IMIAL Level 3 Award in Automotive Refrigerant Handling (EC842-2006) (QCF)

QCA ID No: 500/6771/0

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COURSE HAND BOOK

CONTENT

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IMIAL Level 3 Award in Automotive Refrigerant Handling

Why do I need to take this course?

The basic provisions of Regulation (EC) No 842/2006 describe the prevention and minimisation of the emissions of fluorinated greenhouse gases and states that personnel recovering or handling refrigerant must have a refrigerant handling certificate by July 2010.

The basic provisions of Directive 2006/40/EC calls for a control on the emissions of fluorinated greenhouse gases with a G.W.P higher than 150. From 1st January 2008, EC or National type approval will not be granted to vehicles fitted with an A/C system designed to contain a fluorinated greenhouse gas with a G.W.P higher than 150, unless the leakage rate does not exceed 40 grams per year for a single evaporator system or 60 grams from a dual evaporator system.

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GUIDEANCE FOR CANDIDATES

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- You are advised to read or listen to all the instructions carefully before starting to work and check with your assessor if necessary to ensure that you fully understand what is required.
- Safety equipment and codes of practice associated with engineering must be understood and implemented satisfactorily.
- You may seek general guidance from the assessor on the interpretation of working drawings, symbols, technical specifications of service manuals. However, the outcome and decision should be yours.
- Note: in order to pass this assignment all aspects of safety must be demonstrated to the assessor at all times and follow safety regulations and any codes of practice in operation.

  Failure to do so will: result in the assessment being halted.
- All paperwork should be handed back to your assessor at the end of the task.
- Your assessor should ensure that you have all the relevant tools and equipment needed to carry out the tasks.
- You are required to record all the evidence for the task on the task recording sheet and produce a written report.
- You should read this sheet carefully before starting to work and check with your assessor if you are not sure what you have to do.

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Task 1 – Refrigerant Handling/Transfer and Environmental friendly Recovery of Fluorinated Greenhouse Gases from an R134a Motor Vehicle System

The candidate must show competence in the following tasks to pass the assignment:

Minimum set of skills and knowledge covered by the training programme for practical and theory assessment.

Module Type practical (P)

Theory (T)

Task element
Applicants Practical Task (2. Environmental friendly recovery of fluorinated greenhouse gases.

A requirement under UK Health & Safety Legislation.

P1 Ensure motor vehicle is immobilised before working on it.

P2 Follow health and safety requirements, select appropriate Personal Protective Equipment (PPE) and follow good working practice.

P3 Prepare the motor vehicle for recovery.

P4 Select and use appropriate service equipment.

P5 Identify refrigerant and the difference between service ports/types.

P6 Recover refrigerant from a motor vehicle containing fluorinated greenhouse gases (R134a) into appropriate recovery set.

P7 Correctly handle fluorinated greenhouse gas (R134a) from a source cylinder and transfer a minimum quantity of 300 grams to refrigerant management station or appropriate recovery set.

P8 Complete activity record documentation.

T9 Theory Questions

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UNDERPINNING KNOWLEDGE….

Vehicle Air Conditioning System

- How it works, basically

Any system that lowers temperature operates in similar way. First you take a refrigerant gas and place it in a sealed system. This is then pressurised using a compressor. As it's pressurised, it gets hot by absorbing the heat around it. This hot gas is then circulated through a series of tubes that dissipate the heat. Scientifically, the gas removes heat rather than adds cold, but that's a lesson in physics that doesn't really matter to us right now. The gas can lose lots of its heat, in other words it gets really cold, when you reduce the pressure. As it cools it becomes a liquid. To use this system in a car, it needed very little adaption from its early applications as a refrigeration device. Since it was discovered that Freon (R-12) was harmful to the earth's Ozone layer, it's been phased out for automotive use, and replaced with the slightly less efficient, but harmless R-134a refrigerant, although in my own experience R-143a has been equally as efficient as R-12. Some cars have not been converted from the old R12 to R134a, but this conversion can be done easily.

Components of Automotive Air Conditioning

Basically your air conditioning system is made up of a compressor, a condenser, an evaporator, a refrigerant regulator, suction accumulator (or drier), refrigeration lines and a couple of sensors here and there.

