For system charge and performance evaluation we must take temperatures across the entire system before we can effectively evaluate any part of the system. What we are saying is, every single component within the refrigeration circuit is dependant upon the other components within that system. For that reason it is recommended you take readings from the system in order for any system you want to analyze. I will explain the reasons behind the reading and sequence as you read on. While doing so, I will use acronyms and discuss locations which are outlined on the included diagram. If you are new to the trade, becoming familiar with the following acronyms is highly recommended as you will heat and read them throughout your career.

Acronyms:

Comp = Compressor
Cond = Condenser
MD = Metering device
Evap = Evaporator
ΔT = Delta Temperature (indicating a CHANGE within the same medium)
TD = Temperature Difference (indicating a temperature difference in TWO mediums)
SCT = Saturated Condensing Temperature
SC = Sub Cooling
LL = Liquid Line
SH = Superheat
SST = Saturated Suction Temperature

Readings:

Air entering condenser
Air leaving condenser
Condensing saturation temperature
Liquid line at outlet of receiver / condenser
Liquid line at inlet of metering device
Air entering evaporator
Air leaving evaporator
Evaporator saturation temperature
Suction line temperature at the evaporator
Suction line temperature at the compressor
Compressor voltage and amperage

Systems using vapor compression refrigeration fundamentally all work the same. Since they all work the same, when evaluating the system the criteria and procedures should be the same. To effectively determine and evaluate the net refrigeration effect of the system you must consider all the factors that influence the system. We also must do so in an orderly manner that follows a sense of flow and logic just as the system operates. As the compressor pumps the refrigerant, it is the logical point to begin and follow the same flow that the system maintains.

The compressor pumps the refrigerant to the discharge line. Since no useful information can be gained as far as system performance is concerned, pressures and temperatures in this line are relatively unimportant. Do not misunderstand, a proper operating range exist for this line, however, it reacts to other components opposed to impacts other components. The usual concerns are proper line size or with the few components that might be installed in it like a muffler or oil separator which wile rare, could develop a restriction.

At the condenser we are concerned with far more than just sub cooling. We must consider mediums, the air and the refrigerant. Since the air removes the heat from the refrigerant, we must first prove proper airflow. In optimum conditions by design for entering and leaving air ΔT should be 15 to 20 degrees. If the ΔT is greater than 30, no matter what the SEER rating the unit may have, it is being asked to perform outside its design parameters. When the ΔT is 30 or above reduced BTU capacity and artificially high head pressures result. Because both situations would result in improper flow rate and sub cooling we must correct this before we can proceed. Common causes, dirt, fan speed, improper fan blade, failing motor or capacitor.

Next we need the SCT. It is also imperative that we have the temperature within design parameters If we are in a low ambient condition we will not have the proper pressure differential to push enough refrigerant through the metering device. Metering devices are size by pressure drop and flow rate (tonnage). This requires we bring the SCT to 100 °F. This simulates a 70 to 75°F day where most systems are designed to begin operation. Even systems that are designed for low ambient have components to bring it into this range.

Our next step is to determine our SC. SC is required, however, many technicians have a tendency to misinterpret SC. The SC is only one portion of the system evaluation and can NOT be used as the sole source for charging or system evaluation. Requirements for SC vary only a little and to gain a better understanding of the need one must consider the metering device. The required SC is the difference created by pressure drop through the Cond, LL components and the LL itself plus 1 additional degree SC and the metering device will flow at the correct rate. NOTE: this is in regards to the metering device only not the system. The operation of a refrigeration system needs to be efficient, increasing the SC a little can significantly increase the efficiency without affecting input power a lot and improves overall performance of the system. SC of 10 to 15 degrees is a normal range.

If manufacture specifications are known to have a higher SC, by all means follow their guidelines as it will peak the efficiency of the unit. If you do not have the information, the unit will operate and operate well in the 10 to 15 degree range.

Next we must evaluate the LL. The LL needs to be evaluated as a working part of the system beyond just a transporter of the liquid. Since there are often accessories in the liquid line including the LL filter drier, we must find a way to determine performance. The LL leaving the Cond or receiver will not give up much heat prior to the metering device. This is in relationship to the velocity of the liquid traveling through the line and the TD of the line to ambient conditions. Assuming no change in ambient conditions, there should be no more than a 2°F change in the liquid line between the service and about 6" from the metering device. The 6" is to eliminate any conductive heat transfer that might take place from the cool side of the metering device.

