Proper Filling of Engine Coolant

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It seems that about every 15 years or so a new generation of technicians emerges on the scene that is passionate and excited about engines and vehicles. They may or may not have had some type of formalized education – yet they may be well versed and very savvy but have not had the infield experience as of yet. They are not necessarily young, just new to the world of engines. For them (and even for the veterans), let me give you some facts that you may not be aware of:

- *Antifreeze/engine coolant is the most neglected fluid in the vehicle.*
- *Cooling system neglect is cited as the principal reason for premature engine and transmission failure.*
- *Cooling system failure is the most common cause of mechanical breakdown on the road.*
- *A national survey found that 7 out of 10 vehicles contain rust and scale and two thirds of more than 8,000 cooling system repair jobs were performed on an emergency basis.*
- *Just 1/16th of an inch of mineral deposits on 1 inch of cast iron reduces heat dissipation by 40% and is the equivalent to 3-1/2 inches of cast iron.*
- Over 60% of water pump failure can be attributed to seal failure.
- **Over 50% of engine failures can be attributed to cooling system failure**.

Well that gives you an idea of how critical the cooling system is to a long and happy engine life and how detrimental it can be if it is not in good operating condition. Worse yet, what if the cooling system was the cause of the vehicle engine failure and now has a fresh reman engine installed. What do you think is going to happen at that point?

The cooling system is just that a system (Fig 1) that is pressurized, sealed circulation that consists of 6 major components:

Anti-freeze/Coolant: The fluid in your cooling system is used as a way to dissipate the tremendous amount of heat an internal combustion engine creates. Most new vehicles have an optimum operating temperature of around 200 degrees Fahrenheit or about 93 degrees Celsius; water boils at 212 degrees Fahrenheit, or 100 degrees Celsius and freezes at 0 Celsius or 32 degrees Fahrenheit. That is where Anti-Freeze comes in; it is used as a stabilizer to help keep the mixture in the cooling system from boiling or freezing depending if the vehicle is in use. Anti-Freeze in a 50% mixture with water can change the freezing point from 32 degrees Fahrenheit or 0 Celsius, to –35 degrees Fahrenheit or – 37 Celsius. It moves the boiling point from 212 degrees Fahrenheit or 100 degrees Celsius to 223 degrees Fahrenheit or 106 degrees Celsius. Pressure is the second way that the boiling point is raised; most vehicles have between 13-15 psi (pounds per square inch) in the cooling system.

This can raise the boiling point of the fluid mixture approximately 45 degrees Fahrenheit or just over 7 degrees Celsius.

Water pump: The water pump is a mechanical or electric in some applications pump that circulates the engine coolant/anti-freeze through the radiator and back to the engine**.** Mechanical pumps are usually driven by an accessory drive belt or by the timing belt/chain. Look to see more electric pumps in future vehicles since the mechanical pump does rob horse power.

Thermostat: the t-stat is a temperature sensitive orifice in the cooling system that opens and closes according to engine temperature to regulate the flow of coolant/anti-freeze through the radiator and back to the engine. This allows for the engine to be run at specific temperatures to optimize the performance and emissions levels of the vehicle. Look for a PBT on t-stat's further in this article.

Radiator: The radiator is basically a box with tubing for the coolant to pass through that have many "fins" swedged on the OD of the tubing for thermal conductivity, typically mounted at the front of the vehicle. The coolant is driven through the tubing so that air may pass across the fins and cool the anti-freeze/coolant. The fins then act as thermal conductors to dissipate the heat. *If a radiator is thermally efficient there will be a minimum of 20 degrees Fahrenheit and just over 3 degrees Celsius between upper and lower radiator hose.* Even if the radiator has been flushed and flow checked, it does not mean that it is thermally effective. The fins that are swedged onto the flow tubes can lose their tension and no longer be the heat sync that they were designed to be. Temperature in vs. temperature out is the true testing measure if your radiator and cooling system is doing the job.

Cooling fan: The cooling fan is located directly behind the radiator, whether the vehicle is front or rear wheel drive. Its job is to pull air through the radiator at lower vehicle speeds to keep it from over-heating. Cooling fans can either be mechanical (belt driven on the engine) or electric (mounted on the radiator, temperature controlled)

Drive belts/hoses: All of the antifreeze/coolant in your vehicle is pumped through several hoses. Maintaining them is crucial to preventing serious engine damage from over-heating. Visually inspect the hoses for leakage, cracks or abrasions and the general integrity of the hose; they should be slightly pliable when squeezed with your fingers. Replace any that are questionable. The drive belt/belts should be inspected regularly as well.

