



SOUTH METROPOLITAN TAFE WA

The Saturation process

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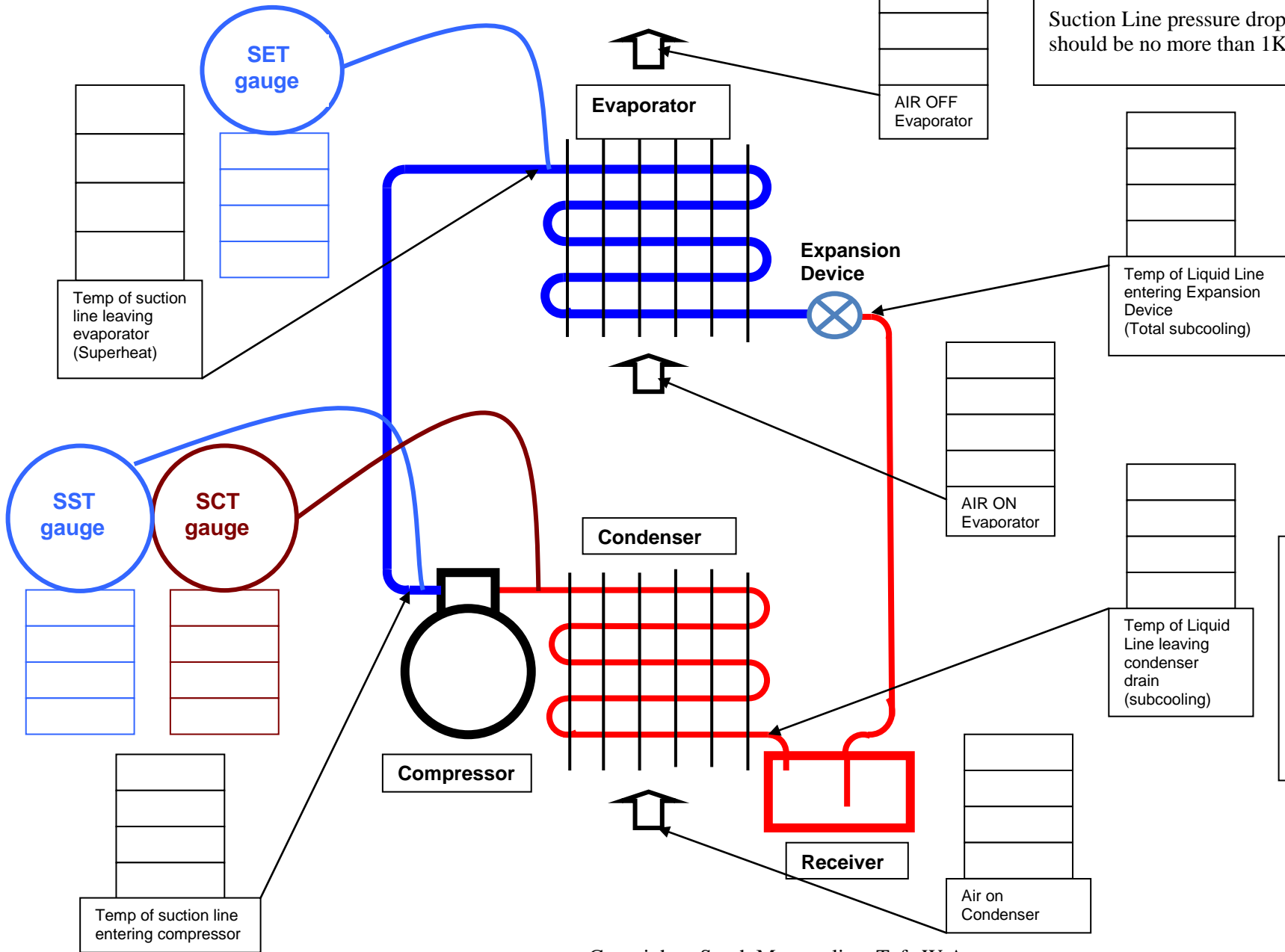


System Type (Air Conditioner, Refrigeration Unit, Other)

Evaporator TD = Air on Evaporator – S.E.T
 Condenser TD = S.C.T – Air on Condenser

Evaporator Superheat approx. 5 - 6K (TX Valve)
 Condenser Subcooling approx. 3 – 6 K

Suction Line pressure drop is taken at SST and should be no more than 1K (less than S.E.T)



Note!
 There is no pressure – temperature relationship when refrigerant is in a superheated condition



Before you begin.....

