TVET CERTIFICATE III IN AUTO ENGINE TECHINOLOGY

COOLING SYSTEM REPAIRING

AUTCS301

Repair the cooling system

Competence

REQF Level: 3

Learning hours: 40

Credits: 4

Sector: Transport and Logistic

Sub-sector: Automobile

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Purpose statement

This particular module describes the performance outcomes, skills and knowledge required to repair the cooling system. Before running an engine, it is very important to check and handle the cooling system if necessary. It can be taught in parallel with the Module on Lubricating system repairing.

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Learning Unit 1 – Description of cooling system components

Introduction

An engine provides mechanical energy from an air/fuel mixture with an efficiency between 20 and 45%. The rest flows in kinetic and heat energy in exhaust gases and in heat energy through metallic bodies due to the frictions. In this context, the cooling system must allow the engine to give its best performance, ensure the durability of this performance and ensure engine reliability by guaranteeing an acceptable level of thermo-mechanical stresses in any point of the engine. This is done thanks to evacuation of the exceeding calories towards outside atmosphere.

LO 1.1 – Select tools, materials and equipment

- **Content/Topic 1 Selection of tools:**

Wrenches (sockets, open end and closed end wrench, hammer, screwdriver,)
A one-piece wrench with a U-shaped opening that grips two opposite faces of the bolt or nut. This wrench is often double-ended, with a different-sized opening at each end. The ends are generally oriented at an angle of around 15 degrees to the longitudinal axis of the handle. This allows a greater range of movement in enclosed spaces by flipping the wrench over.

A one-piece wrench with an enclosed opening that grips the faces of the bolt or nut. The recess is generally a six-point or twelve-point opening for use with nuts or bolt heads with a hexagonal shape. The twelve-point fits onto the fastening at twice as many angles, an advantage where swing is limited. Eight-point wrenches are also made for square-shaped nuts and bolt heads. Ring spanners are often double-ended and usually with offset handles to improve access to the nut or bolt. (Modern Automotive Technology ,Fundementals,services,dignostics, 2006)

- ***Content/Topic 2. Selection of materials:***

  - Metallic brush
    Use brushes for cleaning cooling system components
  - Water container
    You have to select a water container for reserving water
  - Water
    Clean water which can be used for water cooling system
  - Solvents
    You have to select solvents which can be used for preventing wear of the cooling components
  - Antifreeze

  An **antifreeze** is an additive which lowers the freezing point of a water-based liquid. An antifreeze mixture is used to achieve freezing-point depression for cold environments. Common antifreezes increase the boiling point of the liquid, allowing higher coolant temperature.[1]

Because water has good properties as a coolant, water plus antifreeze is used in internal combustion engines and other heat transfer applications, such as HVAC chillers and solar water heaters. The purpose of antifreeze is to prevent a rigid enclosure from bursting due to expansion when water freezes. Commercially, both the *additive* (pure concentrate) and the *mixture* (diluted solution) are called antifreeze, depending on the context. Careful selection of an antifreeze can enable a wide temperature range in which the mixture remains in the liquid phase, which is critical to efficient heat transfer and the proper functioning of heat exchangers. Secondarily but not less importantly, most if not all commercial antifreeze formulations intended for use in heat transfer applications include different kinds of anti-corrosion and anti-cavitation agents that preserve the entire hydraulic circuit from progressive wear. (Modern Automotive Technology ,Fundementals,services,dignostics, 2006)

Figure 1: antifreeze

- Belt

A **fan belt** is one of the essential **car** parts that need regular maintenance. It is a flexible rubber **belt** that puts together certain engine components. It connects the crankshaft pulley and the **alternator** to the engine cooling **fan**

Figure 2 fan belt

- **Content/Topic 3 Selection of equipment:**

- **Air compressor**

Air compressors are designed to provide power to pneumatic tools commonly used in garages, during workshops and on building sites. With the right portable air compressor, you can provide power to any number of pneumatic tools via the same source. That makes an air compressor a must-have for pros and DIY-enthusiasts alike.

Keep reading to learn more about why you should add a portable air compressor to your arsenal of tools. This guide offers step-by-step instructions to help you learn how to use an air compressor correctly.

- **Radiator cup tester**

A radiator pressure cap is designed to maintain pressure in the cooling system at a certain maximum pressure. If the cooling system exceeds that pressure, a valve in the cap opens to bleed the excessive pressure into the reserve tank. Once the engine has cooled off, a negative pressure begins to develop in the cooling system. When this happens, a second valve in the cap allows the coolant to be siphoned back into the radiator from the reserve tank. If the cap should fail, the engine can easily overheat. A pressure test of the radiator cap is a quick way to tell if the cap is doing its job. It should be able to hold its rated pressure for two minutes. Since radiator caps are quite inexpensive, I would recommend replacing it every 3 years or 36,000 miles, just for added insurance. Make absolutely sure that you replace it with one that is designed for your vehicle (1) D., 2010)

- **PPE (Personal Protective Equipments)**

PPE is equipment that will protect workers against health or safety risks on the job. ... The purpose is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels

- **Multimeter**

A digital **multimeter** is a test tool used to measure two or more electrical values—principally voltage (volts), current (amps) and resistance (ohms). It is a standard diagnostic tool for technicians in the electrical/electronic industries.

LO 1.2 – Identify of cooling components

- **Content/Topic 1 Identification of cooling types:**

- **Air cooling**

Some older cars, motorcycle and very few modern cars, are air-cooled. Instead of circulating fluid through the engine, the engine block is covered in aluminum fins that conduct the heat away from the cylinder. A powerful fan forces air over these fins, which cools the engine by transferring the heat to the air. In the case of air cooling, the cooling heat to be removed is dissipated from the surfaces of the engine components directly to the ambient air flowing past.

Heat carried off depends upon the following factors:

In this type of cooling system the heat which is conducted to the cuter parts of engine is radiated & conducted away by the stream of air which is obtained from the atmospheres.

The amount of heat carried off by the air cooling depends upon the following factors:

- The total area of the tin surface
- The velocity & amount of the cooling air

- The temperature of the tins & of the cooling air
- Air cooling is mostly used in motor cycles scooters small cars & small aircraft engines, where the forward motion of the machine gives good velocity to cool the engine.

Air cooling categories

Airstream cooling

This is the simplest type of air cooling. It is frequently used on motorcycles since the airstream flows around their unfaired engines. In the interest of obtaining the greatest possible level of cooling, the transfer of heat to the ambient air is improved by increasing the effective cooling surface with cooling fins. For this reason, cylinders, cylinder head and often also the crankcase are fitted with cooling fins.