- **Compressor:**

This is the heart of your a/c system. The compressor is what takes the refrigerant and pressurises it so it will cool the air inside the vehicle. It's run by an engine belt. The compressor also has an electrically operated clutch that turns the compressor on and off as you demand more cool air. Remember that the compressor is designed to compress refrigerant vapour and not liquid, this is an important part of your understanding of how a vehicle air conditioning system works.

The A/C system splits into two sides, a high pressure side and a low pressure side; defined as discharge and suction. Since the compressor is basically a pump, it must have an intake side and a discharge side. The intake, or suction side, draws in refrigerant gas from the outlet of the evaporator. In some cases it does this via the accumulator.
Once the refrigerant is drawn into the suction side, it is compressed and sent to the condenser.
Common Problems: Clutch or Bearings seized; Lack of or wrong PAG oil; or just worn out.

- **Condenser:**

The condenser is like a miniature radiator, usually mounted at the front of the car right next to the radiator. Sometimes the condenser will have its own electric cooling fan too. The hot, compressed vapour passes through the condenser and gets cooler as it does so. As it cools, it becomes a liquid. The changing of the state of the refrigerant from vapour is another important part of your understanding of how a vehicle air conditioning system works. Condensers must have good air flow anytime the system is in operation.
Common Problems: Clogged: Exterior dirt or damage. Interior metal pieces; incompatible oils used.

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NOTE: It is not uncommon for cooling fan system failures to cause the A/C to stop functioning.

- **Drier or Accumulator:**

The drier, also known as the receiver-drier, is sort of the safety device for your system. The compressor is only supposed to compress the vapour form of your refrigerant. However, there's always a chance that some liquid could make it back that far. The drier catches this liquid before it can damage your compressor. Since even the smallest leak or careless installation can introduce water moisture to the system, the drier absorbs this chemically, using what's called a desiccant (similar to the packet of silicon balls that comes with electronics). The drier also has a filter that catches any foreign body's that might be present.

A suction accumulator's purpose is to filter, dehydrate and act as a reservoir for vapour refrigerant.

- **Thermal Expansion Valve (also known as a TXV or TEV)**

You want to be able to regulate the refrigerant flow so the a/c system has a valve that controls the amount of super-cool refrigerant into the evaporator. This type of valve can sense both temperature and pressure, and is very efficient at regulating refrigerant flow to the evaporator. Several variations of this valve are commonly found. Another example of a thermal expansion valve is Chrysler's "H block" type. This type of valve is usually located at the firewall, between the evaporator inlet and outlet tubes and the liquid and suction lines. These types of valves, although efficient, have some disadvantages over orifice tube systems. Like orifice tubes these valves can become **clogged with debris**, but also have small moving parts that may **stick and malfunction due to corrosion**.

- **Evaporator:**

The evaporator is another little radiator that does just the opposite task as the condenser. As the super-cool refrigerant is passed through its tubes, air is forced through by means of a fan/blower and gets really cold. As it warms up again, the refrigerant starts turning back into a gas/vapour.

Common Problems: Same as Condenser.

That's pretty much it really. Different systems also have sensors here and there to tell its pressure and temperatures, but they are specific to a make and model of vehicle.

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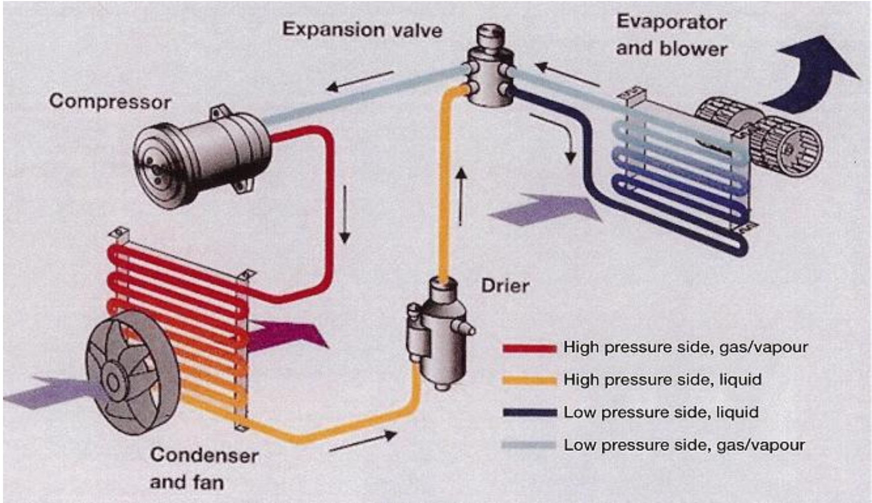
BELOW IS A DIAGRAM OF THE SYSTEM AS EXPLAINED IN THE PREVIOUS SECTION



How Refrigerant Flows Through the System
Explained in a way you can understand it easily.