Allow sufficient time for system to operate and balance

- Turn on system and for a period of time prior to testing temperature differences to allow system to circulate refrigerant
- Ensure no airflow restrictions to evaporator and condenser and all fans are working.

Air Probe; ensure you take air readings in the correct locations

- Condenser air on readings must be taken from the actual condenser inlet and never assume ambient air is the same from within the outside area.
- Evaporator air on readings also must be taken from the actual evaporator inlet and not from the room thermometer or surrounding area.

Evaporator superheat measurements

- Thermostatic expansion valve (T.X.V) superheat checks are advised to be done when the air on the coil temperature is within 6k of design storage temperature
Eg: Cool room with 2.c design storage temperature, check at 8.c air on coil.
Freezer room with -18.c design storage temperature, check at -12.c air on coil.
Air Conditioner's superheat checks should be tested at manufacturer's continuous operation limits where design capacities are based
As a guide the air on the indoor unit's evaporator should be at or lower than 27.c

Touch probe or direct surface contact measurements

- Hermetic compressors can create heat into suction inlet pipe close to compressor due to motor heat in the casing.
- Do not measure vapour entering temperature too close and at least 50mm back from suction inlet to compressor.
- Evaporator superheats can be incorrect if leaving evaporator temperature is taken from a liquid subcooling heat exchanger suction pipe outlet.
Always take this reading after the bulb and before the heat exchanger. (Only when subcooling heat exchanger **is fitted**)
- Subcooling measurements leaving the condenser should always be taken from the drain pipe outlet to the receiver, close to the condenser.
- Subcooling heat exchangers will lower the liquid entering temperature to the expansion device, if one is fitted never assume it will be entering at the same temperature as leaving the condenser. Regardless if one is fitted or not this check is vital for capacity measurements.

Gauge and manifold measurements

- Never assume short distance suction lines will have no pressure drop. Always check S.E.T & S.S.T
- When fitting a high side gauge to a Schrader valve, ensure you use a "quick coupler" to prevent gas losses and liquid/oil discharge on removal.



The terminology

Evaporator and low side (suction)

S.E.T – Saturated Evaporating Temperature – The vapourisation temperature of the refrigerant in the evaporator (low side gauge at evaporator outlet)

S.S.T - Saturated Suction Temperature – Equivalent vapourisation temperature of the refrigerant in the evaporator (low side gauge at compressor suction)

V.E.T – Vapour entering temperature – The temperature of the superheated refrigerant gas entering the compressor at the suction pipe (touch probe)

Evaporator superheat – The difference between leaving evaporator temperature (touch probe) and S.E.T

Evaporator TD. – The difference between the Air on the evaporator (air probe) and the S.E.T

Suction line pressure drop - The difference between the S.E.T and the S.S.T

Suction line superheat. – The extra heat absorbed into the refrigerant gas from the suction line between evaporator and compressor.
This is the difference between the V.E.T and the Evaporator superheat

Total Suction line superheat – This is the total of evaporator superheat and suction line superheat added together

Condenser and high side (discharge)

S.C.T – Saturated Condensing Temperature- The condensing temperature of the refrigerant in the condenser
(High side gauge fitted at compressor discharge) – Note: this pressure should be the same measured anywhere in high side.

L.E.T - Liquid entering temperature to the expansion device (touch probe on liquid pipe into expansion device)

Condenser TD - The difference between the S.C.T and the air on the condenser (Air probe)

Condenser Subcooling - The difference between the S.C.T and the leaving liquid refrigerant temperature from the drain outlet (touch probe)

Total Subcooling - The total of the condenser subcooling and the L.E.T added together.

Filter Drier TD - Where a drier is fitted it is the difference between the temperature of the liquid refrigerant in and out (touch probe)

Discharge Temperature - The temperature of the superheated refrigerant gas leaving the compressor (touch probe)



What to expect.....

Evaporator and low side (suction)

Evaporator TD

A high evaporator TD can indicate a shortage of refrigerant and a low evaporator TD can indicate a surplus of refrigerant

Always confirm airflow is adequate and the evaporator superheat is at recommended levels (check manufacturer recommended specifications)

If the evaporator superheat is correct and airflow is consistent then the evaporator TD is accurate.

