UNIT 5: LUBRICATION AND COOLING SYSTEMS DIAGNOSIS AND REPAIR

LESSON 3: COOLING SYSTEM FUNCTION AND COMPONENTS

I. Terms and definitions

A. **Coolant —** Fluid that carries excessive heat from the engine.

B. **Coolant recovery system —** A hose and recovery tank, attached to the radiator, that holds coolant overflow and provides coolant as needed.

C. **Heater core —** A device that transfers heat from the engine coolant to the surrounding air. The heated air then flows into the passenger compartment.

D. **Radiator —** A unit that removes heat from the cooling system in liquid-cooled engines.

E. **Thermostat —** A coolant control valve that regulates coolant flow based upon engine temperature.

F. **Water jacket —** A hollow area around the engine cylinders where coolant circulates to cool the engine.

G. **Water pump —** An engine-mounted pump that forces coolant to circulate throughout the engine and heating system.

II. The function of engine coolant

A. The engine coolant absorbs heat while circulating within the engine block and cylinder head. When circulated through the radiator, the coolant releases this heat to the atmosphere.

1. In order for a vehicle to run in a variety of weather conditions, coolant must have a high boiling point and a low freezing point.

a. If the coolant were to boil, it would be unable to absorb heat effectively.

b. If the coolant were to freeze, it would be unable to circulate. The frozen coolant would also expand and destroy portions of the cooling system, heating system, and engine assembly.

c. When mixed with an equal part of clean water, a quality coolant will boil at a temperature above 220°F and freeze at a temperature below -34°F.

2. Other coolant functions are as follows:

a. Resist evaporation

b. Provide lubrication for the water pump and other cooling system components

c. Promote the sealing of leaks in the cooling system

d. Inhibit the formation of rust and other oxidants in the cooling system

III. Types of coolants

A. Several types of engine coolants are available, but most vehicles (more than 90%) use ethylene glycol. Not all ethylene glycols are alike. Corrosion inhibitors are added to engine coolants to protect cooling system components. The three basic chemical formulas used to classify engine coolants are listed below.

1. Inorganic Additive Technology (IAT) has been used for decades and is still widely recommended by automotive manufacturers. IAT coolants contain silicates that form a protective barrier on the cooling system components.

a. Silicates work well but are depleted over time and require replacement.

b. Silicate-based protective barriers may become slightly abrasive and have been linked to damaged water pump seals.

2. Organic Additive Technology (OAT) coolants do not contain silicates; instead, they use a blend of two or more organic acids that are used to protect cooling system components.

a. The organic acids react with surface-layer corrosion on aluminum and iron cooling system components to form a coating that prevents further corrosion.

b. OAT coolants are slow acting and may fail to provide protection in areas where cooling system cavitation takes place. Cavitation is a process in which the coolant boils and forms bubbles that pop with great force. These explosive bubbles can remove the protective layer of corrosion inhibitor on cooling system components.

c. OAT inhibitors are not depleted under normal operating conditions; this allows for extended periods of service.

3. Hybrid Organic Additive Technology (HOAT) coolants use both silicates and organic acids. The silicates are used to create a fast, protective layer on cooling system components and the organic acids are used for long-term protection.

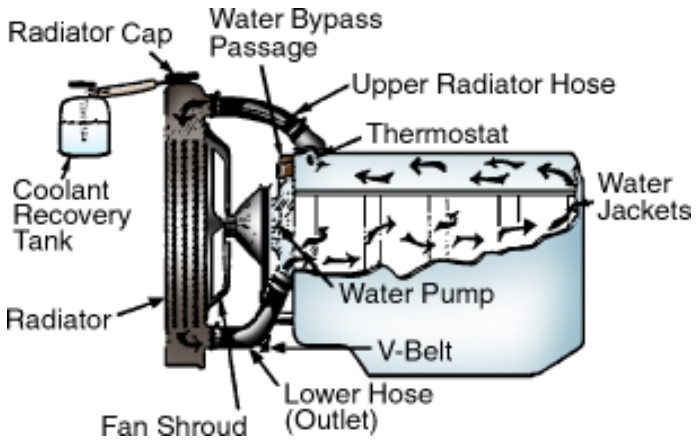
B. To be effective, all the coolant types must be maintained at a mixture (antifreeze to water) of about 50/50 and the types should not be mixed. It is also very important to thoroughly drain and flush the cooling system when replacing the engine coolant. To select the correct coolant for the vehicle, consult the service information.

IV. Cooling system components

A. A radiator is a device made of copper or aluminum.

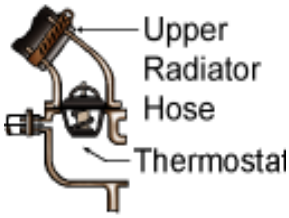
1. The radiator allows air to remove heat from the coolant. As the hot coolant is circulated through the radiator, air moves over the radiator's thin metal fins and lowers the temperature of the coolant.

2. When coolant gets hot and expands, the overflow flows into the coolant recovery tank, and when the coolant gets cooler and contracts or more coolant is needed, it is pulled back into the radiator.



