Introduction to air conditioning

Environment, Air

Air conditioners and refrigerators work the same way. Instead of cooling just the small, insulated space inside of a refrigerator, an air conditioner cools a room, a whole house, or an entire business.

Air conditioners use chemicals that easily convert from a gas to a liquid and back again. This chemical is used to transfer heat from the air inside of a home to the outside air.

The machine has three main parts. They are a compressor, a condenser and an evaporator. The compressor and condenser are usually located on the outside air portion of the air conditioner. The evaporator is located on the inside the house, sometimes as part of a furnace. That’s the part that heats our house.

The working fluid arrives at the compressor as a cool, low-pressure gas. The compressor squeezes the fluid. This packs the molecule of the fluid closer together. The closer the molecules are together, the higher its energy and its temperature.

The working fluid leaves the compressor as a hot, high pressure gas and flows into the condenser. If we looked at the air conditioner part outside a house, look for the part that has metal fins all around. The fins act just like a radiator in a car and helps the heat go away, or dissipate, more quickly.

When the working fluid leaves the condenser, its temperature is much cooler and it has changed from a gas to a liquid under high pressure. The liquid goes into the evaporator through a very tiny, narrow hole. On the other side, the liquid’s pressure drops. When it does it begins to evaporate into a gas.

As the liquid changes to gas and evaporates, it extracts heat from the air around it. The heat in the air is needed to separate the molecules of the fluid from a liquid to a gas.

The evaporator also has metal fins to help in exchange the thermal energy with the surrounding air.

By the time the working fluid leaves the evaporator, it is a cool, low pressure gas. It then returns to the compressor to begin its trip all over again.

Connected to the evaporator is a fan that circulates the air inside the house to blow across the evaporator fins. Hot air is lighter than cold air, so the hot air in the room rises to the top of a room.

There is a vent there where air is sucked into the air conditioner and goes down ducts. The hot air is used to cool the gas in the evaporator. As the heat is removed from the air, the air is cooled. It is then blown into the house through other ducts usually at the floor level.

This continues over and over and over until the room reaches the temperature we want the room cooled to. The thermostat senses that the temperature has reached the right setting and turns off the air conditioner. As the room warms up, the thermostat turns the air conditioner back on until the room reaches the temperature. Any system that loours temperature operates in similar fashion. First we take a gas, like Freon, and place it in a sealed system. This freon is then pressurized using a compressor. As it’s pressurized, 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 we reduce the pressure. As it cools it becomes a liquid. This is when we get cold air blowing on wet sweaty forehead.

To use this system in a car, it needed very little adaptation 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. This is actually good news because for years it was against the law to service our own air conditioning system without a license. Now that the refrigerant is safer, we can all work on our own A/C systems again! Some cars have not been converted from the old R12 to R-134a, but this conversion can be done easily.

2. 1 WORKING OF AIR CONDITIONER

2. 1. 1 COMPRESSOR

The air conditioning compressor is the refrigerant pump of the air conditioning system. The compressor compresses refrigerant inside the system and circulates it to the condenser and then to the evaporator. The evaporator is where the pressurized refrigerant is released, causing a drop in pressure resulting in a cold evaporator, the low pressure refrigerant is then returned to the compressor to be re-pressurized. The air conditioning compressor is driven by a drive belt that is pooured by the engine and can

be engaged and disengaged by an electromagnetic coil on the front of the compressor (Fig. 2. 1).

To maintain the efficiency of the air conditioning system the compressor drive belt should be checked regularly. If it is worn out or degenerated it should be replaced. The system’s hoses should be checked for deterioration, bubbles, cracks and hardening or oily residue, all could be signs of leakage. The correct refrigerant charge should always be maintained, low system refrigerant charge is a common cause of a weak AC system.

Odors can developed in the air conditioning system when a fungus has grown on the evaporator core. Warm damp surroundings provided the perfect breeding ground for fungus, which grows with moisture. Aerosol disinfectants can be used to remedy this condition. While the air conditioner system is running on the full high setting with recirculation feature activated, spray a disinfectant (Lysol, Ozium) into the inlet of the ac system (under the dash on the passenger’s side), be aware whatever we spray will come out of the upper vents, so we may not want our face in front of any vents when doing this procedure. Odors can be prevented from returning by repeating this procedure periodically throughout the summer months. This is the heart of our a/c system. The compressor is what takes the refrigerant (the gas) and pressurizes it so it will cool the air. It’s run by an engine belt. The compressor also has an electrically operated clutch that turns the compressor on and off as we demand more cool air.