1. The **Compressor** draws LOW PRESSURE HOT VAPOUR refrigerant from the **evaporator** (suction port – large line), and compresses the vapour.

2. HIGH PRESSURE HOT VAPOUR from the compressor goes into the condenser. The vapour gives up its latent heat to the cooler outside air through the condenser and changes back to LIQUID (like steam back to water). Now it's a HIGH PRESSURE LIQUID.

3. The HIGH PRESSURE LIQUID travels towards a metering device through a drier and now encounters an orifice (small opening) either an **orifice tube** or expansion valve. When the liquid squirts through this opening, its pressure is reduced and it gets very cold.

4. The now LOW PRESSURE COLD LIQUID absorbs heat from the cab through the evaporator and the liquid inside turns into vapour (boils) (like water absorbing heat and turning to steam) except refrigerants boil at very low temperatures. The boiling point of R134a is -26.3c

4a. Note: If the orifice is an O-tube, under some conditions too much refrigerant might get into the evaporator and not all boil. An accumulator is hooked on the evaporator output to "accumulate" this excess liquid and prevent the liquid from reaching the compressor.

5. This LOW PRESSURE HOT VAPOUR from the evaporator is now drawn into the compressor. Back to step 1.

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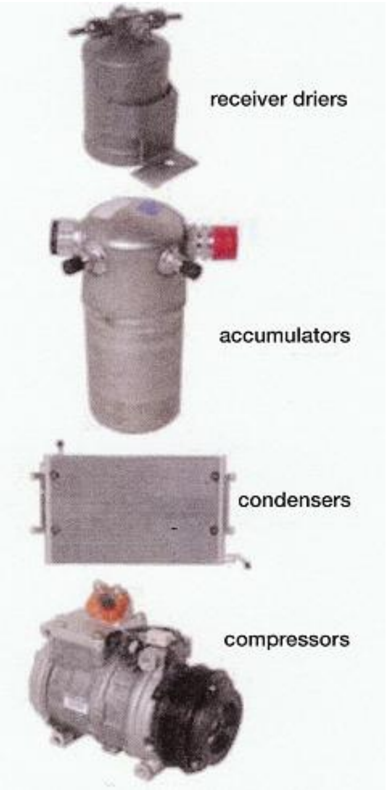
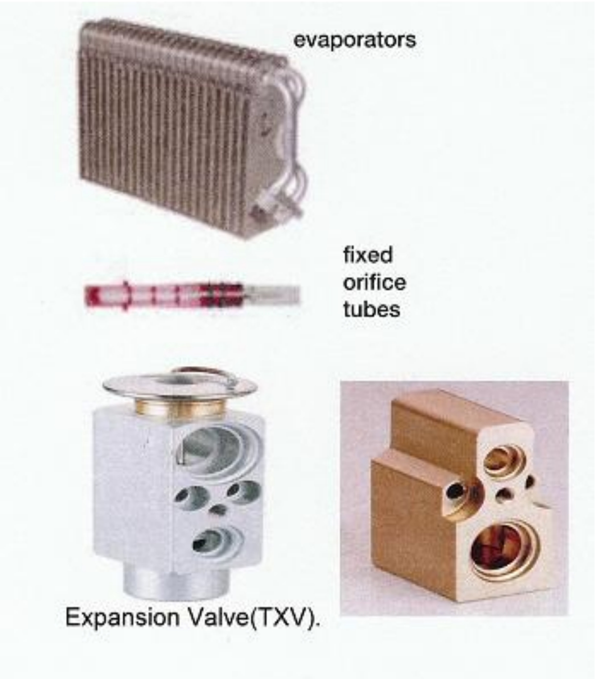
BELOW ARE THE SEPARATE COMPONENTS OF THE A/C SYSTEM





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HOW HEAT IS TRANSFERRED

Heat (thermal energy) always moves from hot places to cold places. This is called heat transfer. Sometimes you want to make it easy for heat to go from one place to another. Sometimes you want to keep heat in one place. So you need to know how heat travels.

