A/C SYSTEM DIAGNOSIS USING SUPERHEAT & SUB-COOLING MEASUREMENTS

Mobile A/C technicians should become familiar with the terms SUPER HEAT and SUB-COOLING. These terms can make A/C diagnosis easier and often more accurate than just using gauge pressures.

DEFINITIONS:

SUPERHEAT- Super heat is the amount of heat in degrees that the refrigerant is heated in the evaporator after it changes state from a liquid to a vapor.

SUB-COOLING – Sub-cooling is the amount of heat in degrees that the refrigerant is cooled in the condenser after it changes state from a vapor to a liquid.

SATURATION – A term used to describe the point at which the refrigerant "changes state" from either a liquid or gas to the opposite.

SATURATION TEMPERATURE – The temperature at which the refrigerant changes state either from a liquid to a gas or vice/versa.

A common tool that A/C technicians should be using in A/C diagnosis is a Pressure Temperature or PT Chart. However, the PT chart information is only valid when there is liquid refrigerant and vapor pressure. It is also only valid when we have a pure refrigerant and not a blend of refrigerants. (Always use an identifier) The most common use of the chart is calculating saturation temperature in the evaporator or condenser. The point at which the liquid has evaporated (evaporator) or has condensed (condenser) is referred to as the Saturation Point. Using the Saturation pressure and the PT chart will give us the Saturation Temperature. The saturation temperature can then be used to calculate Super Heat in the Evaporator or Sub-Cooling in the Condenser.

TO CALCULATE SUPERHEAT:

Obtain the low side pressure reading and convert it to temperature with the chart.

Measure the temperature at the outlet or tailpipe of the evaporator. (Use ONLY a contact type thermometer)

Calculate the difference between these two temperatures to obtain super heat.

TO CALCULATE SUB-COOLING:

Obtain the high side pressure and convert it to temperature with the chart.

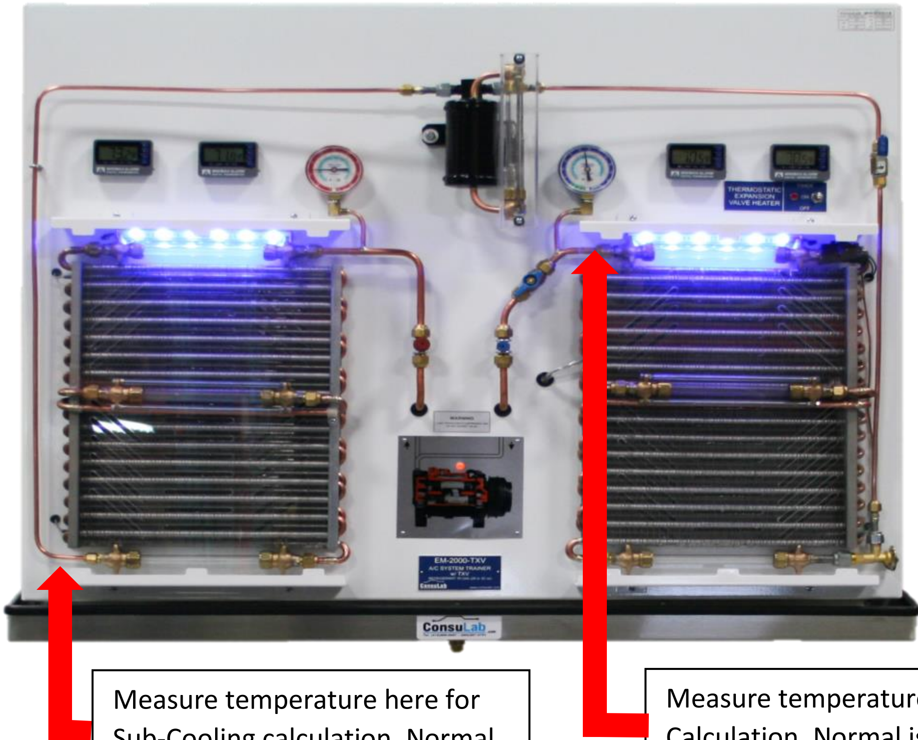
Measure the temperature of the outlet or liquid line of the condenser.(Use ONLY a contact type thermometer)

Calculate the difference between these two temperatures to obtain sub-cooling.