Restrictions in liquid supply to the evaporator also cause high evaporator TD.

A faulty flow control or bulb location can create evaporator TD changes from very small to large.

A high or low evaporator TD can be caused by mismatched equipment, such as indoor or outdoor units being of differing capacity and/or design.

Evaporator superheat

High evaporator superheats indicate a shortage of gas in the evaporator.

Low evaporator superheats indicate a surplus of refrigerant in the evaporator.

This will usually be the fault of the flow control or an absence of refrigerant in the system

Location and angle of the thermostatic expansion valve bulb can cause evaporator superheat to be high or low.

It can also be due to higher than normal outdoor temperatures, condensing problems and excessive load on the evaporator

Suction line superheat and vapour entering temperature.

High suction line superheats will always be the result of poor or incorrectly sized insulation or external heat sources creating heat gain to the suction pipe.

High vapour entering temperatures follow high evaporator superheats but can also be the result of suction line superheat problems.

Low vapour entering temperatures usually indicate a good system where they are equal to or slightly higher than evaporator superheat. They can also indicate the problem of evaporator flooding if they are the same or close to the S.E.T

The problem can also be refrigerant shortage where very low pressure creates a false low or high vapour entering temperature.

Evaporator superheat must be confirmed before the vapour entering temperature is considered accurate.



Note most of the above will be affected by compressor inefficiency or by mismatched/incorrect equipment

What to expect.....

Condenser and high side (discharge)

Condenser TD

A high condenser TD can indicate an inefficient condenser, where it is undersized for the ambient, dirty, blocked fins, airflow/fan problems, overcharged system, and wrong refrigerant or has mixed gases. In this case, typically the unit will suffer high pressure stoppages, not be able to maintain low evaporator temperatures and put added stress on the compressor.

A low condenser TD indicates that it is very efficient, but it can also be the result of lower than design ambient, gas restrictions in the system, high evaporator superheat, too powerful airflow, and shortages of refrigerant. It is essential to check for high evaporator superheats and then then low condenser subcooling to see if it is refrigerant levels causing the problem. A low condenser TD will also lower the subcooling.

You can also carefully partially restrict airflow though the condenser to correct for low ambient, to see if the performance aligns back to expected system design.

Always check for mixed/non condensable gases by performing a pressure/temperature analysis prior to starting a system when it has equalised pressures to ambient. This will establish that the correct refrigerant is in the system

Water cooled condensers have much lower TD's than air cooled types. Condenser fan controls or variable speed drive head controls will float the condenser TD high/low
Capillary tube refrigerant systems can have higher condenser TD's as seen with domestic refrigerators and smaller packaged equipment using static condensers.

HIGH CONDENSER TD'S WORK BETTER IN COLDER CLIMATES

LOW CONDENSER TD'S WORK BETTER IN HOTTER CLIMATES

ALL CONDENSER TD'S MUST BE LOWER WHEN THE DESIGN S.E.T IS LOWER

Condenser Subcooling

High subcooling is typically normal with capillary tube systems, but it is a sign of possible overcharge of refrigerant or mixed gases in most other TXV systems. It is not possible to have higher subcooling with low load on the condenser, undersized condenser or increased fan speeds. Where the condenser becomes more efficient, the subcooling will also lower. Low subcooling occurs with more efficient condensing; a condenser which is efficient will bring the SCT closer to ambient air on. The subcooling will fall and can be 1 to 2K. In this example it is best to ensure that evaporator superheat and design SCT are corrected to check if the unit is actually short of refrigerant. Partially restricting the condenser airflow and matching the design SCT will in most cases correct system evaporator superheat and condenser subcooling.

Restrictions or high evaporator superheat will lower condenser TD and subcooling – If the condenser is starved, it will technically become oversized and appear efficient by temporarily having a low condenser TD due to increased surface area for the volume of refrigerant passing through it.

SUBCOOLING MAY APPEAR TO BE WITHIN 3-6K WITH UNDERSIZED CONDENSERS, BUT THE CONDENSER TD WILL ALWAYS BE HIGH.