RADIATION

Heat transfer by radiation from one body to another occurs in the form of a wave motion similar to that of a light wave or radio wave. No intervening matter is required for heat transfer to take place by radiation. For example, the sun transmits great amounts of heat energy to the earth by radiation across the vacuum of space. By standing close to a fire, you can readily feel the heat radiated by the fire. Heat transfer by radiation will occur between any two bodies that are visible to one another and that exist at differing temperatures.

CONDUCTION

Heat transfer by conduction occurs when energy is transferred by direct contact between molecules of a single body or among molecules of two or more bodies in physical contact with each other. Conduction takes place from the area of the higher temperature to that of the lower temperature. For example, if you hold an iron bar in one hand and place the other end of the bar in a bed of hot coals, the heat will pass from the coals to the bar, and then along the bar to your hand. Physical contact is made in each instance; the coals to the bar, and the bar to your hand.

CONVECTION

Convection is the transfer of heat by the movement of a substance (gas or liquid) through a space. Examples of heat transfer by convection include a current of warm air in a room and warm air rising from hot water.

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UNDERSTANDING YOUR GAUGES READINGS

The vehicle air conditioning system high and low pressure should have a '**quick fitting'** type service connector on an R134a system.

When you connect gauges to the service ports of the a/c system you must observe the gauge readings. The information below should be able to assist you and give you better understanding of there readings and purpose…

Troubleshooting with Gauges FAQ
A visitor comes to us with questions about what might be wrong with the a/c in their car. It goes something like this. My air conditioning was working last week, and then it quit working. What do you this is wrong? Or, maybe something like this… I added some refrigerant to my car, and it still won't get cold. What could be wrong? Well, unfortunately, questions like that are almost impossible to answer without detailed information. That's where the manifold gauge set comes into play. We use a manifold gauge set to get more information about what's happening inside the system. We created this FAQ to help answer some of the most common questions we receive on using a gauge set and hopefully provide some explanation on pressure readings.

Anyone interested in learning how to use a gauge set should first take a few moments to learn how the refrigeration cycle works (you should now have a good understanding of this after reading the previous section on page 6.) This in itself will help you immensely when it comes time to identify the high and low side of the system. You'll also begin to understand the role pressure plays on different parts of the system. That's important, since the gauge set is used to measure pressure within the system.

The basic manifold gauge set
The basic manifold gauge set usually has three hoses. Two hoses will be attached to the service ports on the vehicle during service. Each hose has its own identifying colour. In most cases, the hose intended for the low pressure service post is blue, and the hose intended for the high pressure service port is red. The middle hose should be yellow. That yellow hose will be attached to the refrigerant cylinder while charging or the vacuum pump when the system is being evacuated of air and moisture. Your manifold gauge set should have a corresponding gauge and control knob for each of the two service hoses. Like the colour of the hose, the gauges and control knobs will usually be coloured to indicate high or low pressure.

What are all the numbers on the high and low side gauge?
The low side pressure gauge is called a compound gauge. That means it can be used to measure pressure or vacuum. The numbers around the outside of this gauge indicate pressure in pounds per square inch (PSIG) or Bar, and the numbers near the bottom indicate vacuum in inches of mercury. The smaller scales near the middle of the gauge list the temperature relationship of different refrigerants. The gauges pictured overleaf list the temperature of R12, R22 and R502. Regardless of which refrigerant is being used, the scale designated as PSI or Bar is the one used to read system pressures when charging and diagnosing an a/c system. The working pressure of this gauge is from 0 to 120 PSI. Similar references are present on most modern gauges also in Bar.

The red, high side gauge is used to measure the high pressure side of the a/c system. The working pressure of this gauge is also much higher than the low side gauge. Notice the scale on this high side gauge reads from 0 to 500 PSI.

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I hooked up the service hoses with the car turned off. Both gauges show pressure. What does this mean?

The pressure readings you see when the a/c system is not operating is called static pressure. When the system is off, and temperature is stable, the pressure you see on both the high and low side gauges should be the same or very close. Both the high and low side of the system have equalised.

What static pressure should I expect to see when I hook up my gauge set?