SUGGESTED VIDEO THAT DOES A GOOD JOB OF EXPLAINING "SATURATION, SUB-COOLING and SUPERHEAT"

It is about 30 minutes long and pertains to non-automotive refrigeration, but the concepts are the same and are well explained.

https://youtu.be/nwPA56cXqMA

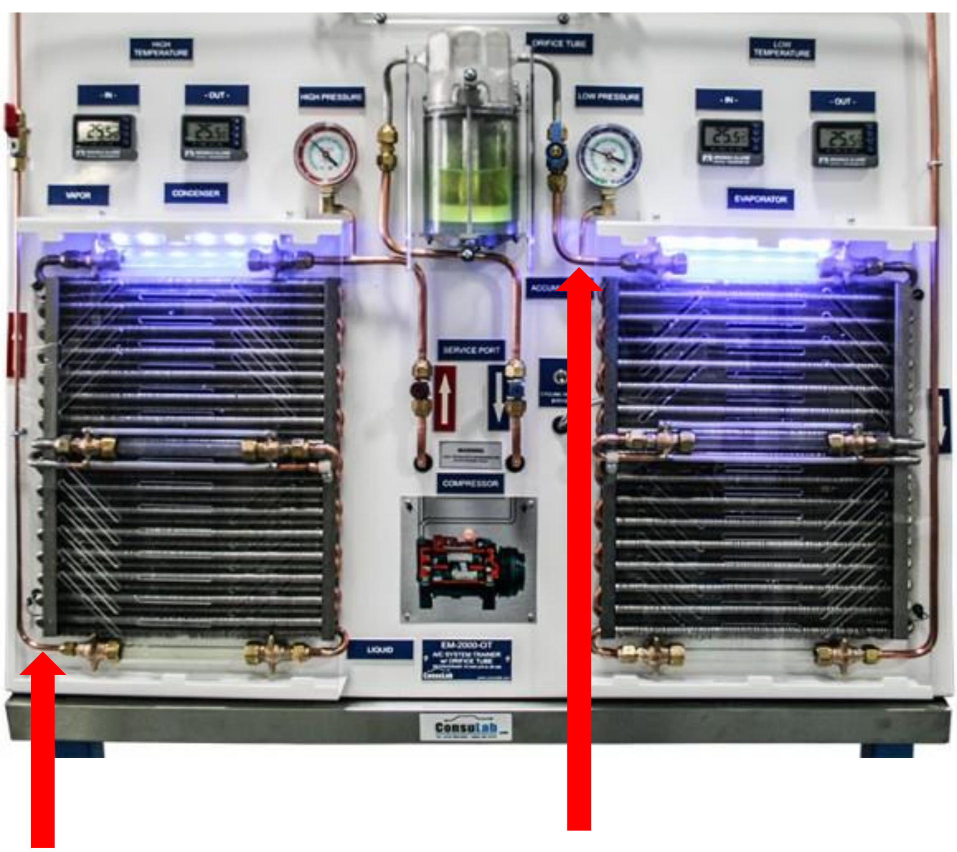


TYPICAL TXV SYSTEM

Measure temperature here for Sub-Cooling calculation. Normal is 10^0 - 20^0 F

Measure temperature here for Superheat Calculation. Normal is 6^0 - 12^0 F

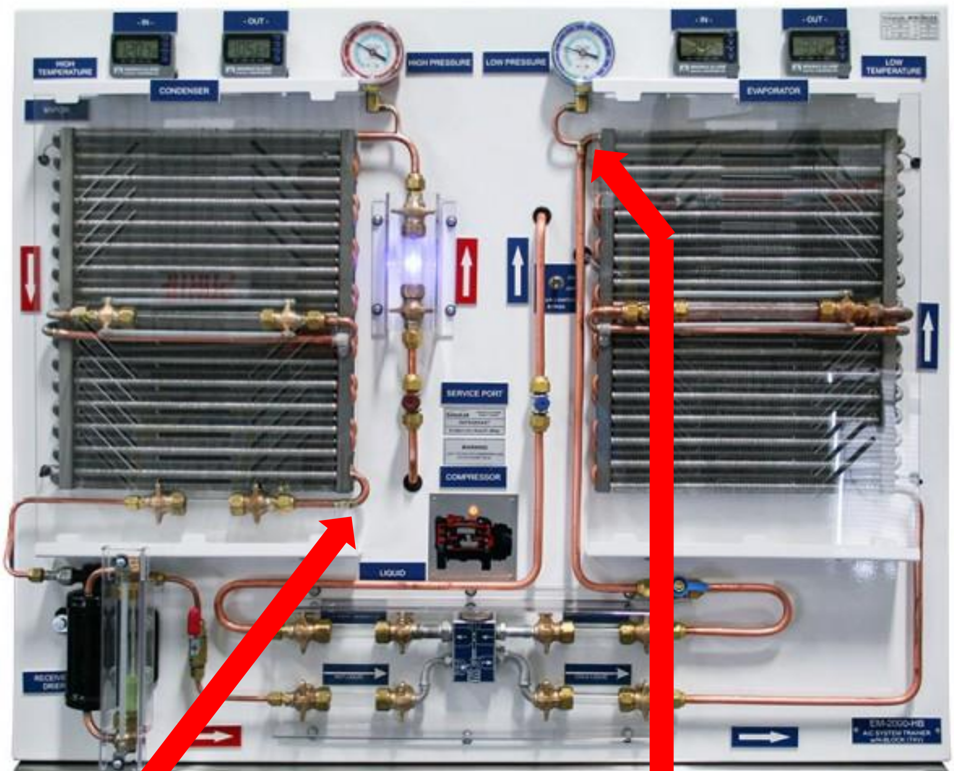