Liquid line subcooling

After leaving the condenser, the refrigerant may pass through a receiver (if one is fitted to system) and travel through the liquid line to the expansion device. For the most, liquid lines are not insulated to allow for extra subcooling to the ambient air. Any further subcooling will increase capacity and available refrigerant volume to the evaporator.

Typically it could be an extra 1 or 2 K but in many cases there is not further subcooling. A liquid line subcooler may be fitted prior to expansion using suction vapour to increase subcooling. Others used dedicated heat exchanger based subcooling with an extra expansion device fitted.

It is always important to check the liquid line subcooling to see:

- ** That the refrigerant has either remained unchanged in sensible temperature from when it left the condenser or reduced
- ** That the refrigerant has increased sensible temperature which may result in flash gas. Flash gas is where the sensible temperature rises back to latent phase.

Some liquid lines are insulated, this is to

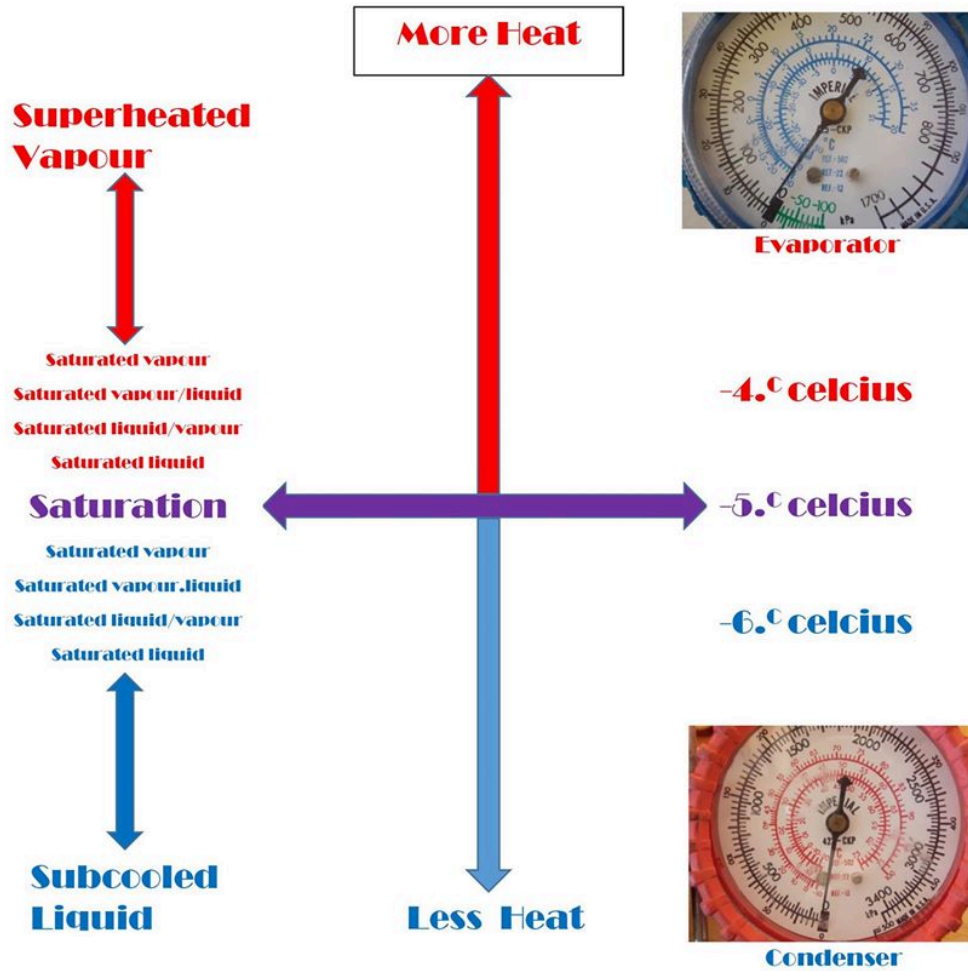
- ** prevent flash gas if the lines pass through a hotter environment. , prevent flash gas by pressure drop through a very cold environment.
- ** Where the expansion valve is in the outdoor unit as in a split system condensing unit, this is to stop flash gas on a saturated liquid line.
- ** In low temperature systems such as freezers, ambient air has too much energy that can de-rate system capacity by adding heat back into the refrigerant.

Your guide to liquid line subcooling is that it must never be a higher temperature entering the expansion device than when it left the condenser.