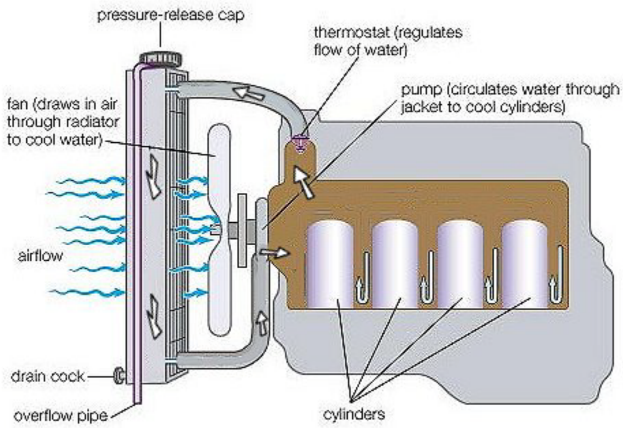

Fig 1 Basic cooling system function and its components. Today's systems are closed loop and have an overflow reservoir.

I know that this information is basic and almost mundane but during this economic climate who if anyone is replacing or repairing anything on a vehicle unless it is broken or not working? The old adage "if it ain't broke don't fix it" seems to be very prevalent today.

All this brings me to what I want to talk about, as far as premature failures of remanufactured or new engines being installed into vehicles today. Back in the later part of the 80's through present day the design of vehicles took a turn into aerodynamic designs that would enhance fuel economy. The front of vehicles got lower and rounder. Bumpers per se disappeared and now became part of the frame structure with aerodynamic plastic covers, cab forward designs became common place and radiators are now typically much lower than the top of the engine. The problem with that is now filling a cooling system no longer is a simple task and the potential for air pocket hot spots is now common place.

Bleeding the cooling system refers to removing all air from the system. Air in the cooling system causes hot spots and subsequently overheating and can lead to serious engine damage. Bleeding the Cooling System becomes a critical part of an engine installation or if you replace a component such as a radiator hose, water pump, or radiator. In any of these cases, you musts take the time to bleed the cooling system to ensure that the air pocket hot spots do not occur. Overheating can readily be caused by air pockets existing in the cooling system obviously because air doesn't transfer heat anywhere close to the same rate as coolant.

To help avoid air pockets, first try to fill the engine with coolant before filling the radiator or reservoir. This can often be done through a thermostat housing, and elbow or whatever may be available as a high point in the engine. Many of today's radiators may not even have a cap on them and the only access is through the reservoir tank. There is equipment available also that will actually draw coolant through the system via vacuum which is an excellent method.

Once the radiator or reservoir is filled, start the engine and turn the heat to max for the whole process of bleeding the cooling system. Turning the heat to max allows the coolant to circulate throughout the whole system and causes any air pockets to exit from the radiator. Then rev the engine to approximately 2,000 RPMs and hold for about 15 seconds. If you don't have an RPM gauge on your dashboard, simply push down slightly on the accelerator pedal until you hear that your engine is working slightly harder than it normally does at idle, but take care not to over-rev the engine. Do this about three times so that the coolant circulates quickly and so that it pushes out any air pockets that may cause overheating.

Many of today's vehicles also have bleeder valves that you can utilize to bleed the cooling system. Some thermostats have bleed holes in them also. Something that technicians have done is to drill and 1/8" hole in the thermostat to allow for air bleeding on a continuous basis. When you feel that you have bled the system completely install the radiator cap and drive the vehicle for about five to ten minutes or until it reaches operating temperature. Keep your eye on the temperature gauge and make sure that it doesn't pass the midway point. If the gauge is showing any signs of overheating repeat the bleeding process to ensure that you get all the air out of the system.

Why have I gone to these lengthy measures to talk about cooling system operation and air pocket hot spots because there continues to be a high insistence of premature engine failures that will have isolated piston scuffing on one side of the skirt (Fig 2). This was on the inboard side of the engine along the lifter valley the highest area of the coolant in the engine block. It also scored only one side of the cylinder Fig 3. Even though the piston was correct the cylinder bore was correct clearance was correct the piston and cylinder still scored due to an isolated hot spot of the cooling system. So what started out as a mundane lesson can provide you with valuable premature failure diagnosis. Cooling systems can be remanufacturer and manufacturers' greatest enemies if the installing technician does not follow proper bleeding procedures.

