PETER HART

Truck air conditioning

ARTSA recently held a successful one-day conference about the causes and mitigations of truck and trailer fires. At that conference Mr Brett Meads from the Australian Refrigeration Council presented on truck air conditioning. What's the connection I hear you say? Well, some refrigerants are flammable and this is adding a new dimension to fire risk and fire-fighting. Before I tell you about this risk, I want to review the basics of truck air conditioning.

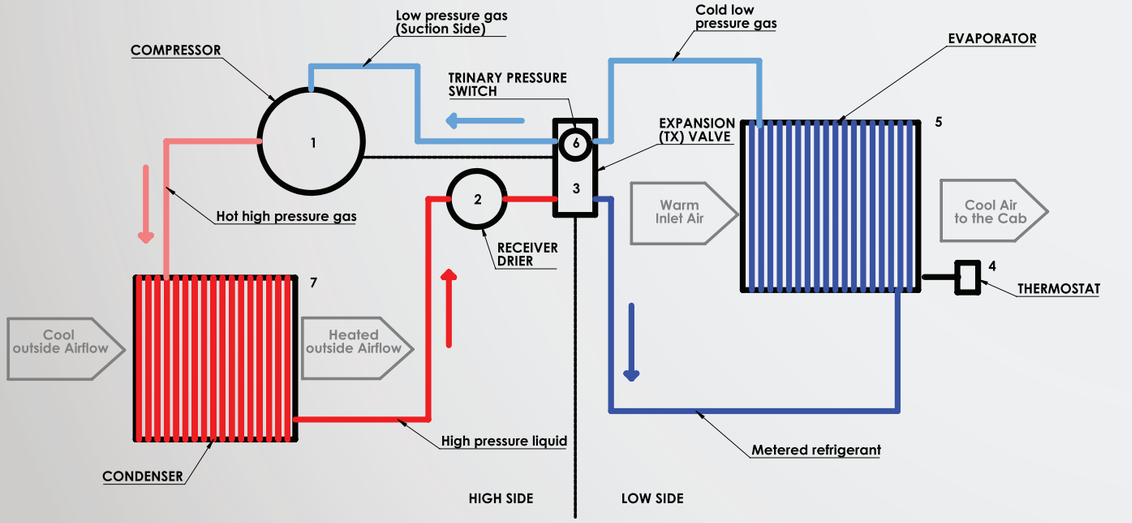
The diagram below shows the refrigeration cycle. The refrigerant path is shown in Pink where the gas is hot, Red where the liquid is warm,dark Blue where the liquid is cool and light Blue where the gas is cold.

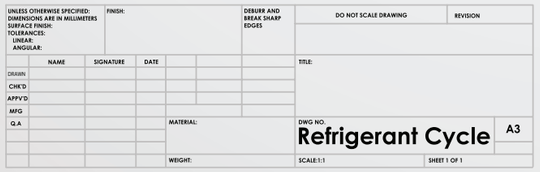
The Condenser (7) is at the front of the truck – on some models it is the grille. The refrigerant gas is cooled and condensed here. The more efficient the cooling the better, so keep the condenser clean.

The Receiver Drier (2) is situated between the condenser and the TX valve at the evaporator. The Receiver Drier (2) has three functions: It stores refrigerant and oil when the system is not being used. It contains a filter to trap debris and it contains a desiccant which removes moisture from the refrigerant. Because it has a liquid storage function it must be mounted vertically.

The Expansion (TX) Valve (3) is a spring-loaded orifice that causes a drop in liquid refrigerant pressure. Its purpose is to get the refrigerant to an acceptable pressure so it can change state to a gas in the evaporator. Because the pressure drops, the refrigerant feels cooler out of the TX valve, but there is no heat rejection going on here.

The Evaporator (5) is where the heat is absorbed, which cools the cabin. The refrigerant changes from a liquid to a gas in the Evaporator. The Thermostat (4) measures the temperature of the delivered air and compares it to the desired air temperature. If further cooling is needed, it causes the electrical controls to operate and engage the compressor clutch (7).