2. 1. 2 CONDENSERS

This is the area in which heat dissipation occurs. The condenser, in many cases, will have much the same appearance as the radiator in we car as the two have very similar functions. The condenser is designed to radiate heat. Its location is usually in front of the radiator, but in some cases, due to aerodynamic improvements to the body of a vehicle, its location may differ. Condensers must have good air flow anytime the system is in operation. On rear wheel drive vehicles, this is usually accomplished by taking advantage of our existing engine's cooling fan. On front wheel drive vehicles, condenser air flow is supplemented with one or more electric cooling fan(s) (Fig. 2. 2).

As hot compressed gasses are introduced into the top of the condenser, they are cooled off. As the gas cools, it condenses and exits the bottom of the condenser as a high pressure liquid. The condenser is like a miniature radiator, usually mounted at the front of the car right next to our big radiator. Sometimes the condenser will have its own electric cooling fan, too. The hot, compressed air passes through the condenser and gets lots cooler. As it cools, it becomes a liquid

2. 1. 3 EVAPORATOR

Located inside the vehicle, the evaporator serves as the heat absorption component. The evaporator provides several functions. Its primary duty is to remove heat from the inside of our vehicle. A secondary benefit is dehumidification. As warmer air travels through the aluminum fins of the cooler evaporator coil, the moisture contained in the air condenses on its surface. Dust and pollen passing through stick to its wet surfaces and drain

off to the outside. On humid days we may have seen this as water dripping from the bottom of our vehicle. Rest assured this is perfectly normal (Fig. 2. 3).

The ideal temperature of the evaporator is 32 Fahrenheit or 0 Celsius. Refrigerant enters the bottom of the evaporator as a low pressure liquid. The warm air passing through the evaporator fins causes the refrigerant to boil (refrigerants have very low boiling points). As the refrigerant begins to boil, it can absorb large amounts of heat. This heat is then carried off with the refrigerant to the outside of the vehicle. Several other components work in conjunction with the evaporator. As mentioned above, the ideal temperature for an evaporator coil is 32 F. Temperature and pressure regulating devices must be used to control its temperature. While there are many variations of devices used, their main functions are the same; keeping pressure in the evaporator low and keeping the evaporator from freezing; A frozen evaporator coil will not absorb as much heat. The evaporator is another little radiator that does just the opposite task as the condenser. As the super-cool liquid is passed through its tubes, air is forced through and gets really cold, right before it hits our face. As it warms up again, the refrigerant starts turning back into a gas.

2. 1. 4 THERMAL EXPANSION VALVE

Another common refrigerant regulator is the thermal expansion valve, or TXV. Commonly used on import and aftermarket systems. 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.(Fig . 2. 4)

Flow control, or metering, of the refrigerant is accomplished by use of a temperature sensing bulb filled with a similar gas as in the system that causes the valve to close against the spring pressure in the valve body as the temperature on the bulb increases. As temperatures in the evaporator decrease, so does the pressure in the bulb and therefore on the spring causing the valve to open. An air conditioning system with a TX valve is often more efficient than other designs that do not use one. A thermal expansion valve is a key element to a refrigeration cycle; the cycle that makes air conditioning, or air cooling, possible. A basic refrigeration cycle consists of four major elements, a compressor, a condenser, a metering device and an evaporator. As a refrigerant passes through a circuit containing these four elements, air conditioning occurs. The cycle starts when refrigerant enters the compressor in a low pressure, low temperature, gaseous form. The refrigerant is compressed by the compressor to a high pressure and temperature gaseous state.

2. 1. 5 RECIEVER-DRIER

The receiver-drier is used on the high side of systems that use a thermal expansion valve. This type of metering valve requires liquid refrigerant. To ensure that the valve gets liquid refrigerant, a receiver is used. The primary function of the receiver-drier is to separate gas and liquid. The secondary purpose is to remove moisture and filter out dirt. The receiver-drier usually has a sight glass in the top. This sight glass is often used to charge the system. Under normal operating conditions, vapor bubbles should not be visible in the sight glass. The use of the sight glass to charge the system is not recommended in R-134a systems as cloudiness and oil that has separated from the refrigerant can be mistaken for bubbles. This type of mistake can lead to a dangerous overcharged condition. There are variations of receiver-driers and several different desiccant materials are in use. Some of the moisture removing desiccants found within are not compatible with R-134a. The desiccant type is usually identified on a sticker that is affixed to the receiver-drier. Neour receiver-driers use desiccant type XH-7 and are compatible with both R-12 and R-134a refrigerants. The ac receiver drier is used to take all of the water out of the ac system, and to take out any contaminants that may plug the ac system. The ac receiver drier should be changed every time we remove any ac component that exposes the sealed ac system to the atmosphere. (Fig. 2. 5)

The ac receiver drier is typically located in the engine compartment and has 2 hoses connected to it. There also may be a low-pressure switch attached to the receiver drier as well. For convenience some ac receiver driers have a small window on the unit to allow we to see if the air conditioning system is

fully charged. Simply turn the ac system on high, wait a few minutes and look at the small window. We should not see any bubbles passing thru the receiver drier.

