How to check the cooling system.

by Butch Thomas as posted in *Auto Trader Classics*

A full restoration of a classic car is useless if the cooling system is not maintained, serviced and worked on properly. The components of a cooling system can only do their intended job when proper mechanical procedure and service is employed. Often the efficiency of a cooling system is compromised due to improper water pump belt tension, corrosion or flow restrictions (liquid or air).

Get the air out

A common issue is an air bound cooling system. A liquid cooling system follows the laws of hydraulics in regard to coolant flow. The coolant must come in contact with the parts that need to be cooled and touch the tubes of the radiator to allow the temperature to be dropped. If there is any air in the system both of these functions are diminished drastically.

The hallmark of an air bound cooling system is a temperature gauge reading that swings from hotter than normal to colder than normal while the engine is running. This can happen over a matter of time as little as 30 seconds to as long as a few minutes. The system is usually greeted with a like swing in heater output, from very hot to very cold.

The heater and temperature gauge fluctuations are caused by air pockets in the coolant. When an air pocket or bubble hits the temperature sending unit there is no heat transfer to it, so the gauge swings to a cold reading. Likewise, when air is pushed through the heater core which is a small radiator, no thermal transfer takes place and the discharge temperature drops in the passenger compartment. When the air pocket moves away and liquid is introduced the coolant starts to boil and thus, the temperature gauge registers this and the heater output becomes very hot.

Bleeding a cooling system is not a difficult task but it can be time consuming.
The radiator should be filled to about one-half to one inch below the top of the neck and all of the tubes should be covered. A supply of coolant should be kept handy. As air is displaced the liquid level will drop. Start the engine and run at a fast idle of around 1,500 rpm. The heater should be turned on to "full hot" but the fan speed is not critical. The high idle speed is required to increase the flow rate of coolant through the system and push out the remaining air. It is necessary to turn the heater on to allow the air to be removed from that circuit of the cooling system. It is preferred to evoke the heater initially so coolant flow starts immediately through the core in vehicles with a heat control valve.

At this time the thermostat will be closed and will start to open as temperature is built. As this occurs the coolant level will drop and need to be topped off to keep the radiator full and not introduce any additional air.

As the coolant heats it will expand and want to push out of the radiator creating a mess and the need for a proper clean up. To eliminate this an excellent tool is the Lisle Radiator Fill Kit that allows a funnel-like reservoir to be attached and eliminates coolant spillage during expansion. If this tool is not used, place a pan under the vehicle to catch any coolant that is spit up.

As the engine is run at high idle the coolant level will eventually stabilize but your job is not done. You will need to monitor the fluid for any signs of air bubbles. These may be very large and obvious or inconsistent small bubbles. This is where the Lisle kit really comes in handy since you can partially fill the funnel and let the engine run and occasionally check for bubbles while you do something else. The trick here is to be patient enough to allow all of the air to work itself out.

After you feel confident the system is empty of air you may want to have a helper raise the idle speed slightly while you top off the radiator level and install the pressure cap. This needs to be done while the engine speed is high. If the throttle is released the coolant will spit out. Any small amount of air still trapped in the system will eventually work itself out with the heating and cooling cycles.

If the thermostat is being serviced and the location lends itself, fill the engine block with coolant before installing the thermostat. Make sure you leave the level low enough so the gasket cement is not affected by the coolant during reassembly. This method will speed up the air bleed time since the engine would be almost completely filled with coolant before the final fill is accomplished.

Understanding and recognizing electrolysis

Electrolysis occurs when electrical current routes itself through the engine's coolant in search of a ground path. Current can be introduced into the cooling system in many ways but the two most common causes are a poor ground to the radiator's electric cooling fan or a poor ground from the starter motor and engine block to the battery. Any application with accessories bolted to the radiator support or to a nearby component is also a good candidate for electrolysis.

Electrolysis is a fast acting problem that attacks not only the heat exchangers in a vehicle but can destroy an entire engine in as little as 20,000 miles, based on industry data. A small amount of measurable voltage can be detected in most cooling systems from a reaction between the coolant and system metals. The value should never exceed a tenth (1/10 or 0.10) volt in applications with aluminum engine blocks and or cylinder heads. Cast iron engines and older-style (copper/brass) cooling systems can tolerate higher stray voltages, as much as 3/10 volt but this would be considered excessive and point to an issue elsewhere.

Electrolysis occurs when a defective or missing ground on an electrical device causes the electricity to seek a path of least resistance when the component is activated. Sometimes the path is a coolant hose or the radiator or heater core itself. As the current draw of the poorly grounded component increases, so does the electrolysis.
For example, a poorly grounded engine and starter motor can put enough current through the cooling system to actually cause a heater core or radiator to come apart in a matter of weeks or even days. This would be dependent on how often the engine was started since the current would only pass through the coolant during crank.

Evidence of electrolysis includes unexplained and or recurring pinhole leaks in a radiator, heater core or even aluminum intake manifolds. Pinholes may form anywhere along the tubes or tank walls, but damage is often concentrated at the tube-to-header joints, or in the tube walls near the center of the core where the electric cooling fan mounts come in contact with the core.