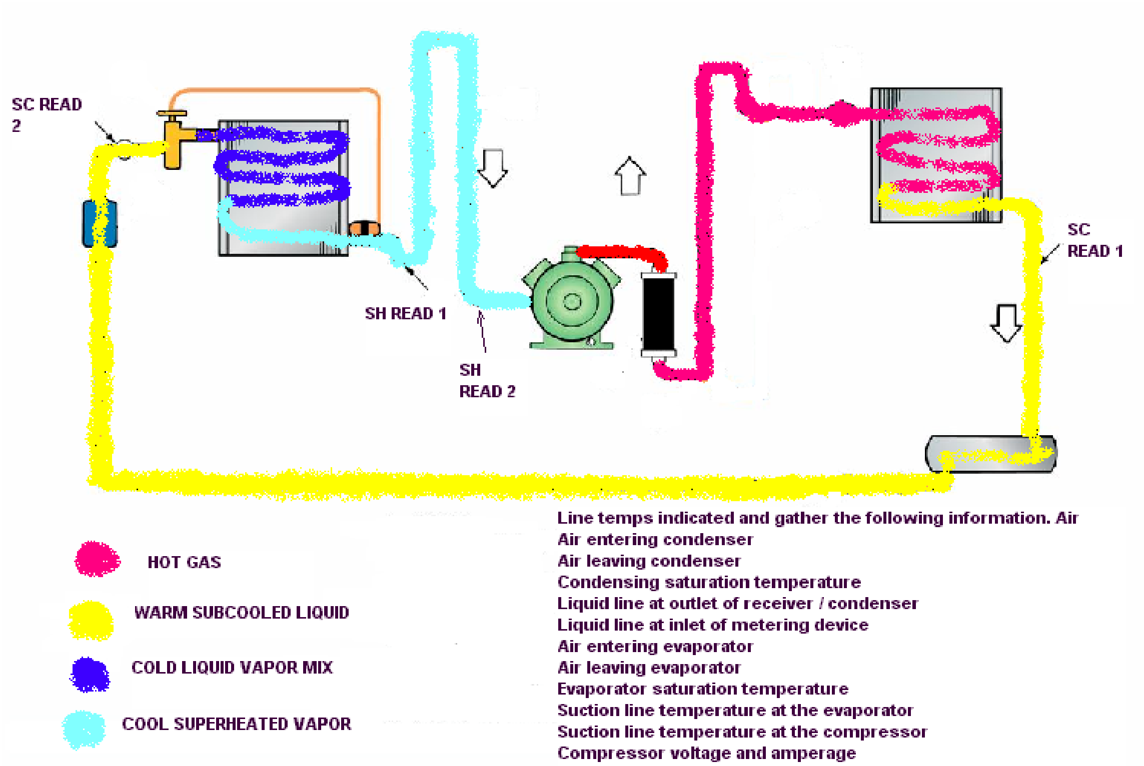
Next we evaluate the evaporator. Yes, I know we skipped the metering device at this point. There is no individualized part that the metering device performs in the system. It is dependant upon the rest of the system since it is effectively just a hole or a valve.

The ∆T at the evap represents system wide performance. It must not go too low or it will not remove enough BTU's from the conditioned space. It also must not be too high. If the ∆T is too high, we are not moving enough air over the evaporator. Not moving enough air over the evap results in not enough BTU's is being absorbed into the refrigerant. This changes the density of the return vapor and lowers the temperatures. In air conditioning we need the evaporator to be below the dew point for humidity control; however, we must not drop the temperature below 30°F where frost will begin to form. If frost begins to form, air flow is reduced further and the coil will quickly begin to ice. If the coil ices, we have a very good chance liquid will pass through the evaporator and suction line possibly resulting in catastrophic compressor failure.

A ∆T of 30°F will result in evaporator freezing. A ∆T of 25°F is likely to frost and freeze if the unit is operated in lower ambient conditions such as happens overnight in the spring and fall. We know the typical air conditioning coil is designed for a 40°F temp and a 55°F leaving air temp. That indicates a TD of 15°F between the air and refrigerant. If you have a 70°F return air and you are maintaining a 25°F ∆T, that would be a discharge temp of 45°F. This would give you a coil temp of 30 at which point frost would begin to form and freeze up is quite possible. For those reasons we need to maintain a ∆T of 15 to 20 degrees across the evap.

Next we must evaluate the superheat produced by the system. We take SH in two locations for two reasons. One is to evaluate how much refrigerant is in the evaporator; the other is to be sure we do not send excessive or inefficient superheat to the compressor. Evap SH can and does vary and levels ranging from 4 to 20 are not uncommon. Most air conditioning systems fall into the 8 to15 degree ranges at the coil. Remember the reason for SH is to prevent liquid from returning to the compressor, no other purpose. Most compressors are designed to work properly with 25 to 30°F SH entering the suction valve. One should measure system SH about 6" from the compressor to prevent conductive heat transfer from the compressor. On residential equipment, measuring the superheat at the service valves if the unit does not have an accumulator or excessive suction line before the valve. The superheat reading at the suction service valve normally is less than 20°F when operating at design conditions.

The compressor amperage and voltage must be taken to determine if the compressor is handling the load correctly.



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