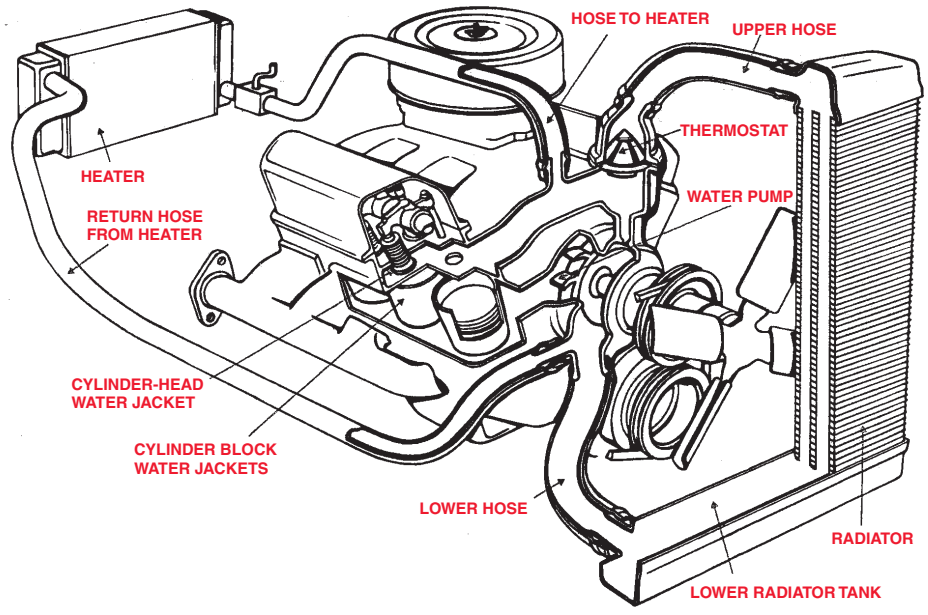
COOLING SYSTEMS

Good Maintenance Insures Good Performance

Maintaining the proper engine coolant temperature is imperative, especially considering today's computerized engine control systems. Failure to achieve a determined coolant temperature can result in poor fuel economy, high emissions output or costly engine damage. Removing the heat is the responsibility of the cooling system. The system functions by the passage of a liquid coolant through cavities and ports cast into the engine block and cylinder heads, which removes the intense heat generated by the combustion process. The temperatures can reach as high as 4,500 degrees F. The heat is absorbed by the coolant and passed through the radiator, where it is cooled by the airflow through the radiator fins and coolant tubes. The process of cooling the engine is continuous, with the exception of a warm-up cycle that is controlled by a thermostat. There are some key components that make up the cooling system, all of which must work together to keep the engine at a safe operating temperature. Let's consider those components, how they function, and some maintenance that must be performed to insure good system performance.

Radiator… The radiator is the cooling tank for the cooling system. Many different configurations may be found within the various year, make and model vehicles. Some vehicles utilize vertical flow radiators, and some systems incorporate horizontal flow designs. Some of the older systems were constructed of copper with metal tanks. Most of the radiators today are constructed of aluminum, and are fitted with plastic tanks, sealed with gaskets and o-rings. It is not uncommon to encounter cracked plastic tanks or leaking seals and o-rings, especially around the transmission coolers that are mounted internally in the radiator tanks.

Antifreeze/Coolant… Most of the attention given to the engine coolant is in relation to its freeze protection. Antifreeze is the common term we use to identify the coolant, but the term is misleading, as the chemical offers much more. The antifreeze provides freeze protection, raises the boiling point of the coolant, serves as a lubricant, and offers protection to the system from corrosion. Little attention is given to the other features, resulting in a degradation of the coolant. This can result in costly engine damage due to inadequate lubrication, corrosion and system contamination.



The mixture should be at least a 50/50 ratio of antifreeze to water, but should not be higher than 75% antifreeze. The coolant must handle engine temperatures exceeding 250 to 275 degrees F without boiling. A 50/50 mixture ratio will raise the boiling point to 265 degrees F, and a 70% mixture of antifreeze to 30% water raises the boiling point to 276 degrees F. The boiling point of

the coolant is further raised by putting the system under pressure. Never pour dirty coolant back into the radiator following a component replacement.

Radiator Cap… The radiator cap functions much like a pressure relief valve on a pressure cooker. The boiling point of the coolant is raised approximately 3 degrees F per pound rating of the radiator cap. For example: A 14 psi rated cap would raise the boiling point of the coolant 42 degrees F. The radiator cap is designed to keep pressure on the system up to a determined PSI rating. When the pressure exceeds the rating of the cap, a valve in the cap opens and releases the pressure. The coolant released is routed from the overflow tube on the radiator into a recovery tank. Once the radiator cools down, a vacuum is created in the cooling system, which opens a secondary valve in the radiator cap, allowing the coolant to be pulled back into the radiator. The hoses must be intact and the system properly sealed for the system to work. If not, you may encounter a radiator that is low on coolant, even though the recovery tank still contains coolant.