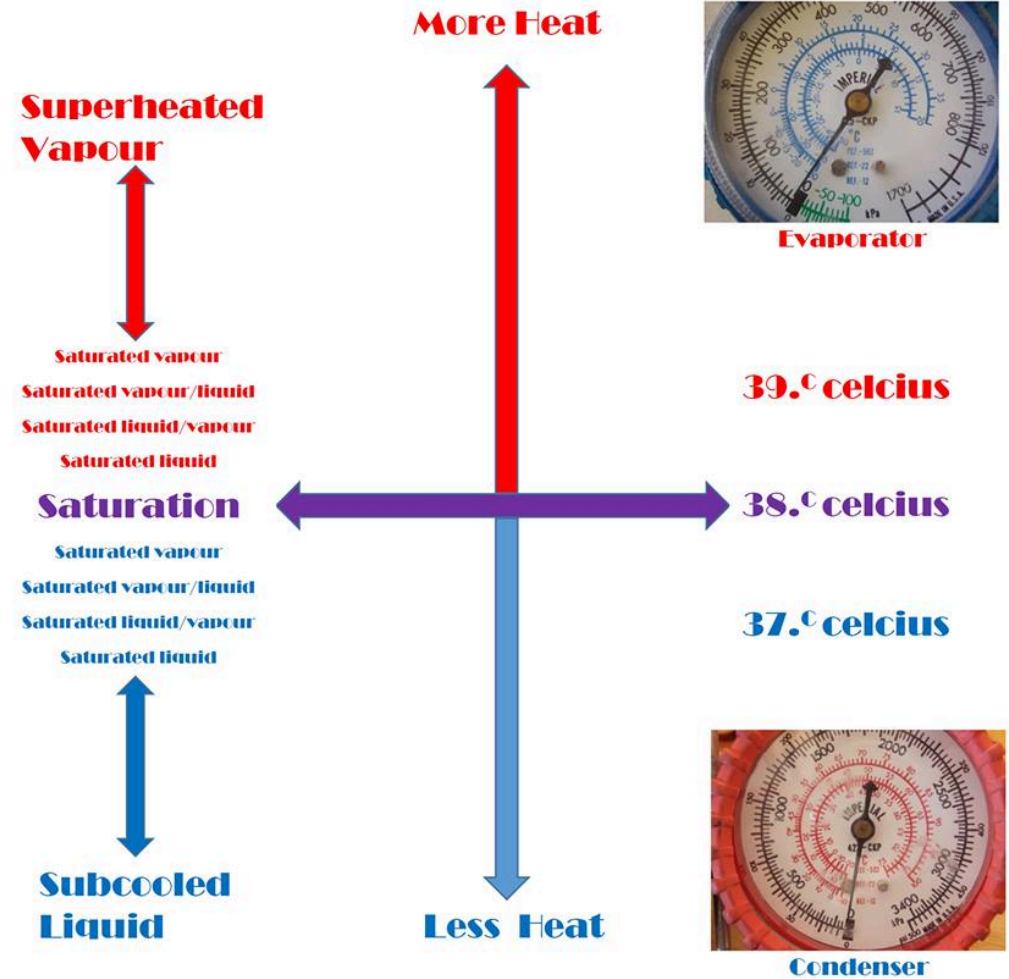
Filter drier TD

Subcooling will be affected by sudden restrictions in the liquid line. Any unwanted liquid line pressure drop will shift the temperature and capacity away from the evaporator and cause a noted temperature change across the line. The filter drier should always be tested as with any other high side flow controls. Always use a touch probe to measure temperatures across liquid line components and ensure that they have not changed the subcooling.