Forced air cooling

This provides for adequate cooling of engines around which the airstream does not flow. A fan is driven by the engine via a V-belt and cools the individual cylinders with the aid of baffles uniformly with the cooling air. Application: e.g. motor scooters.

Advantages of air cooling:

- ✓ Simpler design.
- ✓ Lower weight-to-power ratio.
- ✓ No coolant with anti-freeze required.
- ✓ extensively maintenance-free

Disadvantages of air cooling

- ✓ Greater fluctuations in the operating temperature
- ✓ Power requirements of the radiator fan is comparatively high.
- ✓ Louder noise emanating from the fan due to the rock of the cooling

- **Liquid cooling**

In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. The water when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward motion of the vehicle. The cooled water is again recirculated through the water jackets.

- **Internal cooling of the combustion chamber**

Heat transfer in combustion chambers is a very complex process. The basic equations regarding radiation, convection and conduction can be calculated by putting up a heat balance over the inner and outer surface. This process is influenced by the compressor pressure ratio, with increasing ratio the temperature will raise. The most common way of cooling liner wall is by film cooling. Holes along the liner provide a thin film of air to protect the inner wall. Often this leads to vast amounts of air being wasted. If the film cooling is combined with other techniques, the effectiveness can be increased.

- **Content/Topic 2 Identification of cooling components:**

Radiator

The radiator core is usually made of flattened aluminum tubes with aluminum strips that zigzag between the tubes. These fins transfer the heat in the tubes into the air stream to be carried away from the vehicle. On each end of the radiator core is a tank, usually made of plastic that covers the ends of the radiator,

On most modern radiators, the tubes run horizontally with the plastic tank on either side. On other cars, the tubes run vertically with the tank on the top and bottom. On older vehicles, the core was made of copper and the tanks were brass. The new aluminum-plastic system is much more efficient, not to mention cheaper to produce.

On radiators with plastic end caps, there are gaskets between the aluminum core and the plastic tanks to seal the system and keep the fluid from leaking out. On older copper and brass radiators, the tanks were brazed (a form of welding) in order to seal the radiator.

The tanks, whether plastic or brass, each have a large hose connection, one mounted towards the top of the radiator to let the coolant in, the other mounted at the bottom of the radiator on the other tank to let the coolant back out. On the top of the radiator is an additional opening that is capped off by the radiator cap. More on this later. (Erjavec, 2010)

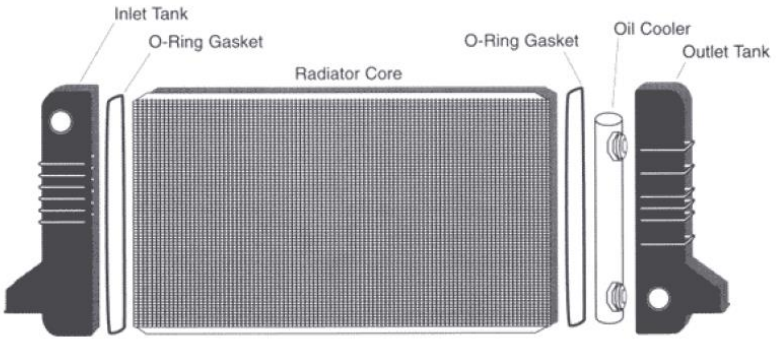


Figure 3 radiator

Another component in the radiator for vehicles with an automatic transmission is a separate tank mounted inside one of the tanks. Fittings connect this inner tank through steel tubes to the automatic transmission. Transmission fluid is piped through this tank inside a tank to be cooled by the coolant flowing past it before returning the transmission

Radiator cooling fans

Mounted on the back of the radiator on the side closest to the engine is one or two electric fans inside a housing that is designed to protect fingers and to direct the air flow.

These fans are there to keep the air flow going through the radiator while the vehicle is going slow or is stopped with the engine running. If these fans stopped working, every time you came to a stop, the engine temperature would begin rising.

On older systems, the fan was connected to the front of the water pump and would spin whenever the engine was running because it was driven by a fan belt instead of an electric motor.

In these cases, if a driver would notice the engine begin to run hot in stop and go driving, the driver might put the car in neutral and rev the engine to turn the fan faster which helped cool the engine.

Racing the engine on a car with a malfunctioning electric fan would only make things worse because you are producing more heat in the radiator with no fan to cool it off.

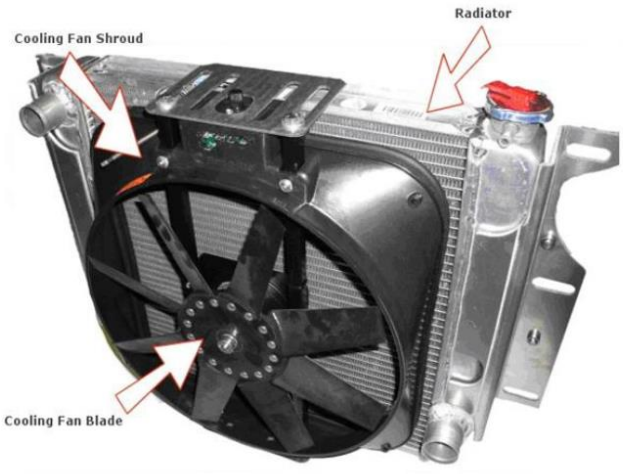


Figure 4 radiator fan

- **Pressure cap& reserve tank**

- As coolant gets hot, it expands. Since the cooling system is sealed, this expansion causes an increase in pressure in the cooling system, which is normal and part of the design. When coolant is under pressure, the temperature where the liquid begins to boil is considerably higher. This pressure, coupled with the higher boiling point of ethylene glycol, allows the coolant to safely reach temperatures in excess of 250 degrees.
- The radiator pressure cap is a simple device that will maintain pressure in the cooling system up to a certain point. If the pressure builds up higher than the set pressure point, there is a spring loaded valve, calibrated to the correct Pounds per Square Inch (psi), to release the pressure.
- When the cooling system pressure reaches the point where the cap needs to release this excess pressure, a small amount of coolant is bled off. It could happen during stop and go traffic on an extremely hot day, or if the cooling system is malfunctioning. If it does release pressure under these conditions, there is a system in place to capture the released coolant and store it in a plastic tank that is usually not pressurized. Since there is now less coolant in the system, as the engine cools down a partial vacuum is formed. The radiator cap on these closed systems has a secondary valve to allow the vacuum in the cooling system to draw the coolant back into the radiator from the reserve tank (like pulling the plunger back on a hypodermic needle) There are usually markings on the side of the plastic tank marked full-cold, and full hot. When the engine is at normal operating temperature, the coolant in the translucent reserve tank should be up to the full-hot line. After the engine has been sitting for several hours and is cold to the touch, the coolant should be at the Full-Cold line. (Erjavec, 2010)

- **Water pump**

A water pump is a simple device that will keep the coolant moving as long as the engine is running. It is usually mounted on the front of the engine and turns whenever the engine is running. The water pump is driven by the engine through one of the following:

A fan belt that will also be responsible for driving an additional component like an alternator or power steering pump.

