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Air Conditioner Compressor Failure

How To Diagnose an A/C Compressor Failure and Prevent It From Happening Again

Adapted from an article written by Larry Carley for *Import Car magazine*

The compressor is the heart of the refrigeration circuit. It pumps and pressurizes the refrigerant to move it through the A/C system. Compressors work hard and run hot, up to several hundred degrees and several hundred pounds per square inch of internal pressure. They rely on only a few ounces of lubricant to keep their parts moving. If the lubricant is lost because of a leak, or the lubricant breaks down due to contamination, the compressor will not last. Sooner or later, the compressor will call it quits.

The most common symptom of a compressor failure (besides no cooling) is a seized compressor. It will not turn when the magnetic clutch engages, and you may hear squeals of protest from the drive belt. Or, the belt may have already broken or been thrown off its pulleys.

Loss of Lubrication Most Common Cause of Failure

Loss of lubrication is unquestionably the most common cause of compressor failure. This can happen when there is a refrigerant leak somewhere in the system that allows refrigerant and oil to escape. Typical leak points are hoses, hose and pipe connections (O-rings and flange gaskets), the evaporator, condenser or the compressor shaft seal. An electronic leak detector or dye should be used to find the leak so it can be repaired.

A restriction inside the A/C system can also starve the compressor for oil. Oil circulates with the refrigerant, so if the orifice tube or expansion valve is blocked it may cause the compressor to run dry and seize.

Compressor Noise

Even if a compressor is still turning, it may have to be replaced if it is leaking, making excessive noise or not working correctly. Some compressors are naturally noisier than others, but loud knocking noises can sometimes be caused by air in the system (the cure here is to vacuum purge the system to remove the unwanted air, then to recharge the system with refrigerant). Metallic noises and bearing noise are usually signals that the compressor is about to fail.

Worn Internals

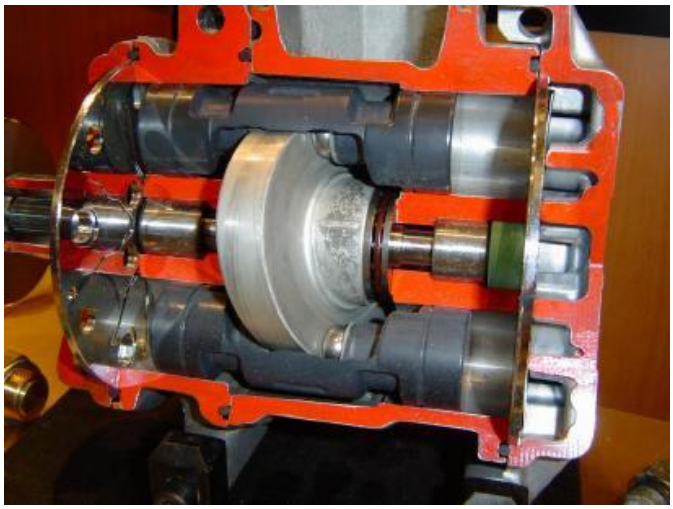
A new compressor may be needed if the unit is leaking internally or not producing enough pressure due to bad reed valves, worn piston rings, or worn or scored cylinders, etc.). A worn compressor or one with internal problems will not be able to develop normal operating pressures with a full charge of refrigerant. This kind of problem can be diagnosed with an A/C gauge set.

Other Causes of Poor or No Cooling

Poor cooling can also be caused by a lot of things other than a bad compressor, so do not replace the compressor until you have ruled out other possibilities such as a low refrigerant charge, too much oil in the system, air contamination, a clogged condenser, plugged orifice tube, inoperative electric cooling fan, etc.

Compressor operation can be affected by sensors in vehicles with automatic temperature control systems. Some have an A/C pressure transducer (usually mounted in the high side line) to monitor refrigerant pressure and shut off the compressor if pressure gets too high; a compressor temperature sensor to turn off the compressor if it gets too hot; and/or a compressor rpm sensor to monitor belt slippage. Mitsubishi, for example, uses a "belt lock controller" to disengage the compressor if the drive belt slips or the compressor seizes.

On 1996 and newer Mercedes-Benz E-Class cars, the A/C control module will disengage the compressor if the refrigerant temperature and pressure sensors do not show a rise when the compressor is being driven.



