TECHNICAL REPORT

I-CAR NEW ZEALAND

HVAC – CHANGING TIMES FOR AUTOMOTIVE AIR CONDITIONING…

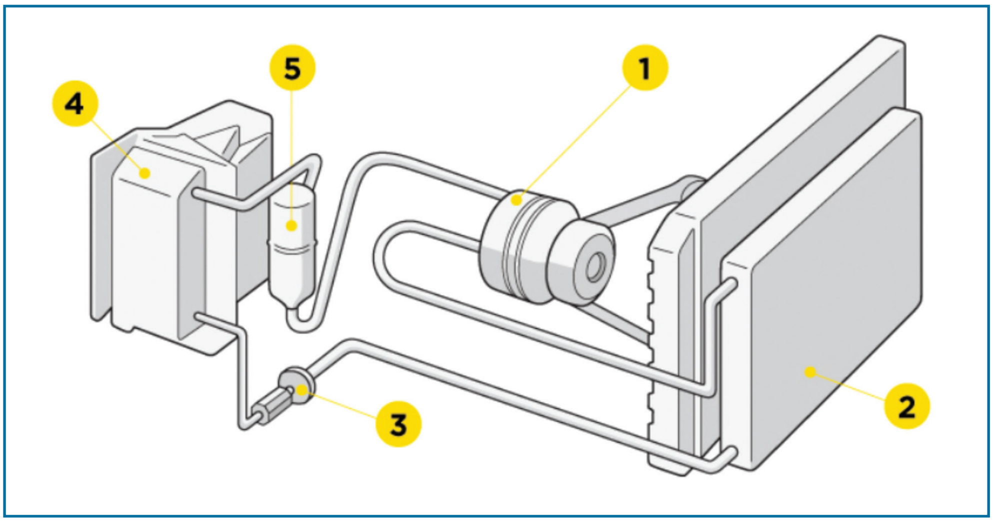
HEATING-VENTILATION-AIR-CONDITIONING –

PART II

In **Part I** we took a brief look at the history of HVAC in the automotive industry, and the progression / development of refrigerants that are appropriate in the new era of global warming and climate change awareness.

Part II is a focus on how A/C systems work, as well as lubrication requirements for both conventional power trains, and electric vehicle applications...

For those of us that are perhaps less familiar with the internal workings of A/C operations, lets take a closer look at the main components in a modern front end, fully integrated A/C system –



There are five main parts that make up vehicle A/C systems :-

1. *Compressor*
2. *Condenser*
3. *Thermal expansion valve or orifice tube*
4. *Evaporator*
5. *Accumulator or receiver/drier*