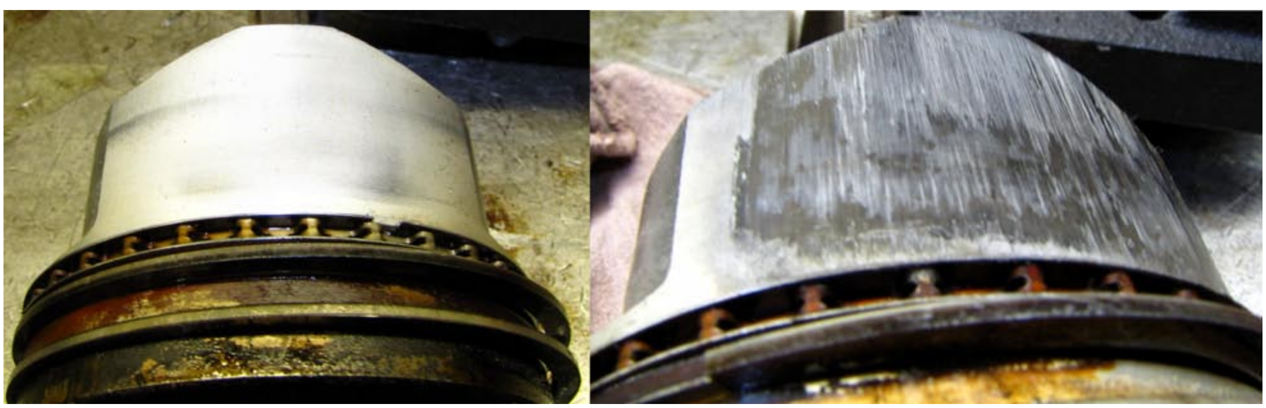

Fig 2 both views above are from the same piston, the scored skirt on the right was on the inboard side of the engine against the lifter valley the highest point of coolant in the engine where an air pocket caused and isolated hot spot and scored only one side of the piston.

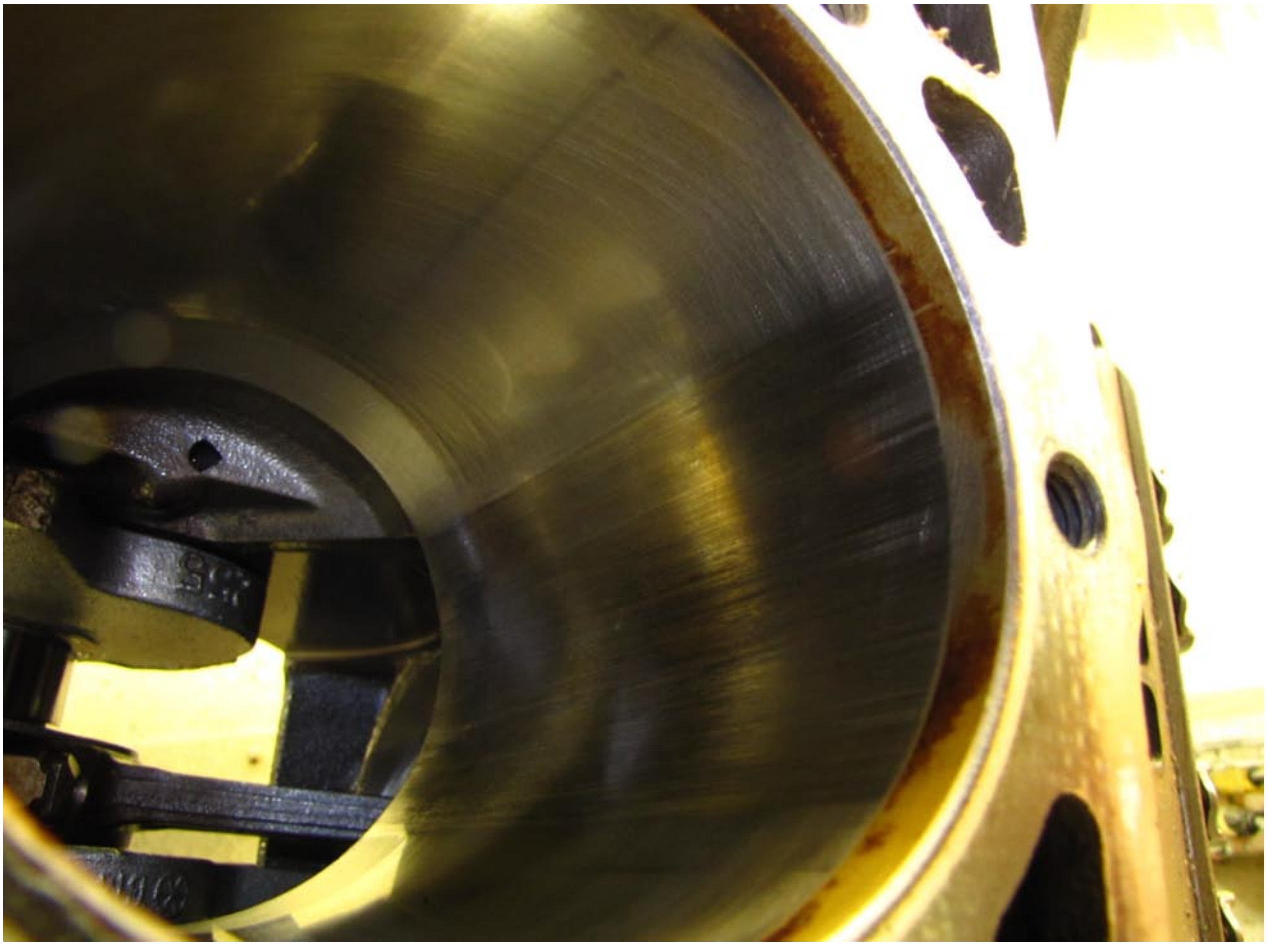

Fig 3 the inside lifter valley side of the cylinder scored due to an air pocket hot spot in the cooling system.