2. 1. 6 ACCUMULATORS

Accumulators are used on systems that accommodate an orifice tube to meter refrigerants into the evaporator. It is connected directly to the evaporator outlet and stores excess liquid refrigerant. Introduction of liquid refrigerant into a compressor can do serious damage. Compressors are designed to compress gas not liquid. The chief role of the accumulator is to isolate the compressor from any damaging liquid refrigerant. Accumulators, like receiver-driers, also remove debris and moisture from a system. It is a good idea to replace the accumulator each time the system is opened up for major repair and anytime moisture and/or debris is of concern. Moisture is enemy number one for our A/C system. Moisture in a system mixes with refrigerant and forms a corrosive acid. When in doubt, it may be to our advantage to change the Accumulator or receiver in our system. While this may be a temporary discomfort for our wallet, it is of long term benefit to our air conditioning system. An accumulator can maintain the pressure in a system for periods when there are slight leaks without the pump being cycled on and off constantly. When temperature changes cause pressure excursions the accumulator helps absorb them. Its size helps absorb fluid that might otherwise be locked in a small fixed system with no room for expansion due to valve arrangement.(Fig. 2. 6)

The gas precharge in an accumulator is set so that the separating bladder, diaphragm or piston does not reach or strike either end of the operating cylinder. The design precharge normally ensures that the moving parts do not foul the ends or block fluid passages. Poor maintenance of precharge can destroy an operating accumulator. A properly designed and maintained accumulator should operate trouble-free.

2. 1. 7 ORIFICE TUBE

The orifice tube, probably the most commonly used, can be found in most GM and Ford models. It is located in the inlet tube of the evaporator, or in the liquid line, somewhere between the outlet of the condenser and the inlet of the evaporator. This point can be found in a properly functioning system by locating the area between the outlet of the condenser and the inlet of the evaporator that suddenly makes the change from hot to cold. We should then see small dimples placed in the line that keep the orifice tube from moving. Most of the orifice tubes in use today measure approximately three inches in length and consist of a small brass tube, surrounded by plastic, and covered with a filter screen at each end. It is not uncommon for these tubes to become clogged with small debris. While inexpensive, usually between three to five dollars, the labor to replace one involves recovering the refrigerant, opening the system up, replacing the orifice tube, evacuating and then recharging. With this in mind, it might make sense to install a larger pre filter in front of the orifice tube to minimize the risk of of this problem reoccurring. Some Ford models have a permanently affixed orifice tube in the liquid line. These can be cut out and replaced with. (Fig. 2. 7)

2. 2 CAUSES OF AIR CONDITIONING PROBLEMS

2. 2. 1 INTRODUCTION

Most of us take the AC in our automobiles for granted. We don’t give it much thought during our daily commute. The only time we think about it is when we it starts giving us problems. But just like all the other important part of a vehicle, its AC should also be maintained properly. Especially in the cities where we get a lot of sunshine, a car without a proper AC is nothing less than a solar heater. It can be quite a punishment to travel in such a car.

There can be various reasons behind a car’s air conditioning problem. There are various components in it and anyone of the AC parts can create trouble. For example, if there is absolutely no cold air from the AC, then it may have one of these problems:

- The fuse might be blown.

- Driver belt may be broken.

- There can be a blockage in the expansion valve, receiver driver or refrigerant line.

- Fault or leakage in expansion valve.

If we are having the problem of decreased cooling in the vehicle, then there might be a slow leak or blockage in the system that needs to be check as soon as possible. A low refrigerant charge, or a slipping AC compressor clutch can also decrease the performance of the AC.

Here we must remember that minor leaks of refrigerant in some air conditioners are normal, but if the leakage increases over time, then see a mechanic immediately. Many of the neour models have external filters to keep the dust particles from reaching inside the car. But with time, these filters can also get clogged and reduce the air flow. Make sure that we clean these filters at regular intervals, especially if we live in a dusty place.

If we experience a musty smell in the car than it is very much possible that mould is blocking the filter and evaporator of the Air conditioner. In such cases, the air might be cold but not cool enough and there will be a strange moisty smell inside the car. Many people might even experience allergic attacks as soon as they enter the car. Take the car to the mechanic immediately, if we suspect any mould or fungal infestation in our car AC.

As we all have experienced at some point of our life, getting the AC of a car is tedious task because we have to send our cars to the mechanic for at least one or two days. This is not only very expensive, but very time consuming too. So, make sure that we keep our car in the best condition possible. Get it serviced on time and don’t ignore any warning signs that our AC might be giving.

