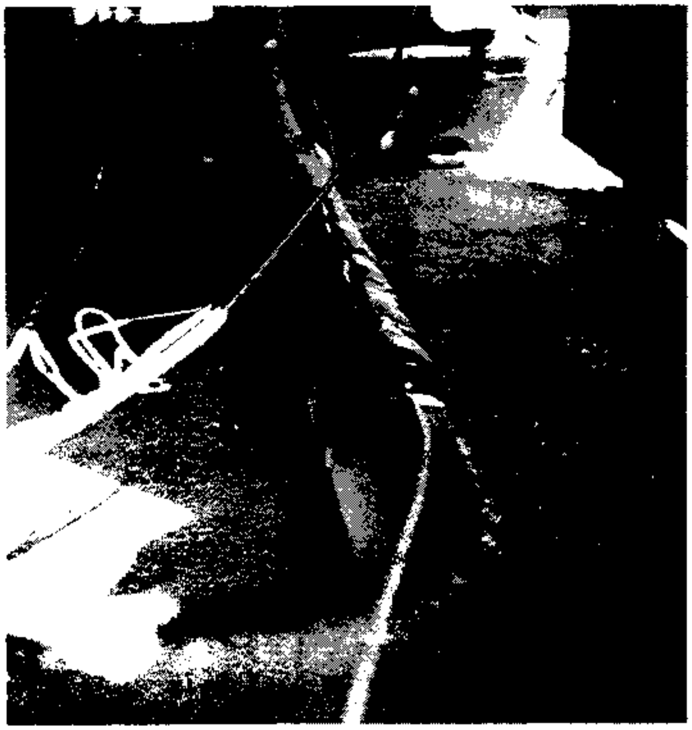

FIGURE 5

4. Important: The most important part of installing the temperature sensor is the proper handling of the insulation around the sensor.

Wrap the pipe and Armaflex with two layers of 1" fiberglass insulation. Extend the insulation at least 6" both ways from the sensor location. Tape carefully in place.

FIGURE 6

5. If sunlight falls directly on the expansion valve bulb location, shade the areas both during the test and after testing is completed. The radiant heat from the sun's rays will heat the Armaflex and cause the expansion valve to overfeed the coil, resulting in flooding at the compressor.

6. Install pressure gauge to monitor suction pressure.

7. Operate system for approximately 30 minutes to be sure the expansion valve has had time to stabilize.

8. After each adjustment allow at least 30 minutes for the valves to re-stabilize.

9. Superheat = actual line temperature minus the saturation temperature corresponding to the pressure read.

   Example 1: Measured line temperature = 48.5 F
   Measured suction pressure = 57.5 PSIG
   Saturated temperature @ 57.5 PSIG = 32.0 F
   Superheat = 48.5 - 32.0 = 16.5 F

   Example 2: Measured line temperature = 48.5 F
   Suction pressure measured at compressor suction service valve 100 feet from expansion valve location = 57.1 PSIG

   It may be necessary to make adjustments for the pressure loss in the suction line. Assuming that the measurement was taken at full load conditions and the tubing was marginally sized, there could be as much as 3 PSIG loss.

   Therefore, the actual suction pressure to use is 57.1 + 3 = 60.1 PSIG and superheat = 48.5 - 34 = 14.5 F.

   Admittedly, there is little reason for concern in the example, but it points out the inherent error possible.

   If the mechanic errs by not insulating the temperature sensor properly, and neglecting line pressure losses, or not allowing sufficient time between tests, the superheat reading he obtains is worthless.

Where to Set Suction Superheat

It has been stated that field measurement procedures are not as accurate as laboratory measurements. For this reason, field adjustments are made to provide a greater margin for safety.

For best results, i.e., safe compressor operation and stable expansion valve operation, it is suggested that the service engineer establish a true suction superheat of 12 F.

Figure 7 is a straight line curve relating the expected error in measurement to ambient temperatures at the point of measurement.

To obtain True Superheat, use the following formula:

True S.H. = Measured S.H. - Correction Factor

Example

Jobsite conditions are:

1. Ambient at point of measurement = 95 F
2. Suction pressure measured = 65 psig
3. Measured suction line temperature = 51 F

True Superheat = (51 - 37.7) - 5.3 = 8 F

In the example, the true superheat is too low and should be adjusted upward.

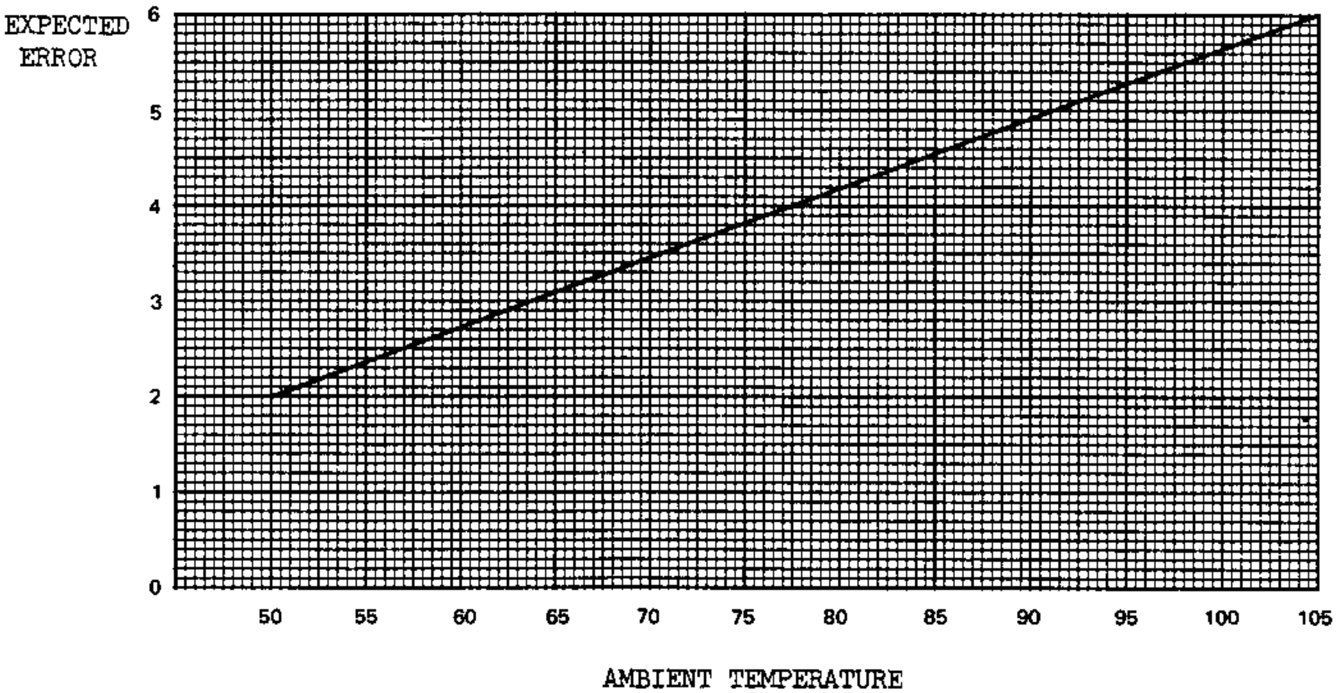

FIGURE 7 - Correction Factor For Superheat Measurement