COMPRESSOR CLUTCH PROBLEMS

If the compressor is not turning, make sure the magnetic clutch engages when energized. Underlying problems here may include a bad relay, fuse, wiring problem or a defective clutch. If the clutch fails to cycle on and off when the A/C is turned on, jumping the clutch lead with a jumper wire from the battery will show if the problem is in the clutch or elsewhere. If the clutch engages, the problem is the clutch power supply (relay, fuse, wiring, switch or control module). Refer to a wiring diagram and work backward toward the battery to find out why the voltage is not getting through.

Many A/C systems have a low-pressure cutout switch that prevents the compressor clutch from engaging if system pressure (the refrigerant charge) is too low. This is designed to protect the compressor from damage in the event of a leak. So if the clutch is not engaging, check the refrigerant charge and the cutout switch. The clutch air gap is also important for proper clutch operation. If the clearance is not correct, the clutch may slip and burn or not engage at all. The specs can be found in a service manual along with adjustment procedures. Generally speaking, most clutches call for a 0.015 to 0.040 inch press fit clearance.

DEFECTIVE COMPRESSORS?

How often do compressors fail as a result of "manufacturing defects?" Not very often. According to one compressor manufacturer who examined 75 compressors that had failed and were returned under warranty, only two were found to have manufacturing defects. The rest failed because of problems such as too little oil in the system, air in the system, contaminants in the system, or "installer error." The latter category included using the wrong type of compressor lubricant, not using enough lubricant, using non-approved flushes to "clean" system parts, and using cross-contaminated refrigerants. Debris left over from a previous compressor failure was the most common cause of repeat compressor failures.

Use the Correct Compressor Oil

Always use the type of lubricant recommended for specific compressors. This is especially important with rotary vane and scroll-type compressors. A replacement compressor may or may not contain lubricant from the factory. In some cases, the shipping oil must be drained before the compressor is installed. In other cases, the compressor may contain a POE or a PAG oil lubricant that may or may not be compatible with the vehicle requirements. Follow the compressor suppliers installation instructions to the letter to avoid warranty problems later on.

Before adding fresh oil to a system, all the old oil should first be removed. This will prevent cross-contamination of lubricants and reduce the risk of overcharging the system with too much oil (which can cause cooling problems). Always refer to the OEM oil capacity chart for the vehicle application. The following is a list of recommended lubricants for R-134a import compressors:

- Behr/Bosch rotary compressors - Ester 100;
- Behr/Bosch piston compressors - PAG 46;
- Calsonic V5 - PAG 150;
- Calsonic V6 - PAG 46;
- Diesel/Kiki (Zexel) DKS, DKV & DCW - PAG 46;
- Hitachi (all) - PAG 46;
- Keihin (all) - PAG 46;
- Matsushita (all) - Ester 100;
- Mitsubishi FX80 - PAG 100;
- Mitsubishi FX105 - PAG 46;
- Nihon (all) - Ester 100;
- Nippondenso 6P, 10P, 10PA, 10P08E - PAG 46;
- Nippondenso SP127, SP134 & 6E171 - PAG 46;
- Nippondenso TV series - PAG 125;
- Panasonic (all) - PAG 46;
- Sanden SD500 & SD700 - PAG 100;
- Sanden SD710, SDB, TV & TRS - PAG 46; and
- Seik-Seiki (all) - Ester 100.

FLUSHING AFTER A COMPRESSOR FAILURE

When a compressor fails, it may spit metallic debris into the A/C system. Most of this debris ends up in the condenser where it can block tubes and interfere with efficient cooling. Some of the debris may be carried to the orifice tube or expansion valve and create a blockage. Debris can even be blown back into the suction tube. If not removed by flushing, it can be sucked back into a new compressor and cause it to fail.

Flushing the hoses is always recommended following a compressor failure. Flushing the condenser is also recommended. But with many condensers, replacement is the only sure-fire way to get rid of contaminants. Older serpentine-style tube-and-fin condensers

can often be flushed successfully, but parallel flow condensers are very difficult to clean. So too are newer style condensers with extremely small extruded tubes. For these kinds of applications, the condenser should be replaced. It is expensive, but not as expensive as ruining a new compressor because of residual debris or sludge in the old condenser.

After flushing, install an in-line filter after the condenser to trap any debris that might still be inside. The filter will prevent anything that works loose from being carried to the orifice tube.