Whenever we take our car on a rough and long ride, make sure that we get it serviced from a qualified mechanic afterwards. Ask the mechanic to put emphasis on the A/C compressor and its other parts

2. 2. 2 MAIN PROBLEMS AND CAUSES

Air conditioning, which was once a great luxury, is now a common feature on most motor vehicles. While the servicing of modern car air conditioning systems is best left to professionals, we can get the most enjoyment from our ac system if we know a bit about how it works and what malfunctions we should be on the lookout for.

1. Odd smells coming from the air conditioning may be caused by bacterial buildups

As our car becomes older, or when the air conditioning system is used infrequently, bacteria, micro-organisms, mold and fungi may start growing, just behind the dash panel on the evaporator causing some very unpleasant odors. Some even claim this can result in headaches and flu like symptom sometimes referred to as “ sick car syndrome.”

This problem can be solved by using an anti-bacterial treatment that destroys the bacteria growth and leaves our car smelling fresh again.

2. If we car does not feel cold enough, then we may need to recharge our system

If we feel that our car doesn’t feel as cold as our friend’s car, then our system may need servicing. The air conditioning system in our vehicle is not usually covered by most manufacturers servicing schedules and the refrigerant gas that is used to operate the system depletes over time. On average most vehicles lose up to 15% per annum. This leakage can be caused when then system is not used during the winter months. Thus

allowing the small “ O” ring seals to dry out resulting in a gradual deterioration in system performance. If this continues, eventually the system will not be able to operate at all.

Most problems of this type can be put right fairly easily by a leak check of our system followed by a complete refill of our air conditioning refrigerant, this is sometimes referred to as a re-gas.

3. Running our air conditioning year round will help maintain the system

If we run the air conditioning in the winter it will help to keep the system well lubricated and leak tight. This is because the refrigerant actually carries the oil that lubricates the system and most importantly the compressor. It also keeps the seals and hoses moist, thus preventing them from drying out and cracking which can lead to leaks.

4. Strange noises coming from the air conditioning should be attended to immediately. If our air-con system suddenly starts making noises we have not heard before it is very advisable to have a qualified vehicle air conditioning specialist to have a look at it.

Some noises could be early symptoms of a compressor failure (the compressor is the air conditioning pump). The compressor is usually the most expensive part on the system ranging from approximately £230 to £600+ and if the bearings in our compressor break down or if the compressor seizes up it also means that other components can become contaminated with metal particles A flush of the system would then be

needed as well as replacement of the compressor, the receiver/drier and the expansion valve – quite a hefty bill!

5. Don’t worry about a pool of water forming under our car after using the A/C

If we see a puddle of water on the ground, usually under the passenger area don’t be alarmed. This is a normal feature of the system as it is only water dripping from the air conditioning evaporator. The evaporator has a drain tube fitted to allow the condensation from the evaporator to drain away from the vehicle.

6. Excessive moisture inside the car can be fixed easily

Sometimes the drain tube from the evaporator may become blocked or detached allowing the condensation to build up inside evaporator. If this occurs water will just build up inside oure car to a point where there are damp carpets or misting / high humidity type problems. These problems can be solved with low-cost servicing.

7. Have our air conditioning serviced regularly, even if there are no visible problems. Just as the other systems of our car need servicing on a regular basis, the same is true for the air conditioning system. The compressor needs oil, or else it will seize up. The filter collects debris and moisture. If the filter becomes blocked, then the performance of the system will deteriorate and it can even quit working entirely (probably when we need it most!)

Normally the refrigerant gas in a car air conditioning system has to be recharged completely within four years from the manufacture date and thereafter every two to three years.

An annual servicing of our car’s air conditioning system will guard against malfunctions in the compressor and other vital parts of the system. Regular maintenance will save we money in the long run and guarantee we comfort in the hottest months. Vehicle manufacturers recommend servicing air-conditioning systems every two years. A fully functional system brings we several major benefits:

Ensures that correct temperatures are being reached.

Reduces pollen and pollution entering our car.

Saves we money.

Reduces the amount of chloroflurocarbons (CFCs) in the atmosphere.

Increases the life of our vehicle’s air conditioning system.

A useful tip in winter is to run the air conditioning to prevent our windscreen misting

3. 1. METHODOLOGY

RELIABILITY ANALYSIS

FAILURE ANALYSIS

4. 1. CONCLUSIONS

The project report mainly deals with how an air conditioner works and explains the various working features of the air conditioner such as the working parts and then deals with the problems associated with air conditioning and the main causes of it. The project also gives an insight to the air conditioning world and how important it is to our modern day world.