A TXV system is designed to have 6 to 12 degrees Fahrenheit of Superheat in the evaporator. The TXV uses a temperature sensing bulb on the outlet of the evaporator. The bulb is usually filled with the same refrigerant as the system. The pressure created in the bulb acts on a diaphragm that pushes the TXV open against a spring that closes the valve. This spring is referred to as the superheat spring.



TYPICAL ORIFICE TUBE SYSTEM

Measure temperature here for Sub-Cooling calculation. Normal is 10^0 - 20^0 F

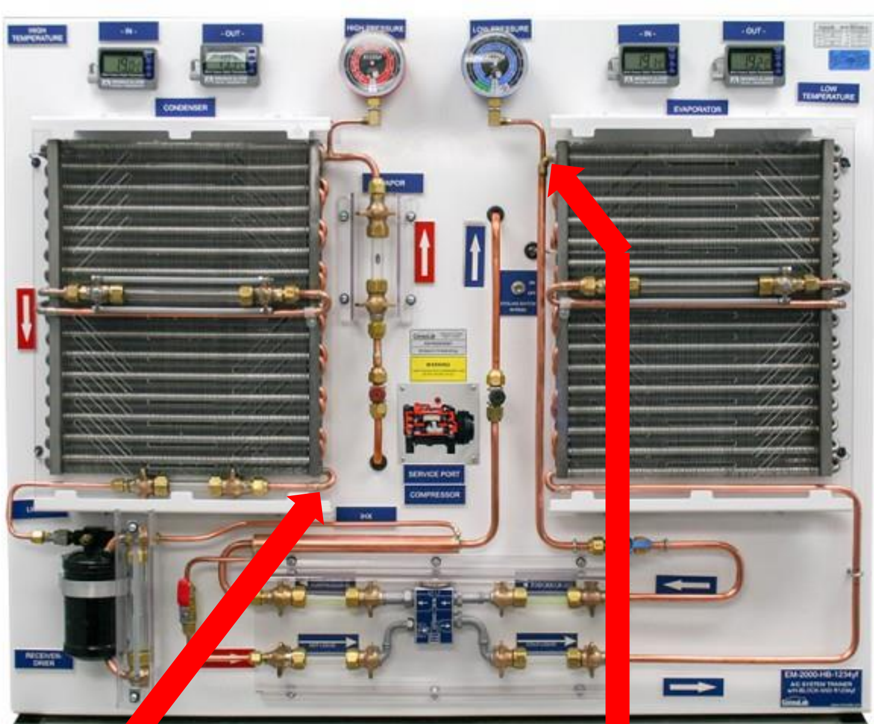
Measure temperature here for Superheat Calculation. Normal is 0^0 – 4^0 F