You should also install a filter screen in the suction hose at the compressor inlet to protect the new compressor from any debris that might be upstream inside the suction hose or evaporator.

Another reason for flushing is to remove residual oil from the system. This is necessary when retrofitting an older R-12 system to the new ozone-safe R-134a refrigerant, but it is also a good way to make sure the system contains the right amount of oil. Simply adding oil to the system to replace that which has been lost is a guess at best, because there is no way to know how much has been lost due to leakage. Estimating a couple of ounces here and there for replacing an accumulator, receiver/drier, condenser, compressor or hoses is not a very accurate means of determining how much oil needs to be added to the system when it is recharged with refrigerant. Flushing gets rid of all the oil so the exact amount specified by the vehicle manufacturer can be added back to the system.

What happens if there is too little or too much compressor oil in the system? Not enough oil in the system will reduce compressor lubrication and may lead to premature failure. Too much oil in the system can puddle in the condenser and obstruct the flow of refrigerant causing a drop in cooling performance.

Other parts that should also be replaced following a compressor failure include the accumulator or receiver/dryer, and the orifice tube or expansion valve. The former contains a bag of desiccant that traps moisture and acts as a filter to protect the system. A new orifice tube or expansion valve is recommended because the small hole in this metering device can become easily plugged with debris. An aftermarket "variable orifice tube" can improve low-speed cooling.

EVACUATING & RECHARGING THE AIR CONDITIONING SYSTEM

After the compressor has been installed and the hoses are reconnected, the A/C system must be thoroughly evacuated with a vacuum pump to pull out air and moisture. If not purged from the system, air will reduce cooling efficiency. Moisture will react with refrigerant oil and produce acids and sludge. Moisture can also freeze and plug the expansion valve causing noise, restrictions or a complete blockage.

A pump capable of achieving high vacuum must be used to pull out all of the contaminants. When air is pulled out of the system, it creates a vacuum that causes

residual moisture to boil and evaporate. For this to occur, the vacuum pump must be capable of pulling at least 29 in. Hg of vacuum throughout the evacuation process (which normally takes about 30 minutes).

One of the best ways to monitor the evacuation process is with a Thermistor Vacuum Gauge that reads in microns (one inch of Mercury equals 25,400 microns). It takes a highly accurate instrument to measure vacuum because even a little pressure left in the system can prevent all the residual moisture from boiling out. Only a 1/2 inch of mercury of pressure (12,700 microns) can reduce the boiling point of water by more than 20 degrees F. Pulling out the last fraction of an inch of pressure is the most critical step in the evacuation process to ensure complete removal of all air and moisture.

After pulling a deep vacuum on an A/C system, close all valves and shut off the vacuum pump. A slow rise in pressure (which you can see on the Thermistor Vacuum Gauge) will occur as the residual moisture continues to boil off inside the system. Pulling additional vacuum will get rid of this moisture. The evacuation will not be complete until the system can maintain a stable vacuum reading below 700 microns for at least three minutes.

The time it takes to completely evacuate an A/C system can be reduced by preconditioning the evaporator prior to hooking up the vacuum pump. Preconditioning raises the temperature so the moisture will boil off faster. The easiest way to raise the temperature of the evaporator is to run the engine with the heater on HOT in the RECIRC mode. Turn the blower fan to HI and close all doors and windows. When the engine reaches normal operating temperature, the evaporator will be thoroughly preheated and ready to evacuate.

If you have difficulty maintaining a stable deep vacuum, there may be a leak in the A/C system, the vacuum pump or the equipment connections. Leak testing should be done prior to evacuating the system because evacuation is not always a reliable way to locate or even identify a small leak in an A/C system. Seals and O-rings that leak under pressure may move under evacuation and not leak.

Finally, recharge the system with the recommended amount of refrigerant and compressor oil. Do not overcharge and do not add too much oil. Check cooling performance to verify that everything is working properly and that the new compressor is doing its job.

GM Analysis of Compressor Failures

Don't replace the compressor until you've ruled out other possibilities for poor cooling.

An analysis of air conditioning compressors in General Motors vehicles that had been replaced for noise, vibration and insufficient cooling concerns has indicated a high number of no trouble found results. Further studies have shown that the root cause of the customer concerns that might lead to a compressor replacement was often a state of refrigerant charge issue or in another area or system of the vehicle.