Each refrigerant has its own static pressure at every corresponding degree in temperature. The important thing to keep in mind is static pressure changes based on temperature. Any change of temperature brings with it a change of pressure. The greater the temperature, the greater the pressure. You can use a refrigerant pressure chart to find static pressures at various temperatures. Static pressure will not be used to determine if a system is fully charged. Using the chart, if the R134a system has a static pressure of 88 psi at 80 degrees F., we can then assume the system has some amount of liquid refrigerant. The system may be full – or – may not be. At the same temperature, if the system showed only 75psi, we could say with confidence, the system is low. This is because static pressures shown on a temperature chart would show inadequate pressure for the presence of any liquid refrigerant.

Can I tell if the system is full with a static pressure reading?

No. We might determine if there is liquid refrigerant in the system, but we won't be able to tell how much liquid it contains. With static pressure, you will only know if the system has some amount of liquid refrigerant present.

What good is a static pressure reading then?

With our initial pressure reading, we can tell if the system has enough pressure to satisfy the low pressure switch and enable the compressor to operate. Static pressure can also be used to determine if a system has enough pressure to begin leak testing. Your static pressure should be no lower than 50psi when leak testing.

What's the minimum static pressure I need for the compressor to operate?

Most systems will have a low pressure cut off switch that turns the system off at approximately 20 psi. The compressor will not function again until the pressure reaches approximately 45 psi. So, in most cases, you will need a static pressure of at least 45 psi before you begin to see the compressor operate.

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Can I test the system with only 45 psi?

You can begin testing with only 45 psi. You won't get any cold air, but you should start to see some compressor engagement. As soon as the compressor engages, it will cycle off rather quickly when the suction side of the compressor draws the pressure on the low side below 20 psi… You will see the low side gauge at 45 psi, drop quickly to 20 psi, at which point the compressor will cycle off. Then the low side gauge will climb back up to 45 psi as the high and low side equalise. At this point, the compressor will kick back on and the cycle will repeat itself. This is called short cycling. The rapid cycling of the compressor is a good indication that the system is low of refrigerant.

When charging, what should my low and high side pressure be?

Ah, this is the most asked question there is. There is no magic answer for this question though. There are too many variables. Compressor (engine) RPM and airflow across the **condenser** are always changing, thus engine speed is always affecting pressure. System design, blower speed, mode setting, refrigerant type, all cause variance in high and low side pressure. For this reason we simply can't say 30 on the low side and 200 on the high side. Though I might add, that's about where you'll usually end up. The reason 30 psi on the low side is just about right is because that translates into an evaporator temperature somewhere around the freezing point of water. Look at your low side R12 gauge and you'll see a temperature scale right next to your pressure scale. That low side pressure translates into evaporator temperature. Since moisture collects on the evaporator, we would like to keep the evaporator temperature slightly above the freeing point. R134a low side pressure will be slightly lower (27 psi) at this temperature. Again, refrigerant type is one of those variables we have to consider.

What should the high side pressure be?

With R12 systems, high side pressure is usually 1.8 to 2.1 times ambient temperature. That means on an 80 degree day, with moderate humidity, we would expect to see between 144 to 168 psi on the high side. On hot humid days (with R12), you could say ambient temperature plus 100 psi and be pretty close.

With R134a it's common to see high side pressure between 2.2 and 2.5 times ambient temperature. On that same 80 degree day we would see between 176 and 200 psi on the high side of an R134a system. The system operates in a specific range based on outside ambient temperature. High side pressure has a broad range relative to temperature because of heat load on the evaporator, humidity, airflow across the condenser, and engine speed.

Should I test with doors open or closed, high idle, blower on high or low?

We should measure high and low side pressure at stable engine speeds. This can be done at engine speeds just slightly above idle. 1,200 to 1,500 RPM is most often recommended. On front wheel drive cars, never rev the engine or hold the engine at high RPM while charging or checking pressures. This can create dangerous high pressure. This is because electric condenser fans are fixed in speed, and will not compensate for high engine RPM. The same holds true on rear wheel drive cars with engine driven fans. A defective fan clutch could cause pressures to reach dangerous levels at higher engine RPM.

We like to test with the system in MAX position on high blower with doors closed. Windows can be open. MAX (recirculate) mode is preferred since we'll need to have the hood up while charging and testing. In fresh air mode, hot engine heat can be drawn into the fresh air cowl under the wiper blades. Same reason we would like to test with doors closed.

