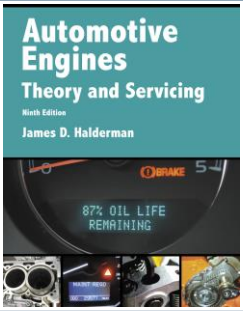
Automotive Engines Theory and Servicing
Ninth Edition



Chapter 14
Cooling System Operation and Diagnosis

OBJECTIVES

14.1 Explain the purpose and function of the cooling system, and cooling system operation.

14.2 Explain the purpose of thermostats, radiators, pressure caps, and water pumps.

14.3 Explain coolant flow in the engine and coolant recovery systems.

14.4 Explain the purpose of cooling fans and heater cores.

OBJECTIVES

14.5 Describe cooling system testing and explain the purpose of coolant temperature warning light.

14.6 Explain cooling system inspection and cooling system service.

COOLING SYSTEM (1 OF 2)

- Satisfactory cooling system operation depends on the design and operating conditions of the system.
  - The design is based on heat output of the engine, radiator size, type of coolant, size of water pump, type of fan, thermostat, and system pressure.
  - The cooling system must allow the engine to warm up to the required operating temperature as rapidly as possible and then maintain that temperature.

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COOLING SYSTEM (2 OF 2)

- Low-temperature Engine Problems
- High-temperature Engine Problems

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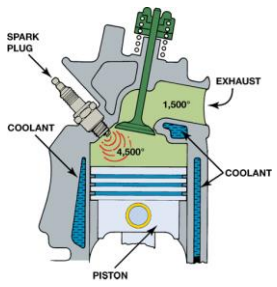
FIGURE 14–1 Typical combustion and exhaust temperatures.



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COOLING SYSTEM OPERATION

- Coolant flows through the engine, where it picks up heat.
  - It then flows to the radiator, where the heat is given up to the outside air.
  - The coolant continually recirculates through the cooling system.

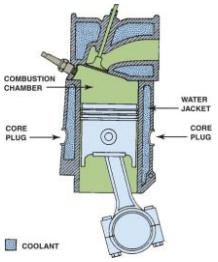

FIGURE 14–2 Coolant circulates through the water jackets in the engine block and cylinder head.

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THERMOSTATS (1 OF 2)

- Purpose and Function
  - There is a normal operating temperature range between low-temperature and high-temperature.
  - The thermostat controls the minimum normal temperature.
  - The thermostat is a temperature-controlled valve placed at the engine coolant outlet on most engines.

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THERMOSTATS (2 OF 2)

- Thermostat Operation
- Thermostat Testing
- Thermostat Replacement

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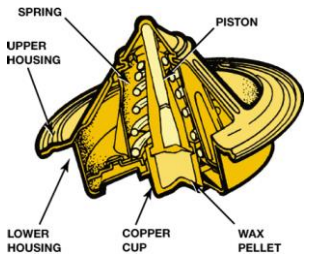
FIGURE 14–4 A cross section of a typical wax-actuated thermostat showing the position of the wax pellet and spring.



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RADIATORS

- Types
  - The two types of radiator cores in common use in most vehicles are:
    - Serpentine fin core
    - Plate fin core

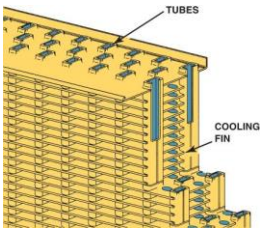

FIGURE 14–11 The tubes and fins of the radiator core.

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PRESSURE CAPS

- Operation
- Functions
- Metric Radiator Caps

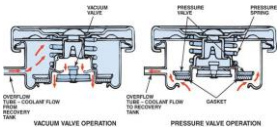

FIGURE 14–14 The pressure valve maintains the system pressure and allows excess pressure to vent. The vacuum valve allows coolant to return to the system from the recovery tank.

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COOLANT RECOVERY SYSTEMS

- Purpose and Function
  - Excess pressure usually forces some coolant from the system through an overflow.
  - Most cooling systems connect the overflow to a plastic reservoir to hold excess coolant while the system is hot.
- Surge Tank

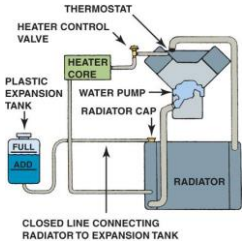

FIGURE 14–15 The level in the coolant recovery system raises and lowers with engine temperature.

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WATER PUMPS

- The water pump (also called a coolant pump) is driven by one of two methods.
  - Crankshaft belt
  - Camshaft
- Water Pump Service

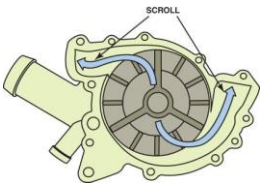

FIGURE 14–17 Coolant flow through the impeller and scroll of a coolant pump for a V-type engine.