B. Water jackets are passages cast within the cylinder block. They help to cool the engine by directing coolant around the combustion chambers and to the other parts of the cooling system.

C. The thermostat is a temperature-operated valve, which is usually located on the front of the engine block near its top. The thermostat is used to control the temperature and flow of coolant.

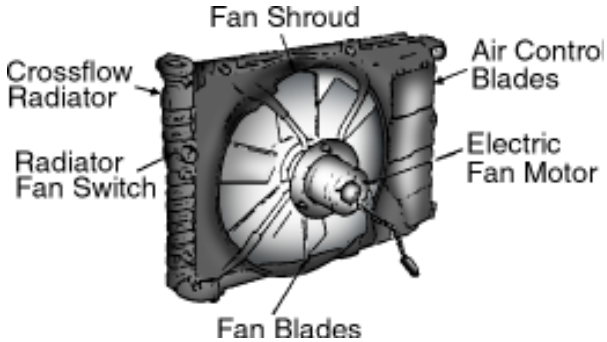


1. When the coolant is cold, the thermostat is closed and allows the coolant to circulate through the engine.

2. When the coolant is hot, the thermostat opens and allows the coolant to circulate to the radiator where the heat can be dissipated.

D. The fan and fan shroud help move air over the radiator and air conditioning condenser when the vehicle is stopped or traveling at slow speeds. When the vehicle is moving at highway speeds, sufficient air is moved through the radiator and the fan is not needed. Consequently, fans are designed to operate only as needed in order to save power. Vehicles are equipped with either an electric or engine-powered (mechanical) fan.

1. Electric fans are driven by a powerful electric motor rather than the engine. These fans are controlled by a thermostatic switch, which is usually located in the lower radiator tank. When the switch senses hot coolant, it actuates the fan motor.



CAUTION: Electric fans are wired "hot" from the electrical system. This means electric fans can come on even when the ignition switch is off. Never work on or near an electric fan unless the battery ground has been disconnected. If the electric fan should come on during a service procedure, serious injury could occur.

2. Mechanical fans are driven by the engine fan belt. Common types of mechanical fans are listed below.

   a. Flex fans have blades made of very thin, flexible metal. At low engine speeds, the fan runs normally. At highway engine speeds, the increased air pressure turns the flexible blades and reduces the power needed to drive the fan.


Flexible Blade Fan

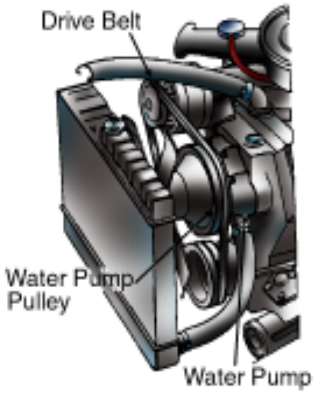
   b. Clutch fans are connected to drive pulleys by a fan clutch, which is controlled by a thermostatic spring. The thermostatic spring senses the temperature of the air coming through the radiator.


Thermo Clutch Fan

   - If the air is relatively cool, the clutch disconnects the fan from the pulley.

   - When the air becomes warm, the clutch engages, increasing the airflow through the radiator.

E. The water pump is a belt-driven device that is responsible for circulating the coolant through the cooling system. The pump is located on the front or side of the engine, depending on engine design.



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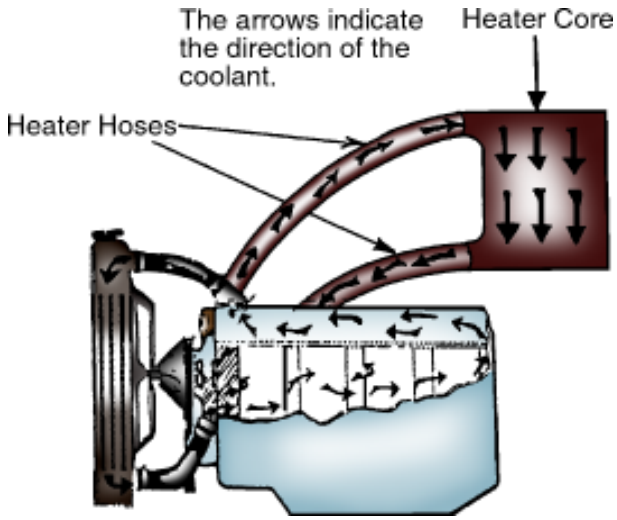
F. Cooling system hoses carry the coolant from the water pump to the other parts of the cooling system. At least five rubber hoses are usually required to carry the coolant.

1. One hose carries coolant from the engine to the radiator (upper hose).

2. Another hose carries coolant from the radiator to the engine (lower hose).

3. Two more hoses carry coolant from the cooling system to the heater and back (heater hoses).



4. Another hose functions to bypass the thermostat to allow the coolant to actuate its temperature sensor.

G. Belts are used to drive the water pump and cooling fan. Belts are also used to drive accessories such as power steering, air conditioning, and emission control components. In many cases, one belt drives two or more accessories.

H. The heater core operates like a small radiator. The heater core allows heat from the coolant to be used to heat the vehicle's passenger compartment.