# AIR CONDITIONING COMPONENTS

## Off-On Switch

Introduces electrical current to the system. Many of these switches have a speed function built in to them. **Replace** the switch if any of these functions do not work properly.

## Compressor Clutch

Converts electrical power to mechanical power. When an electrical load is introduced, a magnet pulls the face of the clutch to the face of the belt pulley causing the pistons to compress the vaporised refrigerant. The gap between the two faces is usually preset at 0.019" to 0.025". Drag or slippage occurs if the gap is out of spec creating heat. Excess heat will result in bearing burn out.

The clutch will obey commands from:

- On-off switch
- High or low pressure switch
- Cycling switch

*Maintenance tips include:*

- Checking all switches for electrical continuity
- Checking gap of clutch faces
- Checking belt alignment

## Compressor

The compressor has the most moving parts and consequently is the most vulnerable part of all the components. It must work hard to create the high pressures that are required inside the system.

There are two types of compressors:

- Upright Square Style (York® or Tecumseh®) – has a crankshaft that moves the piston. It is generally preferred by the off-road equipment because of its ability to withstand extreme situations.

- Vertical Rotary Style (Sanden®, Seltec®, Nippodenso®, Delco®) – has a crown and swash plate to move the pistons.

Lubrication is critical and oil must be in the system at all times.

The compressor is exposed to both the high-pressure side and the low-pressure side and is the “catch basin” for any debris caused by a malfunction in other parts.

Manifold gauge readings of higher than normal on the low (blue) gauge and lower than normal on the high (red) gauge generally mean that the compressor needs replacing.

But…just replacing the compressor does not fix the problem. Something caused the compressor to fail, and a further diagnosis is required.

It is strongly recommended that only new compressors be sold (with the exception of the Delco® A-6 style). Remanufactured compressors have a high failure rate. There generally is not warranty on compressors other than shipping damage. Every compressor is tested at the factory and is ready to work. If premature failures occur, it is always because there is a malfunction of another part. The compressor manufacturers cannot be held responsible for operator neglect or misuse.

**Common Causes of Compressor Failure**

1. **Failed Pressure Switches**

   A compressor will pump when it is told to and continue to pump until it is not told to. Protection switches are built into the system to tell the compressor to stop before it is damaged. If theses switches fail, the compressor will continue pumping until it can’t.

   The **high-pressure switch** (usually set at approximately 350 psi) protects the system for excessive pressure build up, if a restriction should develop on the high side. The system must shut down or it will blow a seal or a valve.

   The **low-pressure switch** (usually set at 7 psi for heavy duty) protects the system from going into a vacuum. If the expansion valve freezes due to moisture, refrigerant will not be fed into the evaporator and therefore the compressor will starve and go into a vacuum. The protection switch must tell it to stop because it has nothing to pump. If it continues, it will pump oil out of itself and will seize up.

2. **Leaking Seals**

   Inactivity over long periods (winter) allows oil to drain away from the front seal. Lack of lubrication causes the seal to shrink and allow the refrigerant to pass by it.

*Maintenance Tip:*

- Operator should turn the air conditioning system on at least once a month to keep the seals and o-rings lubricated.

- See Alternative Refrigeration Section for possible repair.

**3. Contamination**

a) R134a creates scale build-up at high pressures. When this debris flakes off, it inevitably travels to the compressor causing damage:

- By attaching to the reed valves, causing them to stick

- By clogging the oil galleys restricting lubrication

- Wear on the piston walls until compression is no longer possible

b) Moisture is the enemy of air conditioning systems. Because of the high temperatures inside the system, moisture is created. A filter/drier is added to extract any moisture. When it loses its capability, the system is in danger. When moisture is combined with R134a under pressure, a corrosive mixture is created which attacks aluminium. Moisture does not mix well with oil because it dilutes its lubricating abilities. Rusting will occur on steel parts.

*Maintenance Tip:*

.

- Change the drier at least every second year or every time the system has been opened for an extended period.

- Flush and vacuum and R134a system every 3 to 4 years, and install new oil

**4. Hydraulic**

If the evaporator cannot vaporise all of the refrigerant, liquid is dumped into the compressor. This liquid “hydraulics” on the top of the pistons causes rattling, vibration, and excessive pressure on the crank or swash plate.

R12 systems that were retrofitted to R134a have evaporators too small to efficiently convert the liquid into a vapour. A large hose would give the system enough capacity to complete the transformation.