The A/C system refrigerant charge level, either high or low, has been found to be a major contributor to unnecessary compressor replacement. The ability of a refrigerant recycling/recharging tool to recover and measure the weight of the A/C system refrigerant charge will help the technician make a more accurate diagnosis of a charge level concern prior to any component replacement.

A thorough visual inspection should always be performed before any tests or repairs are done. Doing so may find an obvious problem that will save time and eliminate the need for extensive diagnosis. Some additional items, as listed below, should be considered before a compressor is replaced for noise, vibration or insufficient cooling concerns.

The compressor mounting bolts, brackets or braces may be loose or missing.

The compressor drive belt may be frayed, loose or misaligned.

The A/C refrigerant lines may be grounding out on body, chassis or engine components. This may allow noise and vibration to be transmitted into the passenger compartment.

The air flow through the condenser may be insufficient.

The condenser fins may be bent or filled with debris, or the space between the condenser and radiator may be filled with leaves or debris, or the cooling fans may be inoperative or not performing as designed, or the installation of aftermarket accessories may alter or restrict the air flow through the condenser.

Inspect for missing or mispositioned air deflectors, baffles, seals and shrouds.

The compressor cycling switch may not be operating correctly. This may allow the evaporator core to freeze up or the compressor may not stay engaged long enough for proper system pressures to develop.

The air flow through the evaporator core may be restricted.

The cabin filter may be plugged, or the evaporator core may be covered with debris, or the cowl air inlet leaf screen may by plugged.

The A/C system may be overcharged or undercharged with refrigerant. The A/C system charge weight can be measured with the RRR tool after a refrigerant recovery is done.

The A/C system may have an improper amount or incorrect type of refrigerant oil.

An A/C system sealer is not approved for use in GM vehicles.

The refrigerant may be contaminated or contain an excessive amount of air. The A/C system may have been charged with an unapproved refrigerant. The refrigerant identifier on the ACR 2000 should alert the technician to these conditions.

The orifice tube or thermostatic expansion valve (TXV) may be restricted, plugged or inoperative.

The capillary bulb on the TXV must be properly positioned so that the valve will provide proper refrigerant flow.

The desiccant bag in the accumulator may have failed, allowing debris to circulate in the A/C system.

The A/C system charge weight may have been changed. Components with an updated design may have been released. A check for service bulletins applicable to the vehicle being worked on should always be done.

A check for diagnostic trouble codes in all the control modules on the vehicle should be done. Some trouble codes will disable compressor operation after they have set. They must be repaired and cleared before compressor operation is allowed.

Verify that the engine is not operating with a low unstable idle, and that the engine is operating within the compressor engagement parameters (for example, the engine may be overheating or it may be too cold for compressor engagement).

The diagnostic procedures in the HVAC section of the service manual should be performed as written to prevent the misdiagnosis of a customer concern. The HVAC Diagnostic System Check and the A/C System Performance Test are written for a specific model only. They are not generic charts. They follow a logical order with detailed instructions on how to perform each step.

When a thorough HVAC system diagnosis indicates that the compressor should be replaced, follow the procedure in the appropriate service manual. The oil balance instructions are an important part of the replacement procedure. The correct refrigerant oil, as listed in the service manual, must be used in the new compressor. It is recommended that a suction screen filter be installed on Delphi Harrison compressors that do not already have one. The suction screen filter is not approved for use on compressors from other manufacturers. Refer to Corporate Bulletin Number 01-01-39-003A for more information on A/C suction screen kit repair recommendations and procedures. If the compressor has had a catastrophic internal failure, an inline filter may be required to capture the large amount of debris that may be found to be circulating in the A/C system. In addition, the A/C system may require flushing. Refer to Corporate Bulletin Number 01-01-38-006B for more information on flushing procedures and recommendations.

The addition of fluorescent refrigerant leak dye to the A/C system is recommended if the vehicle does not have it installed already. Some vehicles have leak dye installed at the assembly plant and this will be indicated on the A/C charge label. Refer to Corporate Bulletin Number 00-01-38-009B for more information. If leak dye has been added during a previous repair and has been in the vehicle for more than three years, it is recommended that additional dye be added. Finally, a leak check of the entire A/C system should be performed before the vehicle goes back on the road.

Courtesy of General Motors.

R134a A/C Retrofit Guide covers refrigerant conversions

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