The saturation process



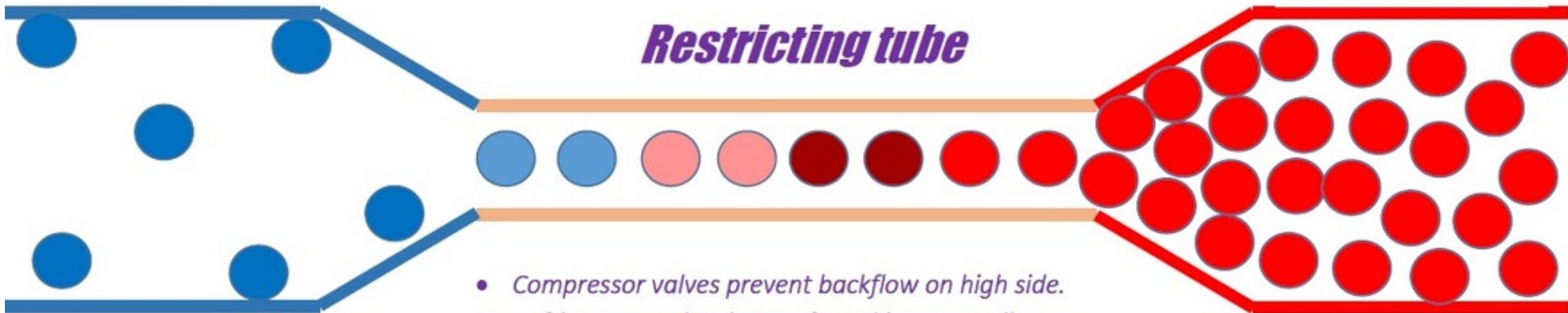
The saturation process



Low Side – Evaporator

High Side – Condenser

The Venturi Effect



Pressure



Temperature



Volume



- Compressor valves prevent backflow on high side.
- Refrigerant molecules are forced into a smaller volume at the inlet of the restricting tube, increasing pressure and temperature. Saturation temperature increases. (high gauge)
- Velocity increases through the restricting tube, smaller volume of refrigerant passes.
- Volume increases on outlet of restricting tube.
- Pressure falls and temperature falls as molecule's of refrigerant expand into the larger volume.
- Saturation temperature decreases. (low gauge)

Pressure



Temperature



Volume



Standard Temperature Differences (TD) between the Air Temperature onto the Cooling Coil and the Saturated Evaporator Temperature

| | Approx. Storage Temperature °C | Approx. Relative Humidity % | Approx. Temp Difference between Air and Refrigerant in K | |
|-----------------------------------|--------------------------------|-----------------------------|--|---------------|
| | | | Forced Draft | Natural Draft |
| Eggs, Dairy Products, Vegetables | 3 ⁰ C | 90 to 95% | 5K | 9K |
| Fruits | 2 ⁰ C | 85 to 90 % | 6K | 11K |
| Cut Meats | 1 ⁰ C | 85 to 90% | 6K | 11K |
| Carcase Meats | 3 ⁰ C | 80 to 95% | 8K | 14K |
| Cheese, Packaged or Bottled Goods | 3 ⁰ C | 70 to 80% | 10K | 16K |
| Frozen Goods | -20 ⁰ C | 85 to 90% | 6K | 13K |
| Room Air Conditioners | 24 ⁰ C | 50% | 20K | *** |
| Frozen Food Merchandiser | -20 ⁰ C | *** | 5 to 10K | *** |
| Meat Merchandiser | 0 ⁰ C | *** | 10 to 12K | *** |
| Dairy Merchandiser | 3 ⁰ C | *** | 10 to 12K | *** |

Saturated Evaporator Temperature = Air on Evaporator Temperature - Temperature Difference (TD)