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COOLANT FLOW IN THE ENGINE

- What are the two ways coolant flows through the engine?
- Coolant flow and head gasket design

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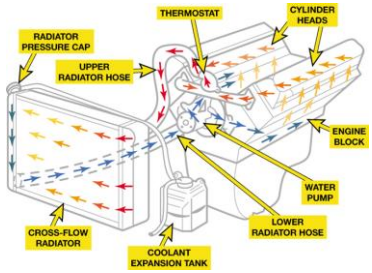
FIGURE 14–22 A series-type cooling system where the coolant first flows through the engine block then to the heads before returning to the radiator after passing through the thermostat.



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COOLING FANS

- Electronically Controlled Cooling Fan
- Thermostatic Fans
  - Silicone coupling
  - Thermostatic spring

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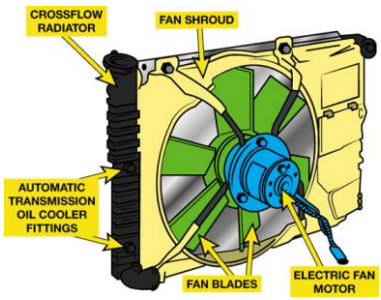
FIGURE 14–24 A typical electric cooling fan assembly showing the radiator and related components.



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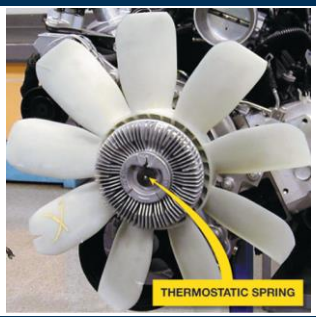
HEATER CORES (1 OF 2)

- Most of the heat absorbed from the engine by the cooling system is wasted.
  - Some of this heat, however, is recovered by the vehicle heater.
  - Heated coolant is passed through tubes in the small core of the heater.

HEATER CORES (2 OF 2)

- Air is passed across the heater fins and is then sent to the passenger compartment.
  - In some vehicles, the heater and air conditioning work in series to maintain vehicle compartment temperature.

FIGURE 14–25 A typical engine-driven thermostatic spring cooling fan.



COOLING SYSTEM TESTING (1 OF 5)

- Many cooling system faults can be found by performing a thorough visual inspection. Items that can be inspected visually include:
  - Water pump drive belt for tension or faults
  - Cooling fan for faults

COOLING SYSTEM TESTING (2 OF 5)

- Heater and radiator hoses for condition and leaks
- Coolant overflow or surge tank coolant level
- Evidence of coolant loss
- Radiator condition

COOLING SYSTEM TESTING (3 OF 5)

- Pressure testing using a hand-operated pressure tester is a quick and easy cooling system test.
- The radiator cap is removed (engine cold!) and the tester is attached in the place of the radiator cap.
- By operating the plunger on the pump, the entire cooling system is pressurized.

COOLING SYSTEM TESTING (4 OF 5)

- One of the best methods to check for a coolant leak is to use a fluorescent dye in the coolant, one that is specifically designed for coolant.
  - Operate the vehicle with the dye in the coolant until the engine reaches normal operating temperature.

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COOLING SYSTEM TESTING (5 OF 5)

- Use a black light to inspect all areas of the cooling system.
- When there is a leak, it will be easy to spot because the dye in the coolant will be seen as bright green.

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FIGURE 14–27 A heavily corroded radiator from a vehicle that was overheating. A visual inspection discovered that the corrosion had eaten away many of the cooling fins, yet did not leak. This radiator was replaced and it solved the overheating problem.

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COOLANT TEMPERATURE WARNING LIGHT

- Purpose and Function
- Precautions
- Common Causes of Overheating

FIGURE 14–31 When an engine overheats, often the coolant overflow container boils.

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COOLING SYSTEM INSPECTION

- Coolant Level
- Accessory Drive Belt Tension
  - Belt tension gauge
  - Marks on the tensioner
  - Torque wrench reading
  - Deflection

FIGURE 14–32 Typical marks on an accessory drive belt tensioner.

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COOLING SYSTEM SERVICE

- Flushing Coolant
- Coolant Exchange Machine
- Hose Inspection
- Disposing of Used Coolant
- Cleaning the Radiator Exterior

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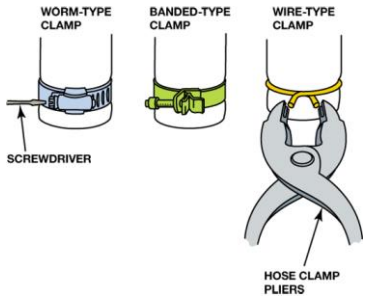
FIGURE 14–35 Hose clamps come in a variety of shapes and designs.



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SUMMARY (1 OF 3)

- The purpose and function of the cooling system is to maintain proper engine operating temperature.
- The thermostat controls engine coolant temperature by opening at its rated opening temperature to allow coolant to flow through the radiator.

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SUMMARY (2 OF 3)

- Coolant fans are designed to draw air through the radiator to aid in the heat transfer process, drawing the heat from the coolant and transferring it to the outside air through the radiator.
- The cooling system should be tested for leaks using a hand-operated pressure pump.

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SUMMARY (3 OF 3)

- Water pumps are usually engine driven and circulate coolant through the engine and the radiator when the thermostat opens.
- Coolant flows through the radiator hoses to and from the engine and through heater hoses to send heated coolant to the heater core in the passenger compartment.

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