**Condenser**

There are two basic components to a condenser: tubes and fins. The refrigerant enters from the top as a hot vapour and must rid itself of the heat to change to a liquid. It relies solely on airflow through the fins to pick up the heat.

Other than damage by an accident, there are only minor things that can cause it to malfunction.

- Bent or missing fins will limit its ability
- Vibration may cause cracks
- Steel fittings may weld themselves to the aluminium ports

There are three universal styles of condensers for the heavy duty market:

- Ports on the same sides
- Ports on the opposite sides
- One to accommodate air-to-air applications.

*Maintenance Tips:*

- Inspect, clean, and straighten the fins regularly
- Eliminate vibration
- Use an anti-seize compound when reinstalling fittings

**Receiver-Drier / Accumulator**

This piece has three functions:

- Filters out contaminants
- Removes moisture
- Stores liquid refrigerant

R134a creates excessive demands on the drier because of the moisture and contamination it generates. This is the only internal defense the system has and **must not** be forgotten about (much like an oil filter during an oil change).

There are two main causes of failure:

- Moisture saturation allows moisture to bypass to the expansion valve, causing freeze-up
- Incorrect installation. Inlet must come from the condenser and the outlet must lead to the evaporator.

*Maintenance Tips:*

- Most driers have moisture indicators that should be inspected regularly
- If the system has been open for extended periods it will attract humidity from the atmosphere and become saturated.
- When in doubt, replacing it could avoid an expensive service on the road.

**Expansion Valve or Block**

This part is located just before the evaporator and serves two purposes:

- To change the refrigerant from a high-pressure liquid to a low-pressure liquid mist
- To monitor the temperature and pressure of the evaporator, and adjust the flow of refrigerant to it.

Causes of Failure:

a) Moisture: this is the coldest spot in the system and the most restricted. Any bit of moisture will freeze, blocking the passage. Ice build-up will appear outside the valve, or the operator will complain that the air conditioning works for a short time, shuts down, and then starts working again. (The ice melts, opening the passage and then freezes again.)

b) Corrosion: Acidic build-up will eventually cause the valve to stick opened or closed. If it sticks closed, the manifold gauges will read high on the high (red) side and low (blue) on the low side. If it sticks open, the gauges will read low on the high side and high on the low side.

c) Damage to the monitoring tubes will not allow the valve to accurately adjust the flow of refrigerant into the evaporator.

Maintenance Tip: Pay close attention to the receiver/drier.

## Cycling Clutch Orifice Tube System (CCOT)

Commonly called a flooded system, and is an alternative to the expansion valve/receiver-drier system. The orifice tube takes the place of the expansion valve, and the accumulator replaces the receiver/drier.

### Orifice Tube

This tube is placed into the inlet of the evaporator. The restrictive hole turns the high-pressure liquid into a super-saturated, low-pressure mist. Because this tube is made of only a filter screen and a restriction orifice, it has not monitoring capabilities. The system relies on a clutch cycling switch to regulate the temperature and pressure by turning the compressor on and off (cycling).

When the orifice tube becomes clogged, it can easily be removed and replaced…but, inspect the old one carefully. It failed for a reason, there is a problem.

- Filings caught in the screen usually indicate that there is either metallic erosion inside the compressor, or there is a deterioration of aluminium somewhere.

- Icing up, discoloration of moisture, and oil contamination. Evacuate, flush, replace the oil, and vacuum.

### Accumulator

This is the large tank between the evaporator and the compressor. It serves the same purpose as the receiver/drier, but it operates on the low-pressure side.

The accumulator removes the moisture.

It stores any of the excess liquid refrigerant that comes out of the evaporator, cleans it, and release only low-pressure, and dry vapour to the compressor.

### Evaporator

This is the ultimate proving ground of a fully functional system. Super-saturated mist is sprayed from the expansion valve, or orifice tube, into the evaporator. The refrigerant is at its coldest state and is ready for the last heat exchange in the cycle.

It relies on the blower motor to pull the warmer cab air into the re-circulation vent and through the fins, and replaces it with conditioned cooler air. The exchange of cool air for warm is vital to complete the cycle. As the liquid refrigerant absorbs

the heat, its temperature is raised to its boiling point. Evaporation changes it back to a low-pressure vapour before it re-enters the compressor.

To attain the required comfort level inside the cab, it is important to have only the air that is inside the cab circulates through the evaporator. Outside vents and windows must be closed. It is also important to equalize the flow of air between the condenser and evaporator. Slower moving vehicles may not have sufficient air flowing through the condenser to support the demand of an evaporator blower set at high speed. Greater efficiency will be achieved with the speed set at a lower setting.