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We would like to keep engine and exhaust heat from causing abnormal heat load on the evaporator. We're not bothered by having the windows down, since this helps create a typical and stable heat load. And it's easy to reach in and feel how cold the vent temps are getting.

Testing should be done with blower speed on high. Low blower speed will reduce heat load on the evaporator to the point where compressor cycling can occur. We want nice stable conditions when testing. When needed, low blower speed can be used to force low side pressure down during testing and adjustment of compressor cut-out pressure.

If 30 PSI is a good low side pressure, then why isn't the system cooling?

Well, there are a couple reasons, but let's look at the most common. Let's take the fixed orifice tube system for example. You can have a system evaporator pressure of 30 psi, and still be low on refrigerant. Let's assume that only half the evaporator is full of boiling, heat removing, liquid refrigerant. Only half the air travelling through the coil is being cooled. Pressure readings indicate core temperature is near thirty degrees, but half the core isn't removing any heat. The system is close to being full, but that discharge air is only slightly cool. On the fixed orifice tube system, most people will charge until the inlet of the evaporator, and the outlet of the evaporator are within a degree or two of each other. That indicates the quantity of refrigerant is enough that the entire coil is being very cold. If the system has a TXV or H block, you will not be able to charge by feeling the evaporator outlet tube like we can on a FOT system. The TXV is very efficient and is designed to tightly control liquid refrigerant from spilling out of the evaporator. The area we would measure is in the evaporator box and not accessible for this purpose.

Secondly, who says the system isn't working. You need to consider the chance of a blend door problem. Just because cold air isn't coming from the vent doesn't mean the system isn't working. I've seen cars with sweat rolling off the accumulator and low pressure line to the compressor, and the technician is under the hood scratching his head because no cold air is coming from the vents. If the low side lines are obviously cold, and pressures are within range, we should think about looking inside the vehicle for the problem.

How can I tell if the compressor is faulty?

Usually the compressor will show the inability to generate enough suction and pressure at or near idle speeds.

If engine speed needs to be substantially increased to bring pressures in range, that's a sign that the compressor is getting weak. Often the complaint is …. Only cools when the engine is revved – or – only cools when driving down the road.

Sometimes it's very simple. If we hood the gauges up and see 80 psi on the low side, and 80 psi on the high side, and the compressor hub is spinning, it's likely that compressor is worn out. It's not producing suction, and it's not producing pressure. We could add or remove refrigerant and still nothing would happen. The compressor must be able to pull a vacuum, and create pressure. Compressors that use a variable stroke are often misdiagnosed as being defective, when only the internal pressure control device is at fault.

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How can I tell if the orifice tube is clogged?
A restricted orifice will usually show as very low suction side pressure and higher than normal high side pressure. When the compressor kicks in, the suction against the restricted orifice will cause the compressor to quickly cycle out. After compressor disengagement, the rise in suction side pressure will usually be very slow. Rapid compressor disengagement and slow engagement may indicate a clogged orifice. A *clogged orifice tube will starve a compressor of oil*.

How can I tell if the expansion valve is operating correctly?
This has to be our least favourite item to diagnose. We've had expansion valves quit working while on the road and show no signs of problem back in the shop. What's worse, an expansion valve can stick closed, stick open, or hang somewhere in between.

Of all the bad expansion valves seen over the years, I think those that stick closed are most common. Those are the easy ones. Gauges will show very low suction side pressure along with lower than normal high side pressure. The low side may even draw into a vacuum. That's a big clue. Those that appear to be stuck closed may have inlet screens clogged with ground up desiccant particles. This will look like beach sand packed into the inlet.

It's common for a defective expansion valve to stick closed; however, the expansion valve can also stick open. This is indicated by higher than normal low side pressure, and slightly higher than normal high side pressure. To some, this might appear as a weak compressor or slightly overcharged system.

What should the readings be when the refrigerant has been fully recovered and the a/c system is empty.
The readings should be zero bar / zero psig at the end of recovery, allowing for boil off and ensuring pressures do not rise.

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GLOBAL WARMING POTENTIAL G.W.P

Air conditioning has to use refrigerants and although there are many types of refrigerants, including air and water, it is necessary to use chemicals for reasons of efficiency and ultimately to conserve energy.