The Trinary Pressure Switch (6) has three separate pressure switches. The low-pressure switch might open when pressure falls below 170 kPa and close when pressure rises above 275 kPa. This switch will turn the compressor off if the refrigerant gas pressure is too low.

The high-pressure switch might open when the gas pressure exceeds 2000 kPa and close again when the pressure drops below about 700 kPa. This contact will turn the compressor off when the pressure is excessive. The third switch is used to control the cooling fan for the condenser. It might close at 1300 kPa and open when the pressure drops below 1000 kPa. In this way the gas pressure at the Trinary switch location is kept in the desirable limits (1000 – 1300 kPa in this example, but dependent on the refrigerant being used).

The compressor (1) is driven by the engine or on an electric vehicle by an electric motor. It typically has multiple cylinders that operate by a swash-plate design. It has a solenoid (magnetic) clutch that is electrically controlled via an on/off switch, thermostat and the Trinary switch contacts and driven by an electric relay.

The Compressor needs to be lubricated by oil that circulates in the refrigerant and collects in the Receiver Drier.

Refrigerants are changing. Brett Meads told the 'Fires Conference' that environmental concerns have resulted in development of ever-more environmentally friendly refrigerants.

The Table shows a high-level comparison of commonly encountered refrigerants.

There is a demand in the aftermarket for hydrocarbon refrigerants, such as propane because of cost saving.

At present truck manufacturers do not use hydrocarbon refrigerants in AC systems. If hydrocarbon refrigerants are used, they must be installed when an empty system is recharged by repairers.

There are two serious problems with this. Firstly, the components in the air conditioning system are designed for the original refrigerant. The system will not work as well with a hydrocarbon refrigerant. Secondly, the refrigerant is flammable. If there is a leak from a hose, tube or evaporator, the leak could deliver flammable gas, such as propane, into the cabin. This is a serious fire risk because it could be ignited by sparking devices, such as a commentator-type blower motor or a sparking relay or switch. In a recent Australian case, the use of hydrocarbon refrigerant in a truck system resulted in the TX valve rupturing because it was the wrong type and released flammable refrigerant into the cabin, which ignited. Because they are flammable, they cannot be used with conventional compressors.

Propane refrigerant has its supporters because it is inexpensive and requires a smaller charge than R134a.

Here is some further information that might be useful:

- Heat transferred into the air is called the latent heat of condensation.
- 'One tonne' of refrigeration is 12.7 MJ (12,000 Btu) of heat removed per hour.
- Compressor failures are usually the result of loss of lubrication, which in turn may be due to low refrigerant in the system.
- R134a refrigerant uses PAG lubricant. This is thinner than the oil used in R12 systems. It is harder to see the leak.
- Different oils are needed for different refrigerants.
- If you are not a professional air conditioning mechanic, you can still detect a leak using soapy water! This method is also effective for detecting air-brake pneumatic leaks.
- Air conditioning systems usually have Schrader values so that the pressure can be measured using a meter. This is useful for fault finding purposes.
- There is probably a sight-glass in the Receiver Drier bottle so you can see if there are air bubbles in the refrigerant.

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Refrigerant	Characteristics	Flammability	Status
R12 (CFC)	- Great refrigerant - High ozone depleting potential - High greenhouse gas leveL - Great refrigerant	Non-flammable (A1)	Not legal in new vehicles. Being phased out
R134a (HFC)	- Great refrigerant - Minor ozone depleting potential (0.055) - Very high greenhouse gas level (1410)	Non-Flammable (A1)	Legal in new vehicles but to be phased out by mid 2020s
R1234yf (HFO)	- Great refrigerant - Zero ozone depleting potential (0) - Very low greenhouse gas level (4)	Low Flammability (A2L)	Likely to be commonly used in new vehicles
R290 (Propane, HC)	- Great refrigerant - Zero ozone depleting potential (0) - Moderate greenhouse gas level (3) - Lower charge needed than R134a	High Flammability (A3)	Legal. Substantially cheaper than R134a or R1234yf
R744 (CO2)	- Adequate refrigerant - Zero ozone depleting potential (0) - Minor greenhouse gas level (1)	Non-flammable (A1)	Legal. High pressures needed. Inexpensive gas