A serpentine belt, which also drives the alternator, power steering pump and AC compressor among other things. The timing belt that is also responsible for driving one or more camshafts.

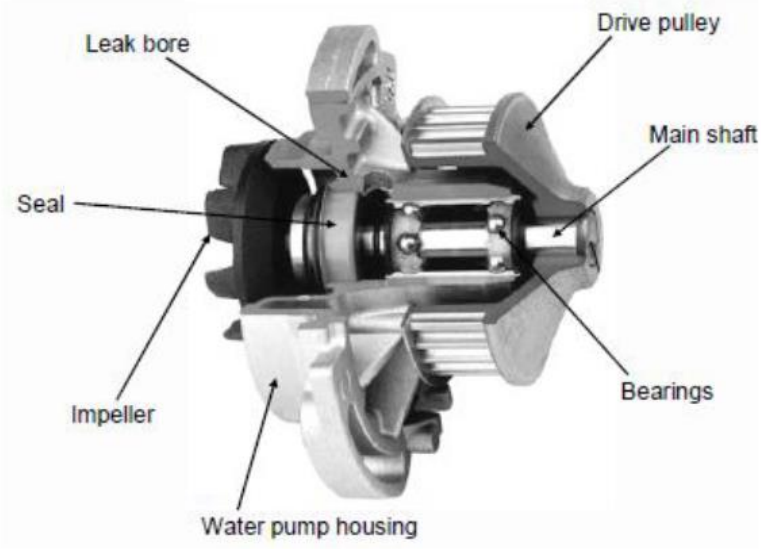


Figure 5 water pump

- **Thermostat**

The thermostat is simply a valve that measures the temperature of the coolant and, if it is hot enough, opens to allow the coolant to flow through the radiator. If the coolant is not hot enough, the flow to the radiator is blocked and fluid is directed to a bypass system that
allows the coolant to return directly back to the engine. The bypass system allows the coolant to keep moving through the engine to balance the temperature and avoid hot spots. Because flow to the radiator is blocked, the engine will reach operating temperature sooner and, on a cold day, will allow the heater to begin supplying hot air to the interior more quickly.

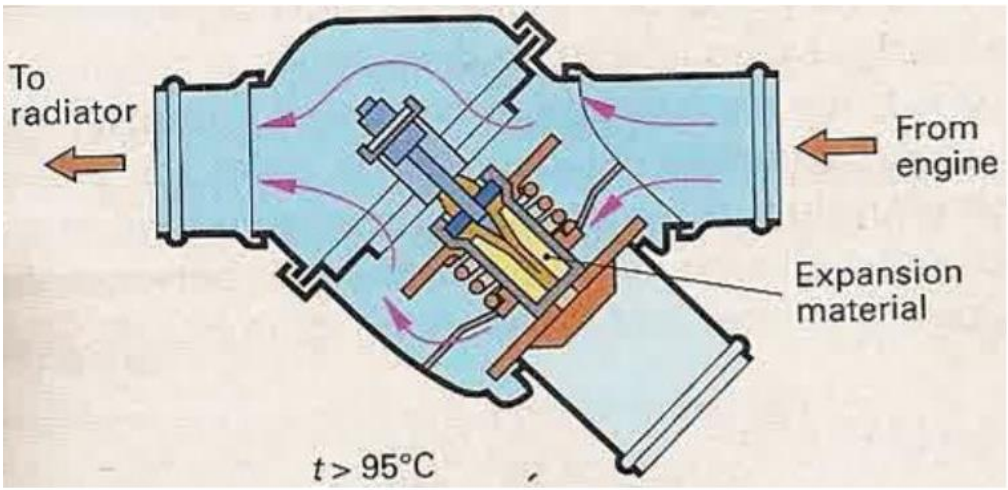


Figure 6 thermostat

- The heart of a thermostat is a sealed copper cup that contains wax and a metal pellet. As the thermostat heats up, the hot wax expands, pushing a piston against spring pressure to open the valve and allow coolant to circulate.
- The thermostat is usually located in the front, top part of the engine in a water outlet housing that also serves as the connection point for the upper radiator hose. The thermostat housing attaches to the engine, usually with two bolts and a gasket to seal it against leaks. The gasket is usually made of a heavy paper or a rubber O ring is used. In some applications, there is no gasket or rubber seal. Instead, a thin bead of special silicone sealer is squeezed from a tube to form a seal.

- There is a mistaken belief by some people that if they remove the thermostat, they will be able to solve hard to find overheating problems. This couldn't be further from the truth. Removing the thermostat will allow uncontrolled circulation of the coolant throughout the system. It is possible for the coolant to move so fast, that it will not be properly cooled as it races through the radiator, so the engine can run even hotter than before under certain conditions. Other times, the engine will never reach its operating temperature.
- On computer controlled vehicles, the computer monitors engine temperatures and regulates fuel usage based on that temperature. If the engine never reaches operating temperatures, fuel economy and performance will suffer considerably.

Bypass system

- This is a passage that allows the coolant to bypass the radiator and return directly back to the engine. Some engines use a rubber hose, or a fixed steel tube. In other engines, there is a cast in passage built into the water pump or front housing.
- In any case, when the thermostat is closed, coolant is directed to this bypass and channeled back to the water pump, which sends the coolant back into the engine without being cooled by the radiator.

Freeze plugs

- Sand cores are used to form the internal cavities when the engine block or cylinder head(s) is cast. These cavities are usually the coolant passages. Holes are designed into the casting to support internal sand forms, and to facilitate the removal of the sand after the casting has cooled. These holes have no purpose after the sand has been removed, therefore a core plug is a cap at the end of these passages, to prevent water or coolant leaking from the engine

Head gaskets& intake manifold gaskets

- All internal combustion engines have an engine block and one or two cylinder heads. The mating surfaces where the block and head meet are machined flat for a close, precision fit, but no amount of careful machining will allow them to be completely water tight or be able to hold back combustion gases from escaping past the mating surfaces.
- In order to seal the block to the heads, we use a head gasket. The head gasket has several things it needs to seal against.

