Automotive Workshop
AUTO 109

Cooling system

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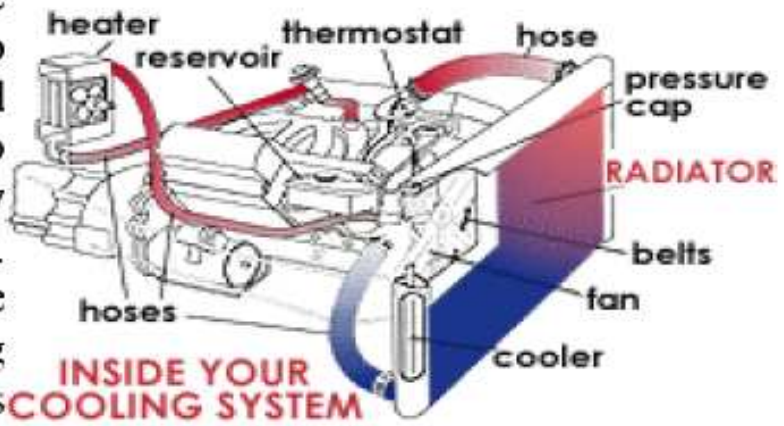
Cooling system

Most of the engines today are liquid cooled and are equipped with a closed cooling system. The cooling system consists of an inner and an outer circuit. The outer circuit includes the radiator and expansion tank. Other components in the cooling system and the car heating system are part of the inner circuit.

Circulation is controlled by a centrifugal pump, the rear face of which is integrated with the cylinder block. The pump is driven by the aid of a belt which gives an even loading on the pump bearings. Both filling and topping up are carried out through the expansion tank.

The cooling medium or coolant is ethylene glycol diluted with clean water in the ratio 50/50. This mixture prevents corrosion and freezing and raises the boiling point to approximately 135 °C. However this only occurs when the system is sealed to 1 – 1.5 kPa. The coolant does not normally require changing, excepting only when the cooling system is drained for repair or similar. It is recommended that the coolant is replaced in a 5 year period.



The engine has a large cooling system with usually an electronically controlled engine cooling fan (FC). The fan draws air through the radiator. The engine cooling fan (FC) operates in two stages depending on engine coolant temperature (engine coolant temperature (ECT)) and pressure in the air conditioning (A/C) system. The fan is controlled electronically via a fan relay from the fuel/ignition system control module.

The thermostat acts as valve to allow cool water to enter the block. It is located in outlet pipe of the engine and opens gradually to allow circulation of water. It prime function is to keep the engine at a steady temperature especially at cold weather and high speeds. If a thermostat is marked at a temperature of 87 degrees Celsius, it means is begins to open at that temperature and will be fully open at a temperature of 102 degrees Celsius.

Causes of Overheating

Overheating can be caused by anything that decreases the cooling system's ability to absorb, transport and dissipate heat, such as a low coolant level, loss of coolant (through internal or external leaks), poor heat conductivity inside the engine because of accumulated deposits in the water jackets, a defective thermostat that doesn't open, poor airflow through the radiator, a slipping fan clutch, an inoperative electric cooling fan, a collapsed lower radiator hose, an eroded or loose water pump impeller or even a defective radiator cap.

One of nature's basic laws says that heat always flows from an area of higher temperature to an area of lesser temperature, never the other way around. The only way to cool hot metal, therefore, is to keep it in constant contact with a cooler liquid. And the only way to do that is to keep the coolant in constant circulation. As soon as the circulation stops, either because of a problem with the water pump, thermostat or loss of coolant, temperatures begin to rise and the engine starts to overheat.

The coolant also has to get rid of the heat it soaks up while passing through the block and head(s). So the radiator must be capable of doing its job, which requires the help of an efficient cooling fan at slow speeds.

Finally, the thermostat must be doing its job to keep the engine's average temperature within the normal range. If the thermostat fails to open, it will effectively block the flow of coolant and the engine will overheat.

Consequences of Overheating

If the engine overheats, the first thing that will happen is a gasoline engine will start to detonate. The engine will ping and start to lose power under load as the combination of heat and pressure exceed the octane rating of the fuel. If the detonation problem persists, the hammer-like blows may damage the rings, pistons or rod bearings.

Overheating can also cause pre-ignition. Hot spots develop inside the combustion chamber that become a source of ignition for the fuel. The erratic combustion can cause detonation as well as engine run-on in older vehicles with carburetors. Hot spots can also be very damaging and burn holes right through the top of pistons.

Another consequence of overheating may be a blown head gasket. Heat makes aluminum swell almost three times faster than cast iron. The resulting stress can distort the head and make it swell in areas that are hottest, like those between exhaust valves in adjoining cylinders, and areas that have restricted coolant flow like the narrow area that separates the cylinders. The typical aluminum head swells most in the middle, which can crush the head gasket if the head gets hot enough. This will cause a loss of torque in the gasket allowing coolant and combustion leaks to occur when the head cools.

If the coolant gets hot enough to boil, it may cause old hoses or an age-weakened radiator to burst under the increased pressure. Pistons may swell up and scuff or seize in their bores, causing serious engine damage. Exhaust valve stems may stick or scuff in their guides. This, in turn, may cause valves to hang open which can damage pistons, valves and other valvetrain components.