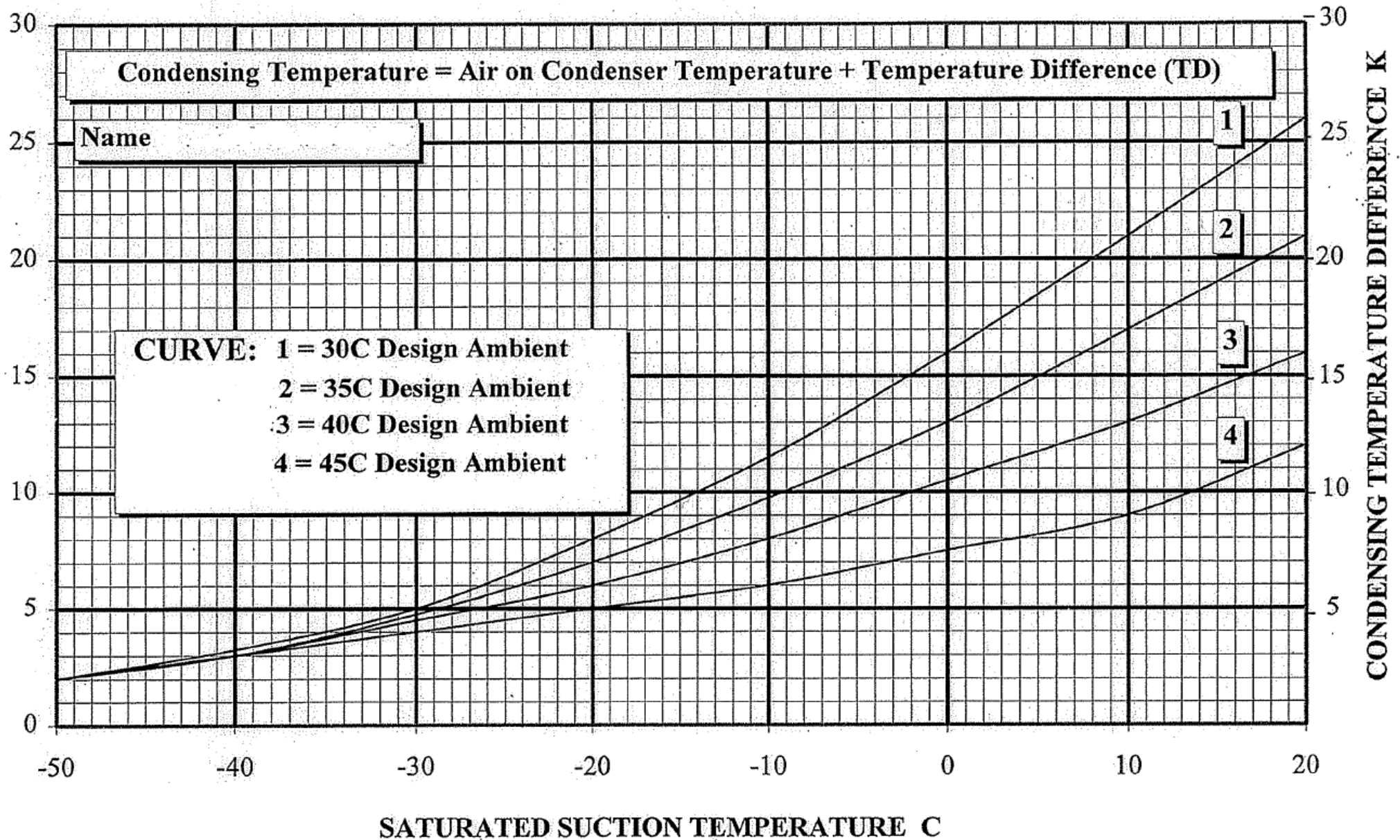
Saturated Suction Temperature = Air on Evaporator Temperature - TD - Pressure Drop K

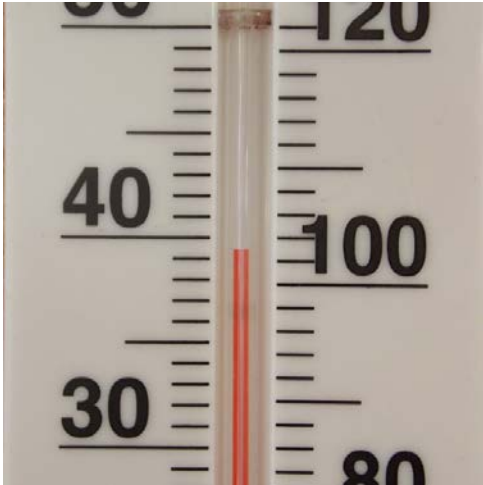
Saturated Evaporator Temperature (SET) is read from a gauge at the evaporator

Saturated Suction Temperature (SST) is read from a gauge at the compressor suction service valve

CONDENSER TEMPERATURE DIFFERENCE CHART

FORCED DRAFT AIR COOLED





Always remember WHERE and WHAT temperature your going to measure. If you assume that an ambient is the same everywhere you could end up with false or incorrect readings and answers

Do you need a touch probe?

Do you need an air probe?

Do you need to take the temperature at the condenser or the evaporator?

Is this a pipe temperature?

LOST?

Knowing the direction your refrigerant is moving, is very important.

Please make sure you have fully read and reviewed the

“Before you begin” & “The Terminology” pages

Please study the refrigeration diagram