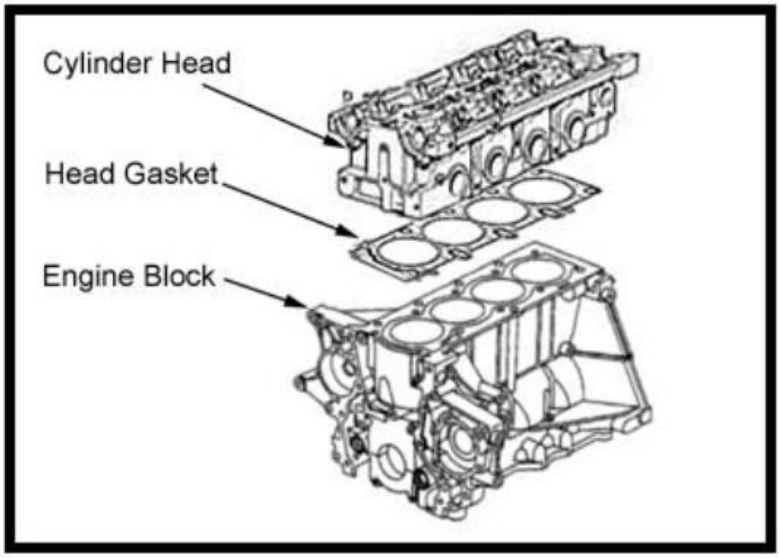


Figure 7 Head gaskets& intake manifold gaskets

- The main thing is the combustion pressure on each cylinder. Oil and coolant must easily flow between block and head and it is the job of the head gasket to keep these fluids from leaking out or into the combustion chamber, or each other for that matter.
- A typical head gasket is usually made of soft sheet metal that is stamped with ridges that surround all leak points. When the head is placed on the block, the head gasket is sandwiched between them. Many bolts, called head bolts are screwed in and tightened down causing the head gasket to crush and form a tight seal between the block and head.
- Head gaskets usually fail if the engine overheats for a sustained period of time causing the cylinder head to warp and release pressure on the head gasket. This is most common on engines with cast aluminum heads, which are now on just about all modern engines.
- Once coolant or combustion gases leak past the head gasket, the gasket material is usually damaged to a point where it will no longer hold the seal. This causes leaks in several possible areas. For example: combustion gases could leak into the coolant passages causing excessive pressure in the cooling system. Coolant could leak into the combustion chamber causing coolant to escape through the exhaust system, often causing a white cloud of smoke at the tailpipe
- Other problems such as oil mixing with the coolant or being burned out the exhaust are also possible.
- Some engines are more susceptible to head gasket failure than others. I have seen blown head gaskets on engines that just started to overheat and were running hot for less than 5 minutes. The best advice I can give is, if the engine shows signs of overheating, find a place to pull over and shut the engine off as quickly as possible.
- Head gaskets themselves are relatively cheap, but it is the labor that's the killer. A typical head gasket replacement is a several hour job where the top part of the engine must be completely disassembled.
- On V type engines, there are two heads, meaning two head gaskets. While the labor won't double if both head gaskets need to be replaced, it will probably add a good 30% more labor to replace both. If only one head gasket has failed, it is usually not necessary to replace both, but it could be added insurance to get them both done at once.
- A head gasket replacement begins with the diagnosis that the head gasket has failed. There is no way for a technician to know for certain whether there is additional damage to the cylinder head or other components without first disassembling the engine. All he or she knows is that fluid and/or combustion is not being contained.

Heater core

The hot coolant is also used to provide heat to the interior of the vehicle when needed. This is a simple and straight forward system that includes a heater core, which looks like a small version of a radiator, connected to the cooling system with a pair of rubber hoses.

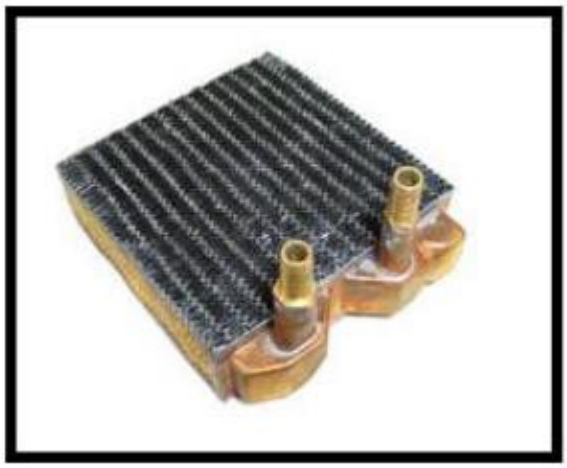


Figure 8 radiator core

- One hose brings hot coolant from the water pump to the heater core and the other hose returns the coolant to the top of the engine.
- There is usually a heater control valve in one of the hoses to block the flow of coolant into the heater core when maximum air conditioning is called for.
- A fan, called a blower, draws air through the heater core and directs it through the heater ducts to the interior of the car. Temperature of the heat is regulated by a blend door that mixes cool outside air, or sometimes air conditioned air with the heated air coming through the heater core.
- This blend door allows you to control the temperature of the air coming into the interior. Other doors allow you to direct the warm air through the ducts on the floor, the defroster ducts at the base of the windshield, and the air conditioning ducts located in the instrument panel.

Hoses

There are several rubber hoses that make up the plumbing to connect the components of the cooling system. The main hoses are called the upper and lower radiator hoses. These two hoses are approximately 2 inches in diameter and direct coolant between the engine and the radiator.

Figure 9 hoses

- Two additional hoses, called heater hoses, supply hot coolant from the engine to the heater core. These hoses are approximately 1 inch in diameter. One of these hoses may have a heater

control valve mounted in-line to block the hot coolant from entering the heater core when the air conditioner is set to max-cool. A fifth hose, called the bypass hose, is used to circulate the coolant through the engine, bypassing the radiator, when the thermostat is closed. Some engines do not use a rubber hose. Instead, they might use a metal tube or have a built-in passage in the front housing.