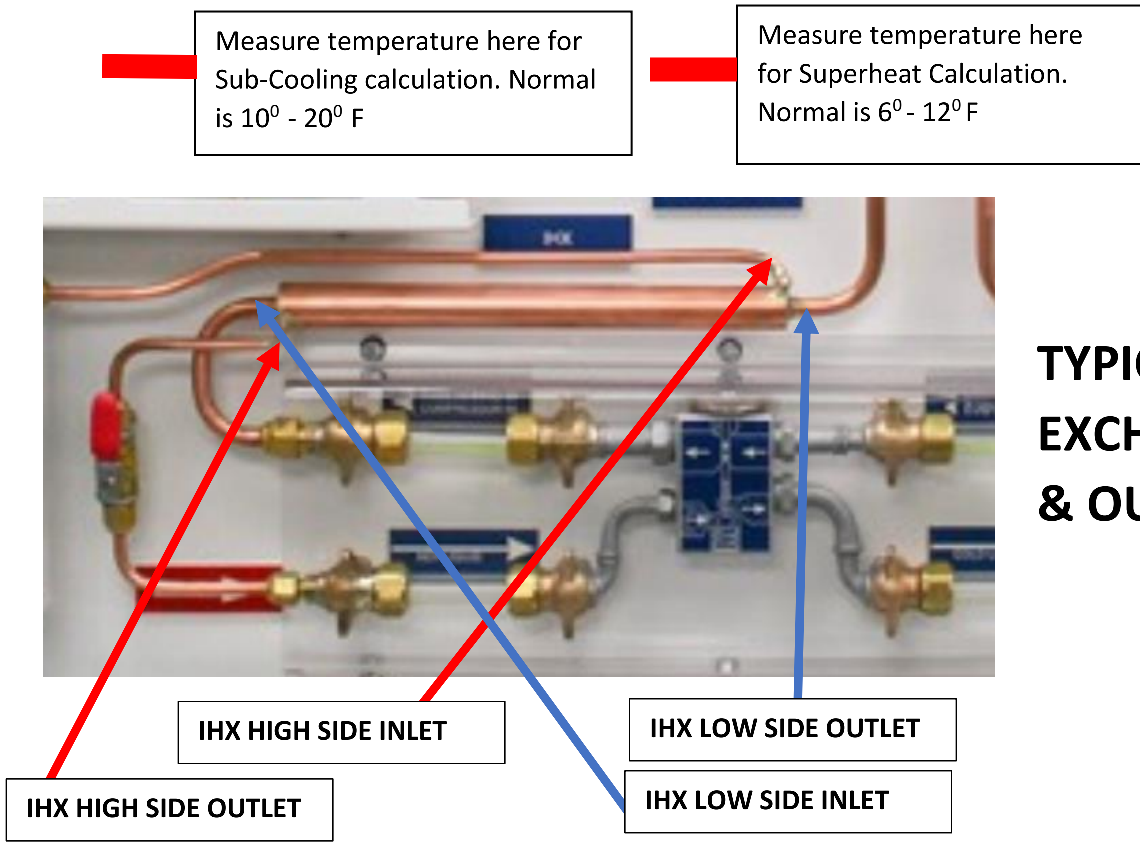
TYPICAL H-BLOCK (TXV) SYSTEM

Measure temperature here for Sub-Cooling calculation. Normal is 10^0 - 20^0 F

Measure temperature here for Superheat Calculation. Normal is 6^0 - 12^0 F



TYPICAL H-BLOCK (TXV) SYSTEM WITH IHX (INTERNAL HEAT EXCHANGER

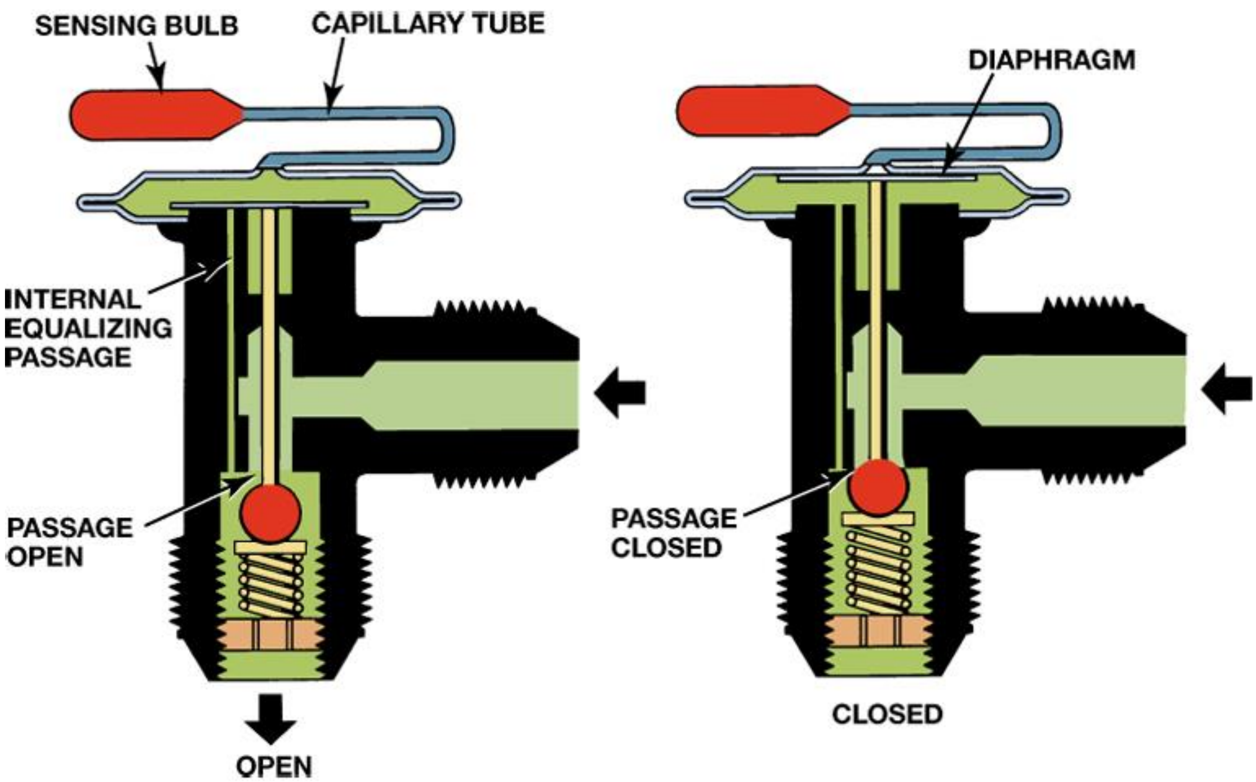


TYPICAL IHX HEAT EXCHANGER INLET & OUTLETS