THE LATENT HEAT PRINCIPLE

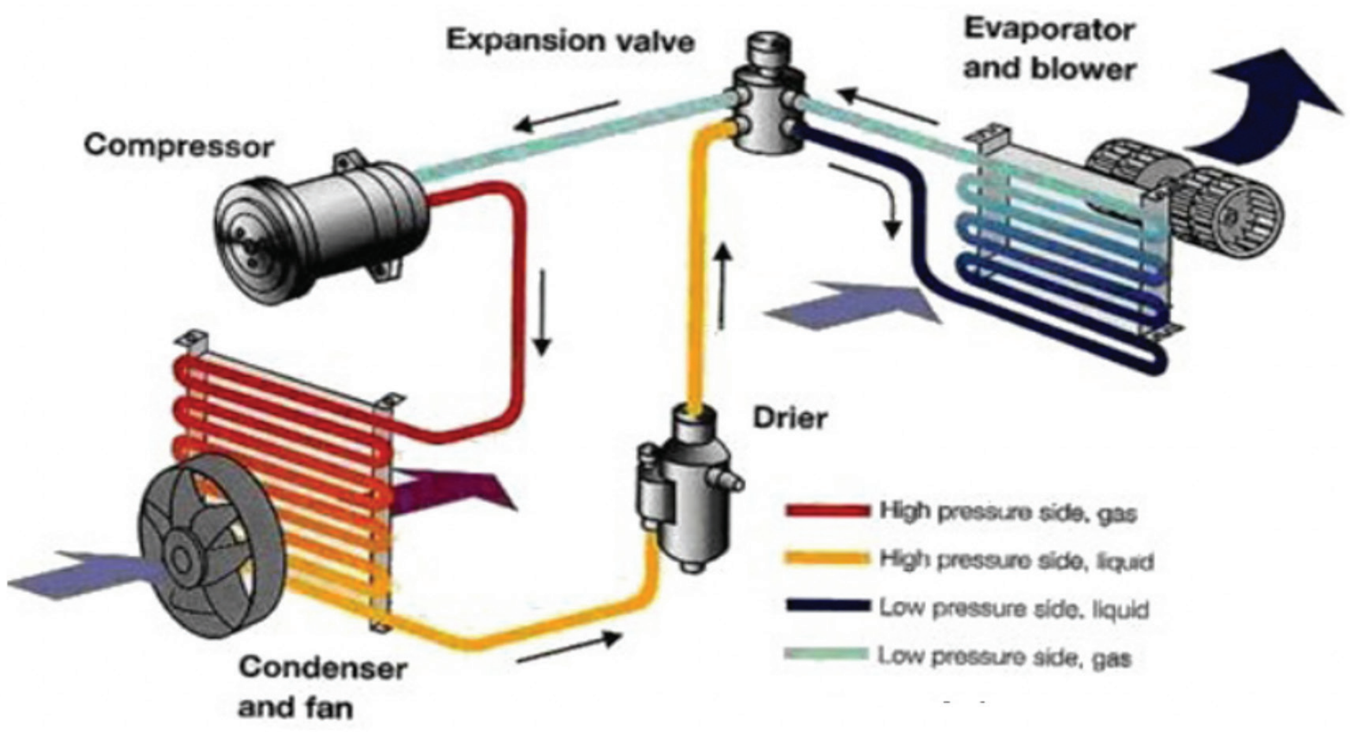
Think of the A/C system as being a "continuous loop", whereby a pump pushes refrigerant continuously around the system, and while there is no start or finish point, for explanatory purposes, let's start with the pump -

Refrigerant gas is pumped, via the **COMPRESSOR** (1) under high pressure to the **CONDENSER** (2). This high pressure generates a substantial amount of heat which is cooled as it travels through the condenser – "condensing" the gas into a liquid.

Essentially, the condensor is a type of radiator, in that air passing over the tubes & cooling fins, with the addition of a cooling fan and/or vehicle movement, drastically reduces temperature. As the cooling liquid travels beyond the condenser, toward the vehicle interior via high pressure tubing, it passes through an **EXPANSION VALVE** (3) - often referred to as a "TX valve" or an "orifice tube". This valve (in addition to reducing the pressure generated by the compressor/pump), removes pressure in the liquid refrigerant , allowing it to expand, turning the liquid into vapour. The latent heat principle now comes into play – as the Thermal Expansion (TX) valve dramatically restricts the amount of vapour passing through – it makes the refrigerant extremely COLD. This cold, low pressure vapour now enters the **EVAPORATOR** (4). The evaporator is essentailly another radiator – but as the refrigerant is now very cold, it is the **AIR** that is cooled by the radiator, rather than the **RADIATOR** being cooled by the air. Essentially, condensation is turned into evaporation.

All A/C systems will have either a **RECEIVER/DRIER** or an **ACCUMULATOR** (5). Receiver/dryer units are located after the Condenser and accumulators are located after the Evaporator. In both instances, these components are required to both filter the refrigerant, and remove moisture in the system.

So – after completing the loop through the evaporator, the refrigerant is then sucked back into the compressor to start the whole cycle again …



LUBRICATION REQUIREMENTS FOR A/C SYSTEMS :-

Whether you fully understand the operations of an A/C system or not, if your bodyshop is de-gasing / re-gasing collision damaged vehicles (and aside from recognising the different refrigerants, as explained in part I), any technicians performing these tasks must be aware of OEM specifications for refrigerant oils.

Accepting the fact that the refrigerant gas is "moving" through the entire closed loop A/C system, the only other moving part(s) is the compressor (pump).

The compressor requires constant lubrication to ensure functionalilty & longevity of the bearings, seals, and other moving parts. The appropriate oil (and correct quantity) is carried within the refrigerant gas / liquid, as it travels around the "closed loop" – ensuring that all the moving parts are lubricated.