- These hoses are designed to withstand the pressure inside the cooling system. Because of this, they are subject to wear and tear and eventually may require replacing as part of routine maintenance. If the rubber is beginning to look dry and cracked, or becomes soft and spongy, or you notice some ballooning at the ends, it is time to replace them. The main radiator hoses are usually moulded to a shape that is designed to rout the hose around obstacles without kinking. When purchasing replacements, make sure that they are designed to fit the vehicle. There is a small rubber hose that runs from the radiator neck to the reserve bottle. This allows coolant that is released by the pressure cap to be sent to the reserve tank. This rubber hose is about a quarter inch in diameter and is normally not part.

LO 1.3 – Describe cooling components

- **Content/Topic 1Description of Cooling system components:**

  - Definition
    - The coolant follows a path that takes it from the water pump, through passages inside the engine block where it collects the heat produced by the cylinders. It then flows up to the cylinder head (or heads in a V type engine) where it collects more heat from the combustion chambers. It then flows out past the thermostat (if the thermostat is opened to allow the fluid to pass), through the upper radiator hose and into the radiator.
    - The coolant flows through the thin flattened tubes that make up the core of the radiator and is cooled by the air flow through the radiator. From there, it flows out of the radiator, through the lower radiator hose and back to the water pump. By this time, the coolant is cooled off and ready to collect more heat from the engine.
    - The capacity of the system is engineered for the type and size of the engine and the work load that it is expected to undergo. Obviously, the cooling system for a larger, more powerful V8 engine in a heavy vehicle will need considerably more capacity then a compact car with a small 4 cylinder engine. On a large vehicle, the radiator is larger with many more tubes for the coolant to flow through. The radiator is also wider and taller to capture more air flow entering the vehicle from the grill in front.
    - The coolant that courses through the engine and associated plumbing must be able to withstand temperatures well below zero without freezing. It must also be able to handle engine temperatures in excess of 250 degrees without boiling. A tall order for any fluid, but that is not all. The fluid must also contain rust inhibiters and a lubricant.
    - The coolant in today's vehicles is a mixture of ethylene glycol (antifreeze) and water. The recommended ratio is fifty-fifty. In other words, one part antifreeze and one part water. This is the minimum recommended for use in automobile engines. Less antifreeze and the boiling point would be too low.

- In certain climates where the temperatures can go well below zero, it is permissible to have as much as 75% antifreeze and 25% water, but no more than that. Pure antifreeze will not work properly and can cause a boil over.
- Antifreeze is poisonous and should be kept away from people and animals, especially dogs and cats, who are attracted by the sweet taste. Ethylene Glycol, if ingested, will form calcium oxalate crystals in the kidneys which can cause acute renal failure and death.

- **Purpose**

In internal combustion engine, cooling system has the following functions:

- To heat up engine quickly to optimal operating temperature and to dissipate excess heat during engine operation.

- **Location**

The **cooling system** is made up of: passages inside the engine block and heads. a water pump to circulate the **coolant**. a thermostat to control the temperature of the **coolant**.

- Operation

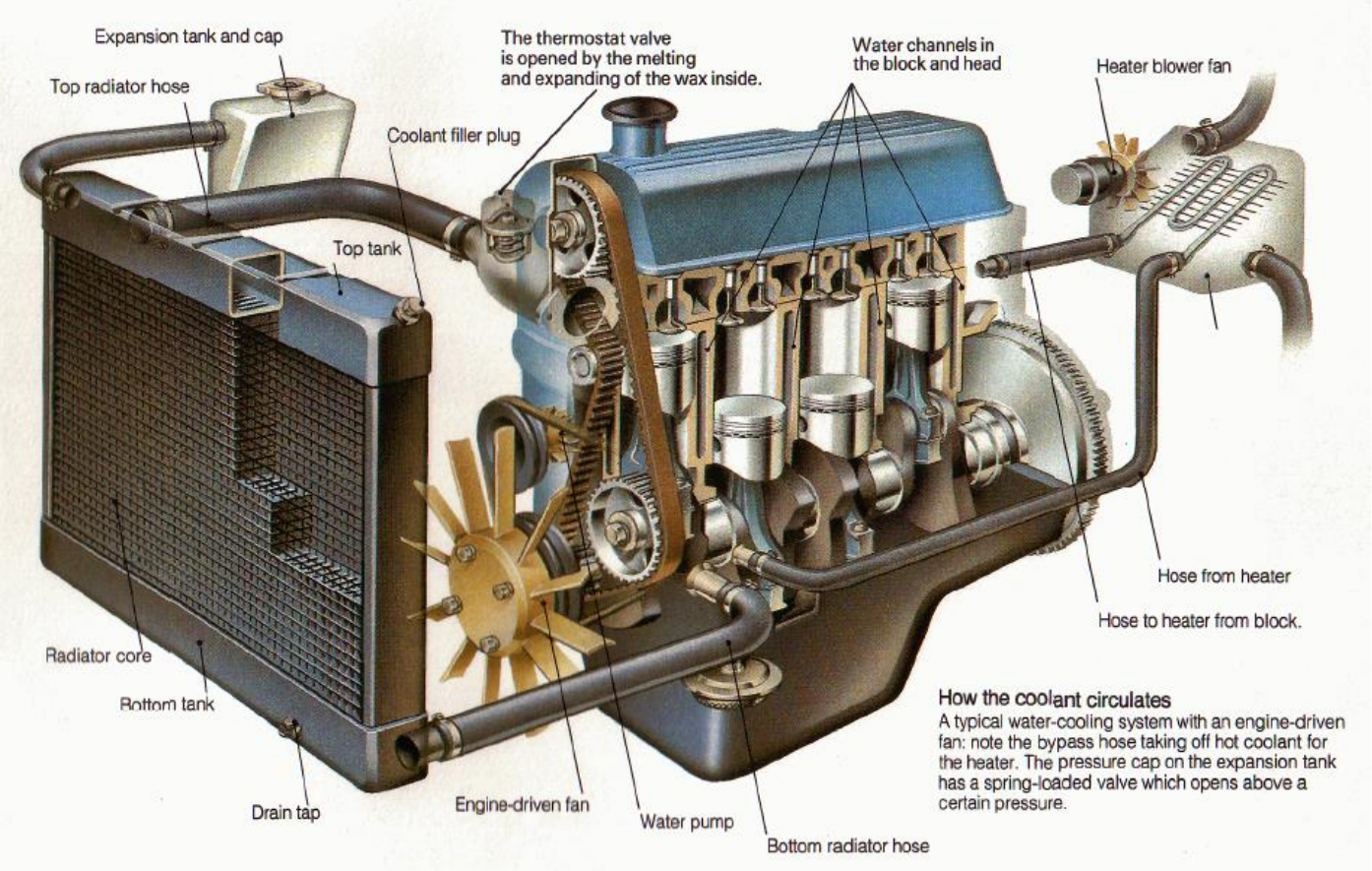


Figure 10 cooling system

- Generally this is done by circulating coolant liquid usually water mixed with an antifreeze solution through special cooling passages. Some engines are cooled by air flowing over finned cylinder casings.
- A water-cooled engine block and cylinder head have interconnected coolant channels running through them. At the top of the cylinder head all the channels converge to a single outlet. A

pump, driven by a pulley and belt from the crankshaft, drives hot coolant out of the engine to the radiator, which is a form of heat exchanger. Unwanted heat is passed from the radiator into the air stream, and the cooled liquid then returns to an inlet at the bottom of the block and flows back into the channels again.