Water Pump… The water pump may well be considered the heart of the cooling system. Its purpose is to circulate the coolant through the engine block where the coolant can remove the heat generated by the combustion process. Some water pumps are driven by a fan belt/serpentine belt, or in some cases driven by the timing belt. Water pumps that are driven by the timing belt should be replaced during a timing belt replacement. This procedure is considered preventive maintenance, and can save the customer from paying for the same labor twice. The most common water pump failures involve seal leakage or corrosion damage to the impeller, due to worn out or contaminated coolant. Don't confuse normal vent-hole weepage with seal leakage.

Thermostat… The purpose of the thermostat is to get the engine to normal operating temperature as soon as possible. The thermostat is usually located in the upper part of the engine in the water outlet housing. When the engine is cold, the thermostat is in the closed position, which prevents coolant flow to the radiator. The coolant is directed through a by-pass system back into the engine, which speeds up the warm-up cycle. It is a temperature sensing valve that opens and closes in relation to coolant temperature. A paraffin element that reacts to heat is the heart of the valve. Some thermostats are computer controlled by the PCM. The degree rating of the thermostat recommended by the vehicle manufacturer should always be followed, as it can affect the performance, fuel economy and emission output of the engine. Some are convinced that removing the thermostat will make the engine run cooler, especially for summer driving. Actually, increasing the speed of the coolant through the engine and radiator may make the engine run hotter, as the heat collected does not have time to dissipate. In some cases, the engine will never reach its normal operating temperature, which affects performance, fuel economy and emissions. Low coolant temperature can prevent a computer controlled system from going into closed-loop. A thermostat replacement should be a part of the cooling system service, as it is an inexpensive part that can cause a catastrophic failure. Unfortunately, many wait until the thermostat fails and the engine overheats.

Hoses and Belts… The hoses are the arteries that carry the coolant to and from the engine, radiator and heater core. Unfortunately, the hoses are seldom given any attention until one starts spilling coolant. They are subjected to pressure, heat from the coolant and high underhood temperatures. Often they come in contact with engine lubricants, which can deteriorate the rubber, causing premature failure. They may look perfect externally and be cracked and severely deteriorated internally. Look for evidence of cracks, ballooning, or soft and spongy hoses. Check the belts for evidence of cracking or chemical contamination, which can lead to premature failure. Check for proper belt tension, which includes a properly functioning belt tensioner.

Cooling Fans… Moving air through the radiator fins is a must in keeping the engine cool. While the coolant removes the heat from the engine, the airflow through the radiator dissipates the heat from the coolant, allowing it to return to the engine to remove more heat. This can be a difficult task, as many vehicles are fitted with A/C condensers, external transmission coolers, engine oil coolers and power steering coolers, all of which can obstruct air flow. Some vehicles are fitted with fans mounted to the water pump and are belt driven, while others are electrically driven and are controlled by a temperature sensor and the PCM. They may incorporate single or dual fans with multiple speeds. High ambient temperature and slow moving traffic pose the most challenges for good airflow. Make certain that all air dams, deflectors and shrouds are in place, as they are critical in achieving good airflow across the radiator and engine.

Heater Core… A second radiator of a sort is the heater core, which is fitted in the ventilation plenum. The engine coolant is routed through the heater core via two heater hoses. The coolant is supplied by the water pump to one port on the heater core, and returns to the engine via a second port. A heater control valve is usually incorporated into the system. Its purpose is to restrict coolant flow to the heater core when the heater control is in the off position. This reduces the cabin temperature and improves the air-conditioning output. A blower motor and fan moves air across the fins and tubes of the heater core, providing warm air for the cabin. Blend doors, which are controlled by actuators, mix a combination of outside air with the air passing through the heater core. This process regulates the temperature in the cabin to a comfortable level.

The components illustrated make up the cooling system. Each component plays an important part in the cooling process. Understanding the theory of how a cooling system functions, and how the system is affected when a deficiency occurs, improves the chances of making an accurate diagnosis on the first attempt.

NEGLECTED MAINTENANCE

Cooling systems normally get attention in one of two scenarios: 1) Most vehicle owners are aware of the need to have their antifreeze tested for freeze protection during the early fall or winter. 2) The next condition is when the green or orange stuff is spilling all over the ground, or the engine is overheated. Many technicians focus on the freeze protection and do not consider other possibilities that could result in a cooling system failure. We have a responsibility to fully evaluate the overall condition of the cooling system and the individual components that could jeopardize the system's performance.

A high percentage of vehicle breakdowns occur due to cooling system related failures that could include belts, hoses, thermostat, water pump, coolant leakage problems, or restrictions due to internal corrosion. Once the corrosion inhibitors in the antifreeze break down, the system will start to corrode, resulting in holes forming in the radiator or other components. Installing a new water pump on a contaminated system can result in premature seal failure in the new pump. The damage incurred may reflect deposits of rust, scale, or a white powdery residue forming on the tubes in the radiator, which can restrict coolant flow. Conditioners and cleaners may return a marginal system to normal operation; however, extreme cases will require a component replacement.