All that is required to test for this condition is a direct current voltmeter. Connect the voltmeter's negative lead to the vehicle battery negative and submerge the positive lead in the radiator making sure it does not touch anything. The important step is to perform several tests under various conditions such as key on, key off, engine running at high idle speed, electrical accessories activated, headlights and rear defroster on, etc. If zero volts are detected during these tests there is no problem and you can confidently state electrolysis is not present.

If any stray voltage is found it is important to perform a second test with both battery cables disconnected. For this procedure connect the meter in this manner: negative lead to a very clean and unpainted area of the engine block or to the disconnected negative battery cable; positive meter lead submerged in the engine coolant, again making sure it does not touch any metal. Make sure the disconnected battery leads do not touch each other or any other part of the vehicle. It is a good idea to insulate them with some clean shop rags or electrical tape.

If voltage is detected with the battery disconnected the cooling system is contaminated and must be flushed clean before any other repairs are made. With the battery disconnected the coolant voltage should be zero. If it isn't the following could be the cause: depleted coolant, over diluted coolant, metallic sludge in the system, acidic coolant, make-up water containing chloride (salt from a water conditioner). This is the result of a chemical reaction in the engine between the dissimilar metals, corrosion and coolant that created a weak battery.

Internal hose degradation
Contrary to what many think a hose does not deteriorate from the outside in but from the inside out. The only time external wear will overtake internal degradation is when the hose is soaked in oil from an engine leak or is rubbing against something and is worn through.

Electrochemical degradation (ECD) occurs when the coolant becomes acidic from the additive package being consumed and depleted over time. ECD causes micro-cracks within the hose tube that allow the coolant to attack the hose reinforcement. Over time this weakens the yarn material that makes up the reinforcement of the hose. Accelerated by high underhood temperatures and constant movement, ECD produces a pinhole leak and will cause the hose to burst before it has reached its expected life cycle.

ECD can not be detected visually with the hose on the engine but can usually be identified by squeezing the hose to determine if it feels very squishy or extremely hard. Also, be on the look out for bulging at the ends where the hose connects to the engine and radiator. If any of these conditions exist the hose and thus, the reliability of the vehicle are in question.

Other factors that impact hose life are ozone from the atmosphere (which attacks any rubber component) and abrasive coolant compositions or debris in the cooling system. Hoses injured from thermal cycling will usually have a hardened, glossy appearance with surface cracks showing on the outside. On the inside the interior yarn fiber may be damaged, causing the coolant hose to feel soft in places. A hose in this condition can burst without notice.

Service life of anti-freeze

Anti-freeze does not loose its ability to not freeze but over time the additives and anti-corrosion inhibitors become neutralized or worn out. When this occurs the coolant no longer provides the necessary protection required for long engine and cooling system component life. For this reason all coolants are considered consumable and eventually need to be replaced. A three year coolant change interval is recommended.

Engine coolant will degrade quicker in an application that is put under severe duty and high thermal loads. This is a result of the normal boiling that is occurring in the engine around the exhaust valves. In addition, all coolants will absorb moisture even though the modern cooling system is identified as a "closed" design. Humidity gets wicked into the coolant through the overflow/expansion tank and from the radiator cap seal when the engine is at rest.

Checking the freeze point does not tell you that the additive package is still good. That is why the coolant needs to be replaced on scheduled intervals.

The most common anti-freeze testers use either a needle or a series of balls to determine the temperature at which the coolant will freeze. Most if not all of these testers are designed to check coolant at 60 F degrees. Liquid temperature colder or hotter than this will skew the readings. With this in mind you do not want to check the freeze protection of your coolant on a 40 F degree morning or when the engine is very hot. There are temperature compensated coolant testers but you can not buy them for $3.99 at the discount store!

The most accurate method to check the coolant's potency is to use a refractometer. This is a device that measures the sample's refractive index of light when subjected to the test liquid. Once again the nominal test temperature for the coolant is around 60 F degrees if a compensated unit is not used or the data referenced from a compensation chart.

What it all means

Regardless of the coolant you use in an engine the best method to maintain the system is a good preventive maintenance (PM) program. The installation of new, fresh coolant every three years will always be the best way to guarantee long engine and component life. If the vehicle is under heavy load that interval should be dropped to every two years.

Anti-freeze should be mixed 50/50 water and coolant. This will provide the best freeze and boil-over protection. Tap water should not be used due to its impurity. Distilled water needs to be employed. It is the easiest and most cost effective to purchase already mixed 50/50 name brand coolant -- this eliminates all concerns.

If good PM is provided and any work is performed with sound mechanical procedure, the cooling system will go about its job silently. Miss any one of these steps and the system will become your worst enemy!

Follow along as the crew at Classic Restorations demonstrates the proper method to check your cooling system.

Source
Classic Restorations Inc.
150 Route 17
Sloatsburg, New York 10974
845-712-5500