- Usually the pump sends coolant up through the engine and down through the radiator, taking advantage of the fact that hot water expands, becomes lighter and rises above cool water when heated. Its natural tendency is to flow upwards, and the pump assists circulation.
- The radiator is linked to the engine by rubber hoses, and has a top and bottom tank connected by a core a bank of many fine tubes. The tubes pass through holes in a stack of thin sheet-metal fins, so that the core has a very large surface area and can lose heat rapidly to the cooler air passing through it.
- On older cars the tubes run vertically, but modern, low-fronted cars have cross flow radiators with tubes that run from side to side. In an engine at its ordinary working temperature, the coolant is only just below normal boiling point. The risk of boiling is avoided by increasing the pressure in the system, which raises the boiling point. The extra pressure is limited by the radiator cap, which has a pressure valve in it. Excessive pressure opens the valve, and coolant flows out through an overflow pipe.
- In a cooling system of this type there is a continual slight loss of coolant if the engine runs very hot. The system needs topping up from time to time.
- Later cars have a sealed system in which any overflow goes into an expansion tank, from which it is sucked back into the engine when the remaining liquid cools. The radiator needs a constant flow of air through its core to cool it adequately. When the car is moving, this happens anyway; but when it is stationary a fan is used to help the airflow. The fan may be driven by the engine, but unless the engine is working hard, it is not always needed while the car is moving, so the energy used in driving it wastes fuel. To overcome this, some cars have a viscous coupling a fluid clutch worked by a temperature sensitive valve that uncouples the fan until the coolant temperature reaches a set point.
- Other cars have an electric fan, also switched on and off by a temperature sensor. To let the engine warm up quickly, the radiator is closed off by a thermostat, usually sited above the pump. The thermostat has a valve worked by a chamber filled with wax. When the engine warms up, the wax melts, expands and pushes the valve open, allowing coolant to flow through the radiator. When the engine stops and cools, the valve closes again. Water expands when it freezes, and if the water in an engine freezes it can burst the block or radiator. So antifreeze usually ethylene glycol is added to the water to lower its freezing point to a safe level.

Learning Unit 2 – Perform heat transfer

LO 2.1 – Select tools, materials and equipment

- **Content/Topic 1 Selection of tools:**
  - Wrenches:
  - Sockets,
  - Open end and closed end wrench,
  - Hammer,
  - Screwdriver.
- **Content/Topic 2 Selection of materials:**
  - Metallic brush
  - Water container
  - Water
  - Solvents
  - Antifreeze
  - Belt
- Content /Topic3 Selection of equipment:
  - Air compressor
  - Radiator cup tester
  - PPE (Personal Protective Equipments)
  - Multimeter

LO 2.2 – Treat water and air

- **Content/Topic 1 Water treatment**
  - **Thermo syphon**

- Thermosiphon (or thermosyphon) is a method of passive heat exchange, based on natural convection, which circulates a fluid without the necessity of a mechanical pump. Thermosiphoning is used for circulation of liquids and volatile gases in heating and cooling applications such as heat pumps, water heaters, boilers and furnaces.
- Thermo-syphoning also occurs across air temperature gradients such as those utilized in a wood fire chimney or solar chimney.
- This circulation can either be open-loop, as when the substance in a holding tank is passed in one direction via a heated transfer tube mounted at the bottom of the tank to a distribution point even one mounted above the originating tank or it can be a vertical closed-loop circuit with return to the original container.
- Its purpose is to simplify the transfer of liquid or gas while avoiding the cost and complexity of a conventional pump. Please note the diagram depicted with this article is for illustration

purposes only and not a working model as there is no illustrated water supply to replenish the tank when the tap is used.

- **Water pressure**

As coolant gets hot, it expands. Since the cooling system is sealed, this expansion causes an increase in pressure in the cooling system, which is normal and part of the design. When coolant is under pressure, the temperature where the liquid begins to boil is considerably higher.

- Content/Topic 2 Air treatment

- **Air flow**

Airflow refers to the amount of moving air around a given space or area. It is created by the natural means of wind and circulation, or it can be created artificially by the mechanical means of a fan or blower unit

- **Air pressure**

The air around you has weight, and it presses against everything it touches. That pressure is called atmospheric pressure, or air pressure. It is the force exerted on a surface by the air above it as gravity pulls it to Earth. Atmospheric pressure is commonly measured with a barometer

LO 2.3 – Check of cooling system

- **Content/Topic 1 Check the temperature gauge on dashboard.**

Step 1

Unplug the temperature gauge from the sending unit. This is usually located to the right of the engine.

Step 2

Turn the ignition key to the "On" position. Do not start the car.

Step 3

Ground the temperature gauge wire to the engine. You should use jumper wires to ground the temperature gauge.

Step 4

Check the temperature gauge inside the car. The reading should be in the middle between hot and cold.

Step 5

Turn the ignition key to the "Off" position.

Step 6

Check the fuses inside the car. If the fuse connected to the temperature gauge is burned out you should replace it.

Step 7

Ground the jumper wire connected to the sending unit terminal located next to the engine.

Step 8

Turn the ignition key to the "On" position.

Check the temperature gauge inside the car. If the temperature now reads hot, then there is a open wire in the sending unit. You should immediately have the temperature gauge repaired.

- **Content/Topic 2 Check engine light on your dashboard.**

✓ When your car's check engine light illuminates your dashboard, it's usually accompanied by a sinking feeling in the pit of your stomach. The light could be a minor issue, such as a faulty gas cap, or it could mean something more serious, such as a misfiring engine. In many cases, it means that you'll be visiting the car dealer to repair the issue and get the light turned off.