COOLING SYSTEM ELECTRICAL LEAKAGE

Electrolysis, which is current flow in the cooling system, can result in a deterioration of the system, much like that of extreme corrosion due to contaminated or worn out coolant. Both conditions can result in coolant leaks and a restricted coolant flow. Often, flushing a cooling system and installing new coolant is all that is necessary to eliminate the electrolysis. In some cases, identifying a poor ground return circuit will be necessary to correct the condition. Electrolysis is becoming common with the newer vehicle designs, which incorporate lightweight metals, ungrounded plastic radiator tanks and an abundance of electrical accessories and systems. Many of the electrical accessories are consumer add-ons and are improperly grounded. The electrolysis effect can occur when current takes the path of least resistance and travels through the engine coolant, seeking a ground. When this occurs, the coolant becomes electrically charged and becomes an electrolyte. Soft metals, such as aluminum radiators or heater cores, succumb to electro-chemical reaction. This can be evidenced by a white, black or green crusty deposit forming around the solder joints, resulting in coolant leakage. Pinholes may form in the radiator and heater core. A poorly grounded starter motor may destroy a radiator or heater core within a few weeks, while an improperly grounded electrical accessory may take months to encounter the same condition. Installing a ground on the radiator or heater core is not the best solution, and could actually complicate the condition. While a ground may eventually have to be added, identifying the component or accessory with the improper ground is the best solution. Electric cooling fans, or any electrical accessories grounded near the radiator, are likely suspects.

Low voltage levels may be detected in any cooling system, due to the different metals in the system reacting with the coolant and basically becoming an electrolyte. The voltage level should not exceed 0.1 volts. Testing for electrolysis can be performed with a digital voltmeter set on the 12 volt DC scale. Attach the negative lead of the meter to the negative post of the battery, and the positive lead should be placed in the coolant. Make certain the test probe does not make contact with the filler neck or the core of the radiator. Two readings should be taken, one with the engine off and the other with the engine running at 2,000 rpm, with all electrical accessories

on. Be careful, as the cooling system may be hot and under pressure. A voltage reading in excess of 0.3 volts confirms electrical leakage into the cooling system. If the condition is present, flush the system, install new coolant and re-test. If the condition is still present, a thorough ground inspection must be performed. Pinpointing the problem involves the process of elimination. While observing the voltmeter reading, have someone individually turn all electrical accessories off, one at a time. When the voltage drops below 0.1 volts, you have identified the problem circuit. It will be necessary to check or add a ground to that circuit. If the condition is still present after turning off all electrical accessories, pull the fuses one at a time, while observing the meter. If pulling a fuse results in a voltage drop below 0.1 volts, the next step is identifying the component that is feeding off that fused circuit. This will require the use of a wiring diagram. To determine if the starter circuit is the culprit, crank the engine while observing the voltmeter. Intermittent problems are difficult to pinpoint. For example, some components, such as an electric cooling fan, may not function until the engine reaches a determined temperature. Make it a point to examine the add-on electrical accessories first. This is where we often identify poor grounds.

COOLANT REPLACEMENT

For optimum system protection concerning freeze protection and corrosion inhibitors, a 50/50 mixture of antifreeze to water is the target. The typical coolant drain and fill procedure only removes half of the system's coolant. This leaves the system with insufficient corrosion protection, as the new antifreeze is diluted when mixed with the existing coolant. This situation has prompted many vehicle manufacturers to recommend using coolant flush/exchange machines to service the cooling system. This process guarantees a complete exchange of coolant and the proper concentration of water to antifreeze mixture. These systems reduce the amount of waste generated by the typical flush and fill procedure, and it's good for the environment, too. The procedure reduces the possibility of air pockets, which often require several miles of driving in order to adequately purge the system of air. Further, it eliminates costly time the technician must spend in topping off the radiator to achieve a complete fill. Antifreeze should be replaced every 2 years or 30K miles, with the exception of the long life coolants such as GM's DexCool, which has a life expectancy of 5 years/150K miles.

ANNUAL INSPECTION

A thorough inspection of the cooling system should be performed annually. Consider the following checks:

1) The system should be pressure tested and checked for leaks.

2) When conditions of low coolant are evident, or the system requires continual topping off and there is no evidence of leakage, the use of a trace dye and a black light may be necessary.

3) The radiator cap should be pressure tested for its PSI rating.

4) Examine all hoses and belts for deterioration, cracking, etc.

5) Check the condition and operation of the cooling fan/fans, pulleys and tensioner, if equipped.

6) Check for belt tightness and alignment.

7) Make certain the A/C condenser, radiator, and other coolers are free of bugs and other debris that can restrict airflow.

8) All shrouds, air deflectors and valence panels must be in position.

A thorough cooling system service is a good service to provide for the customer, one that may prevent them from becoming stranded, or potential damage being done to the engine from overheating.

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