We hope that this page will give you a better understanding of some of the most common refrigerants in use today for air conditioning and answer any queries you may have.

We have not made this too technical, we could show you the exact chemical compositions, but you will gain more information by viewing refrigerant manufacturer sites on the web.

Details are given for the following reference terms with a brief explanation, such as its effect on the Ozone layer and Greenhouse effect.

ODP
The ODP or Ozone Depletion Potential is the potential for a single molecule of the refrigerant to destroy the Ozone Layer. All of the refrigerants use R11 as a datum reference and thus R11 has an ODP of 1.0. The less the value of the ODP the better the refrigerant is for the ozone layer and therefore the environment.

GWP
The GWP, or Global Warming Potential, is a measurement of how much effect the given refrigerant will have on Global Warming in relation to Carbon Dioxide, where CO_2 has a GWP of 1. This is usually measured over a 100 year period. In this case the lower the value of GWP the better the refrigerant is for the environment.

REFRIGERANTS

R11
R11 is a single chlorofluorocarbon or CFC compound. It has a high chlorine content and ozone depletion potential (ODP) and high global warming potential (GWP). The use and manufacture of R11 and similar CFC refrigerants is now banned within the European Union even for servicing – ODP = 1, GWP = 4000

Note: Although the use of R11 is banned, it was used as the datum for ODP therefore having an ODP of 1. The ODP of all other refrigerants are compared to R11.

R22
R22 is a single hydro chlorofluorocarbon or HCFC compound. It has low chlorine content and ozone depletion potential and only a modest global warming potential. R22 can still be used in small heat pump systems, but no more new systems can be manufactured for use in the EU after late 2003. From 2010 only recycled or saved stocks of R22 can be used, as it will no longer be manufactured. – ODP = 0.05, GWP = 1700

Phase out dates for R22
From 1 July 2002 no more cooling only air conditioning equipment can be manufactured that uses refrigerant R22.

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From 1 January 2004 no more heat pump equipment can be manufactured that uses refrigerant R22.

After 1 January 2010 no more virgin refrigerant R22 can be used in existing systems. After 2015 no more recycled refrigerant R22 can be used in existing systems.

If you have recently installed an R22 air conditioning system the phase out dates should not cause you concern. Your system will only require additional refrigerant should a leak or major repair is required and this can be affected within current legislation until 2015.
There is already a “drop in” replacement refrigerant for R22 with zero ODP – R417A – see below.

R134A
R134A is a single hydro fluorocarbon or HFC compound. It has no chlorine content, no ozone depletion potential, and only a modest global warming potential. – ODP = 0, GWP = 1300

R407C
R407C is a ternary blend of hydro fluorocarbon or HFC compounds, comprising 23% of R32, 25% of R125 and 52% of R134a. It has no chlorine content, no ozone depletion potential, and only a modest direct global warming potential. – ODP = 0, GWP = 1610

R410A
R410A is a binary blend of hydro fluorocarbon or HFC compounds, comprising 50% of R32 and 50% of R125) it has no chlorine content, no ozone depletion potential and only a modest global warming potential. – ODP = 0, GWP 1890

R417A
R417A is the zero ODP replacement for R22 suitable for new equipment and as a drop in replacement for existing systems.

There are currently no restrictions on equipment or use of the following refrigerants: R134A, R407C, R410A and R417A.

ALTERNATIVE REFRIGERANTS

R290
R290 – Pure propane, a hydrocarbon (HC) an efficient naturally occurring refrigerant with similar properties to R22, but has no ozone depletion potential and an extremely low global warming potential. Whilst it is environmentally safe, it is also highly flammable and must only be used after careful consideration is given to safety. – ODP = 0, GWP = 3.

Ammonia
Ammonia – A highly efficient refrigerant that has been used in industrial applications for many years and with success. It is however; highly toxic and very careful consideration must be given to any design or application.

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GENERAL NOTES

Refrigerants should only be handled and used by *Competent and trained persons*

The design, application and safe use of all refrigerant based systems, together with control measures is covered by BS EN378. This standard supersedes BS4434.

It is a criminal offence to release refrigerants to atmosphere and all existing system charges must be reclaimed or recovered by approved companies for either re-use, recycling or controlled destruction.

Remember the higher the G.W.P the higher the contribution to the global greenhouse effect.

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