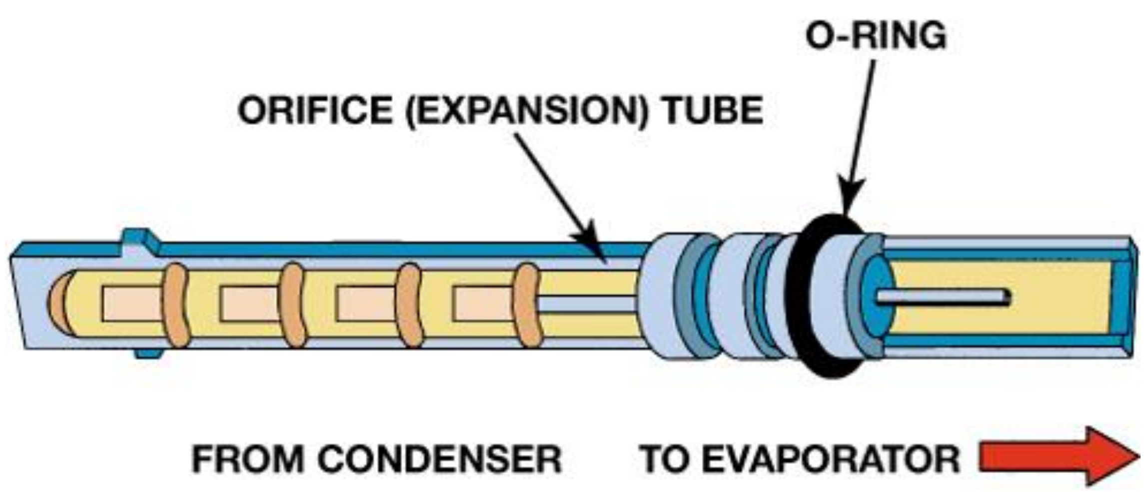
These measurements can give the technician information regarding the liquid refrigerant level in the evaporator or condenser. The liquid level in these components can provide insight as to what is happening in the system when some norms are applied.

REFRIGERANT METERING DEVICES

THX (THERMAL EXPANSION VALVE)