Causes of Failure:

a) Not enough air through the fins

   i) Check the blower motor for functionality
   ii) Clogged fins. The re-circulated air may carry dust that sticks to the moist fins and build-up to block air passages. Cleaning is essential.
   iii) Oil soaked. If there is evidence of oil on the outside of the evaporator there is a corrosion problem. The system is no longer sealed. Replace the evaporator, flush the system, and replenish the oil.

Note: using a thermostatic switch, also known as a Renko valve, regulates Cab temperature. When replacing this, it is essential that its capillary tube be re-installed into the coldest part of the evaporator fins. Inserting it into the middle of the lower half will give the thermostat the true reading that it requires to make the necessary adjustments.

**Other Components**

**Hoses**

These “rubber roadways” are the means of transporting the oil and refrigerant from station to station. The hose assemblies must be of high quality and capable of withstanding the extremities of temperatures and pressures inside the system.

There are three different sizes of assemblies in most air conditioning applications.

**Discharge Line**

This #8 hose (13/32” ID) runs from the compressor to the condenser carrying high-pressure, high-temperature, vapour refrigerant. It is very hot to touch.

**Liquid Line**

This #6 hose (5/16” ID) carries high-pressure liquid to the expansion valve/block. The receiver-drier is spliced into this line and is ideally only warm to touch.

**Suction Line**

A #10 hose (1/2” ID) connects the outlet port of the evaporator and carries the low-pressure vapour back to the compressor. An accumulator is installed on this line in a CCOT system. It will feel cold.

Note: If a retrofit from R12 to R134a has been done, and the suction line is short, there may not be enough capacity effect the total transformation from liquid to a vapour before the refrigerant reaches the compressor. This will cause a hydraulicing effect in the compressor. In this case, a larger diameter hose is substituted (#12 ID) to allow more capacity.

**Fittings**

Always replace any fitting with a steel fitting. R134a becomes very caustic under pressure and attacks fine ferrous metals such as aluminium. This corrosion creates contamination. Be sure to use and anti-seize compound when connecting steel fittings to aluminium ports to avoid welding.

**Oils**

Oil is necessary for lubrication of the system and is conveyed with the refrigerant. Some refrigerants do not have the capability of picking up certain oils and therefore they must be compatible.

Mineral oil is only used in R12 systems.

R134a systems will function with either Ester Oil or PAG Oil. These oils are extremely hygroscopic (attracts and holds moisture) and exposure to the atmosphere will contaminate it, rendering it useless. Bulk purchases are not recommended.

**Mystery**

It is virtually impossible to determine how much oil is actually inside any system that has been in use. Too much oil will block passage; not enough oil will starve the system of lubrication. It is always a guessing game as to how much oil to add when repairing a system.

**Rules:**

- Vacuuming will not pull the oil out. Oil must be flushed from a system

- Formula for replacing oil: ad 1 oz of oil for any component being replaced, except the compressor.

- After complete flushing or a new installation:

    a) drain oil from compressor and replace with manufacturer's suggested quantity

    b) add 1 oz for the condenser

    c) add 1 oz for the drier or accumulator

    d) add 1 oz for the evaporator

    e) add 1 oz for each 10' of hose in the entire system.

**Service Tips**

- do not flush through the compressor $\longrightarrow$ drain oil and replace

- do not flush through the drier or accumulator $\longrightarrow$ replace part

## Refrigerants

R12

R12 is no longer available on the open market due to environmental issues. There are many vehicles that still operate with this refrigerant, but when they need repair they can no longer be filled with R12. These systems must be retrofitted to R134a or use an alternative refrigerant.

R134a

This refrigerant has been designated as the preferred replacement for R12. All North American manufacturers have designed their systems to function using R134a.

Consumers have not fully accepted R134a because of many reasons:

- It is less efficient than R12 and are compromising their effort

- The small molecule is difficult to contain in a sealed system. Leakage occurs at a rapid rate and frequent repairs are needed.

- Excessive pressures and high build-up of heat put extreme strain on the components.

- Moisture is an instant problem. When combined with R134a and acidic mixture is formed that corrodes the aluminium portions of a system.

- R134a, while under pressure, forms a highly toxic chemical called phosgene gas (agent orange).

- Service technicians are exposed to a highly carcinogenic substance that can cause serious health concerns if proper precautions are not followed.

R134a is not totally environmentally friendly and therefore is only a stopgap solution. The termination date for R134a is January of 2025 or sooner.