✓ The check engine light more formally known as the malfunction indicator lamp is a signal from the car's engine computer that something is wrong. Automakers started standardizing their systems with 1996 model-year vehicles under a protocol called OBD-II, which instituted a list of diagnostic trouble codes and mandated that all cars provide a universal connector to access this information. The connector is usually located under the steering column and is relatively easy to access. Before 1996, carmakers had their own engine diagnostic systems, primarily to ensure their cars were compliant with EPA pollution control requirements.

✓ Check engine lights come in orange, yellow or amber, depending on the manufacturer. If the light begins flashing, however, it indicates a more serious problem, such as a misfire that can quickly overheat the catalytic converter. These emissions devices operate at high temperatures to cut emissions but can pose a fire hazard if faulty.

- **Content/Topic 3 Check the tension of belt**

Belt tension is measured by plucking the belt span while holding a sensor close by. Belt tension is adjusted until the belt span frequency, or measured tension level is within manufacturer's recommendations.

- **Content/Topic 4 Check the radiator cap for damage**

✓ Before you get too deep into the diagnostics, double check that the pressure indicated on the radiator cap matches the cooling system pressure specified by the manufacturer. You can find this information in a repair manual, factory service manual, or online.

- ✓ Visually inspect that cap to make sure the spring moves freely and there is no debris or corrosion under the cap.

Pressure Testing the Radiator

- ✓ If you have a radiator pressure tester, then you can inspect the cooling system on your own. This may help you find leaks or determine if the radiator cap has gone bad. You may also be able to rent this tester from your local auto parts store.
- ✓ To begin, pop open the hood and find the radiator. It is usually located right in front of the vehicle's engine. Now remove the radiator cap by pushing it down first and then twisting it counter-clockwise.

- ✓ Take the cap adapter and screw it onto the pressure tester's end. Keep screwing until you cannot screw it anymore. If you don't know what the cap adapter looks like, check the label of the pressure tester's packaging and see if it shows it on there. You can also look it up on the internet as well.

- ✓ After you've secured the cap adapter onto the pressure tester, screw the other end of the cap adapter onto the radiator filler neck until it is tight.

- ✓ The pressure tester should now be sealed against the radiator. If it is not, you may not be using the correct adapter for your specific radiator.

- ✓ Using the pump handle, start pumping the tester until you reach the pressure indicated on your radiator cap. See if the gauge can store the pressure. If the pressure begins to fall and you're sure you have a good seal against the radiator filler neck, you have a leak in the cooling system.

- ✓ See if you notice any external coolant leaks while the system is pressurized, as they will be easier to find this way. Any leaking components will need to be replaced.

- ✓ When you're done with your pressure test, unscrew the radiator cap adapter slowly so coolant doesn't spill everywhere. It may be a good idea to have a pan or bucket handy to catch any that overflows. Top up any coolant that was lost, and clean up any coolant that has spilled onto the ground.

- **Content/Topic 5 Check the coolant levels in your vehicle.**

- ✓ Prevent costly damage by checking your car's coolant levels
- ✓ Check your coolant level every time you refuel
- ✓ Never remove the radiator cap when the engine is hot
- ✓ It's not actually water in your engine, but coolant. Coolant, which is often green or red, contains chemicals that stop the liquid from freezing in sub-zero climates and prevents corrosion damage inside the engine.
- ✓ Checking the level is important as it can prevent problems such as your engine overheating and your vehicle breaking down. Thankfully, checking the level is an easy job to do.

- ✓ First and foremost, before you inspect your car's cooling system you must ensure the engine is cool. Let it sit for a few hours after driving before you remove the radiator cap, otherwise hot coolant can spray out, causing burns. It's also a good idea to consult your owner's manual at this point as it can guide you through the specifics of your vehicle.
- ✓ Generally, low and high markings on the side of the plastic overflow bottle connected to the cooling system tell you if there is enough coolant in the engine. The coolant level should be between the two marks. The overflow bottle usually has a brightly coloured cap and is connected to the radiator at the front of the car.
- ✓ To check the levels, lift your car's bonnet, and be sure that it's secured. Then locate your coolant reservoir, and make sure that the water level is between the minimum and maximum levels.

- **Content/Topic 6 Check of leakages**

- ✓ Pressure testing the cooling system is a simple process to determine where a leak is located. This test is only performed after the cooling system has cooled sufficiently to allow you to safely remove the pressure cap. Once you are sure that the cooling system is full of coolant, a cooling system pressure tester is attached in place of the radiator cap.
- ✓ The tester is than pumped to build up pressure in the system. There is a gauge on the tester indicating how much pressure is being pumped. You should pump it to the pressure indicated on the pressure cap or to manufacturer's specs.
- ✓ Once pressure is applied, you can begin to look for leaks. Also watch the gauge on the tester to see if it loses pressure. If the pressure drops more than a couple of pounds in two minutes, there is likely a leak somewhere that may be hidden.
- ✓ It is not always easy to see where a leak is originating from. It is best to have the vehicle up on a lift so you can look over everything with a shop light or flashlight.
- ✓ If the heater core in leaking, it may not be visible since the core is enclosed and not visible without major disassembly, but one sure sign is the unmistakable odor of antifreeze inside the car. You may also notice the windshield steaming up with an oily residue.

Figure 11 cooling system pressure tester

Internal leak test

- ✓ If you are losing coolant, but there are no signs of leaks, you could have a blown head gasket. The best way to test for this problem is with a combustion leak test on the radiator.
- ✓ This is accomplished using a block tester. This is a kit that performs a chemical test on the vapors in the radiator.
- ✓ Blue tester fluid is added to the plastic container on the tester. If the fluid turns yellow during the test, then exhaust gasses are present in the radiator.
- ✓ The most common causes for exhaust gasses to be present in the radiator is a blown head gasket. Replacing a bad head gasket requires a major disassembly of the engine and can be quite expensive.
- ✓ Other causes include a cracked head or a cracked block, both are even more undesirable than having to replace a head gasket.