This is the reason that many automotive workshops recommend using the A/C system on a regular basis – to prevent the seals and rotating parts from drying out and damaging the compressor, or creating leaks.

Cut away of a typical A/C compressor unit

Conventional lubricants used in A/C systems are **P**oly **A**lkyline **G**lycol (**PAG**) oils. These oils attract moisture AND perhaps more importantly, are electrically conductive.

That's not really an issue in conventional Internal Combustion Engine (ICE) vehicles, as by and large, the compressor functions by being driven mechanically via a drive belts and pulleys from the motor (with moisture being taken care of by the receiver/drier).

While some electric vehicles (namely hybrids), utilise both belt -drive and electric power to run the compressor, ALL electric vehicles (whether they be Dedicated Battery, Hybrid or Plug-in), use High Voltage (HV) to operate the A/C compressor. By neccessity, this requires an in-system lubricant that is not electrically conductive.

Dedicated, electrically powered A/C compressor (Orange cabling identifies HIGH VOLTAGE)

The required refrigerant lubricant is **P**oly**O**l **E**ster (**POE**). While this oil is available as a generic product, most vehicle – makers have an OEM specification (genuine part no.), should replacement / top-up be required.

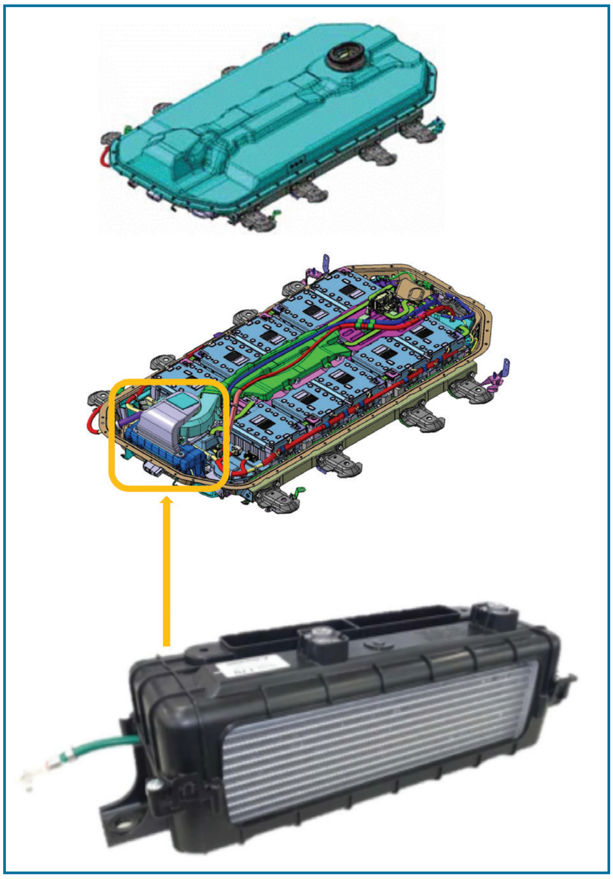
For obvious reasons, **Re-Gasing** electric vehicles with conventional charging stations **MUST NOT BE DONE**, as there will be contamination of the oils which can create an electric field, in and around any of the metal parts.

Any HV "leakage" has the potential to electrocute anyone coming into either direct contact with, or be in close proximity to, those affected components.

It can also be argued that **De-Gasing** could create similar problems – traces of PAG oil remaining in connection ports on conventional charging machines may also contaminate a POE system – There is generally no way of measuring the concentration of PAG oil contamination in a POE system that would compromise its insulative properties.

Lastly, for further reinforcement of the fact that non-conductive oils must be used, we need only to look at the Mitsubishi Outlander PHEV – All of the above information and guidelines should be implemented, but with this particular vehicle, cross contamination of any sort is likely to result in catastrophic failure of the A/C system, and possible battery damage.

This comes about as the vehicle's standard A/C system also assists in cooling the HV (300v) traction battery, located in the floor pan. By necessity, A/C cooling of the battery can be accomplished without the cabin HVAC operating – Its not hard to imagine how contamination of the AC system with conductive oils that may leak current, would react with the HV traction battery …



Battery cooling unit of the Mitsubishi Outlander

These articles have been written by Martyn Lane:
I-CAR Instructor, Weld Test Administrator
and Technical Specialist to the auto body industry