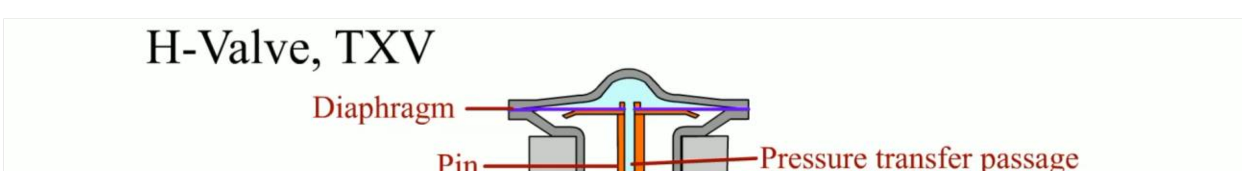


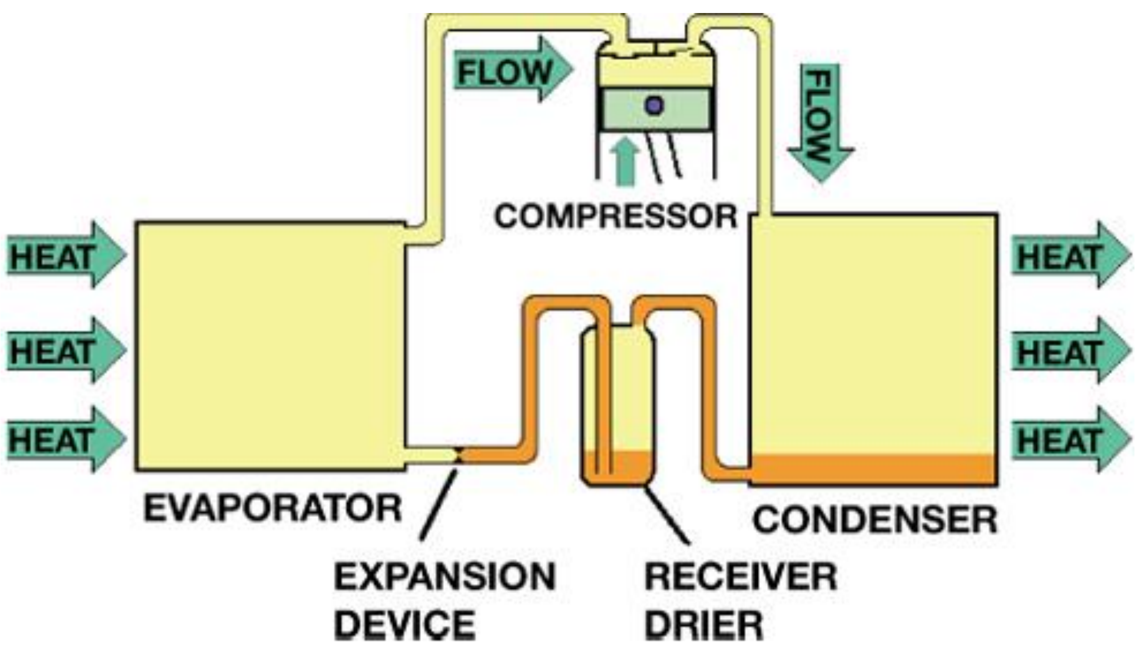
ORIFICE TUBE



An Orifice Tube System most commonly runs a flooded evaporator and has very low Superheat. They will have 0 to 4 degrees Fahrenheit of Superheat.

TXV (H-BLOCK)





Condensers on both TXV and Orifice Tube Systems are designed to have 10 to 20 degrees Fahrenheit of Sub-Cooling.

SUPERHEAT

An evaporator with higher than normal superheat has a low liquid refrigerant level in the evaporator. This condition has caused the vaporized refrigerant to continue to absorb heat. This increased heat will also result in low vapor density and reduce the compressors ability to raise the pressure on the high side.

Causes for a low liquid level in the evaporator could be:

A low refrigerant charge in the system.

A restricted metering device (orifice tube, TXV or H-Block).

A restriction in the low side before the evaporator.

Higher heat load on the evaporator.

If the superheat is lower than normal, then the liquid refrigerant level in the evaporator is high. The amount of heat available cannot vaporize all the refrigerant.

Causes for a high liquid level in the evaporator could be:

A system over-charge.

A flooding metering device (orifice tube, TXV or H-Block stuck open).

Low heat load on the evaporator.

SUB-COOLING

A condenser with higher than normal sub-cooling has a high liquid refrigerant level in the condenser. The condenser sheds the heat quickly and continues to drop in temperature.

Causes for a high liquid level in the condenser could be:

A system over-charge.

A restricted metering device (orifice tube, TXV or H-Block).

Increased air flow across condenser.

If the sub-cooling is lower than normal, then the liquid refrigerant level in the condenser is low. The condenser is not shedding all of the absorbed heat.

Causes for a low liquid refrigerant level in the evaporator could be:

A low charge in the system.

Restricted air flow across condenser.

A flooding metering device (orifice tube, TXV or H-Block stuck open).

THE REFRIGERATION CYCLE SIMPLIFIED

HIGH PRESSURE