Learning Unit 3 – Perform repair of cooling system

LO 3.1 – Select tools, materials and equipment

- **Content/Topic 1 Selection of tools:**
  - Wrenches
  - sockets,
  - open end and closed end wrench,
  - hammer,
  - screwdriver,)

- **Content/Topic 2Selection of materials:**
  - Metallic brush
  - Water container
  - Water
  - Solvents
  - Antifreeze
  - Belt

- **Content /Topic3Selection of equipment:**
  - Air compressor
  - Radiator cup tester
  - PPE (Personal Protective Equipments)
  - Multimeter

LO 3.2 – Replace and adjust cooling system components

- **Content/Topic 1 Adjustment of Belt and Hoses**

Accessory Belts

Many of the same elements that attack hoses also attack belts—heat, oil, ozone, and abrasion. Almost all cars and trucks built today have a single multi-grooved serpentine belt that drives the alternator, water pump, power-steering pump, and air-conditioning compressor. Older vehicles may have separate V-belts that drive the accessories. The Car Care Council says chances of a V-belt failure rise dramatically after four years or 36,000 miles, while the critical point for a serpentine belt is 50,000 miles. Any belt should be changed when it shows signs of excessive wear. But many new composite belts don't show signs of wear until the failure occurs.

Here are tips for inspecting belts:

- Look for cracks, fraying, or splits on the top cover.
- Look for signs of glazing on the belt's sides. Glazed or slick belts can slip, overheat or crack.
- Twist a serpentine belt to look for separating layers, cracks, or missing chunks of the grooves on the underside.
- Replacement belts should be identical in length, width, and number of grooves to the factory belt. Serpentine belts are usually kept tight with an automatic tensioner. Signs of a belt-tension problem include a high-pitched whine or chirping sound and vibration noises. Without proper tension, belts will slip and generate heat or fail to turn the accessories.
- If in doubt, check with a qualified technician about any cooling problems, and always consult your owner's manual for routine maintenance procedures.

Timing belt replacement guide

- Most manufactures have recommended replacement Intervals for replacing timing belts. A typical service Interval in between 50,000 and 60,000 miles. It is important to replace timing belts at recommended Intervals even if the vehicle has a non-interference engine. Proper maintenance prevents expensive tow bills and possible accidents due to loss of engine power while traveling at highway speeds.

Coolant and Heater Hoses

- Hoses are the cooling system's weakest structural component. They are made of flexible rubber compounds to absorb vibrations between the engine and radiator, or, in the case of heater hoses, the engine and body's firewall. Designed to hold coolant under pressure, hoses are also subjected to fluctuating extremes of heat and cold, dirt, oils, and sludge. Atmospheric ozone also attacks rubber compounds.

- The most damaging cause of hose failure electrochemical degradation (ECD)isn't easy to detect. According to engineers for the Gates Corporation, a parts maker, ECD attacks hoses from the inside, causing tiny cracks. Acids and contaminants in the coolant can then weaken the yarn material that reinforces the hose. Eventually, pinholes can develop or the weakened hose may rupture from heat, pressure, or constant flexing.

Some easy, basic maintenance can help prevent coolant hose failure:

- Check the white coolant-recovery tank often to ensure proper fluid level. Marks on the tank indicate the proper level for when the engine is cold or hot. If the tank is low after repeated fillings, suspect a leak. Also check for white, light green, blue, or pink coolant tracks in the engine bay, which is residue left from leaking coolant.
- When the engine is cool, squeeze the hoses with your thumb and forefinger near the clamps, where ECD most often occurs. Feel for soft or mushy spots. A good hose will have a firm yet pliant feel.
- Inspect for cracks, nicks, bulges usually while hot), or a collapsed section in the hose and oil contamination, or fraying near the connection points.
- Look for parallel cracks around bends (caused by ozone), a hardened glassy surface (heat damage), or abrasive damage (hose is rubbing).
- Flush and replace the coolant according to the owner's manual. Clean coolant is less likely to support ECD.
- Never remove the radiator cap when the engine is hot, as the hot coolent will be under pressure. Also, be aware that an electric cooling fan can come on at any time.
- The upper radiator hose fails more often than any other hose, followed by the water pump bypass hose (if your vehicle is so equipped), and the outlet heater hose from the engine to the heater core. Experts recommend, however, that all hoses be replaced at least every four years or when one fails. Always use replacement hoses designed to fight ECD.

- **Content/Topic 2 Replacement of worn equipment**

- Radiator damage

How to Replace a Car Radiator

Car radiators remove heat from coolant after it's cycled through the car engine. Cars overheat and damage is caused without a functioning radiator.

The radiator is a main part of the cooling system. Coolant flows through the tubes inside the radiator, which are surrounded by fins that direct airflow. When the vehicle is moving down the road, air flows through these fins and cools the coolant. The lower temperature coolant is then sent back to the engine. A failed radiator can lead to engine overheating and potential engine damage.

Part 1 of 1: Replacing the radiator

Materials Needed

Air compressor (optional)
Cooling system vacuum fill tool (optional)
Flare nut wrench of the appropriate size
Free repair manuals - Autozone provides free online repair manuals for certain makes and models
Jack and jack stands

Pliers
Protective gloves
Ratchet and sockets of the appropriate size
Ratchet extension
Safety glasses
Screwdriver
Wrenches of the appropriate size
Step 1: Raise and support the vehicle. Safely support the vehicle by jacking it up and supporting it with jack stands. Place a wheel chock behind the rear wheels and set the parking brake.
Step 2: Drain the coolant from the radiator. Open the petcock valve or remove the lower radiator hose to drain the coolant from the radiator.
Step 3: Disconnect the radiator reservoir hose. Loosen the hose clamp using either pliers or a screwdriver, depending on the clamp design. Disconnect the hose by twisting and pulling it away from the radiator.
Step 4: Remove the upper radiator hose. Loosen the hose clamps using either pliers or a screwdriver, depending on the clamp design. Then remove the hose by twisting and pulling it away from the connection.
Step 5: Remove the lower radiator hose. Loosen the hose clamps using either pliers or a screwdriver, depending on the clamp design. Then remove the hose by twisting and pulling it away from the connection.
Step 6: Disconnect the cooling fan electrical connector. Disconnect the cooling fan electrical connector by pushing on the tab and pulling it back.
Step 7: Remove the cooling fan mounting bolts. Remove the cooling fan mounting bolts using a ratchet, extension and socket of the appropriate size.
Step 8: Remove the cooling fan. Remove the cooling fan from the vehicle.
Step 9: Disconnect the transmission cooler lines. Disconnect the transmission cooler lines from the radiator using a flare nut wrench to prevent rounding off the fittings.
Step 10: Remove the radiator mounting bolts. Remove the radiator mounting bolts using a wrench or ratchet and socket of the appropriate size.
Step 11: Remove the condenser mounting bolts. Remove the condenser mounting bolts using a wrench or ratchet and socket of the appropriate size.
Step 12: Remove the radiator. Remove the radiator from the vehicle.
Step 13: Mount the radiator. Mount the new radiator in position.
Step 14: Install the condenser mounting bolts. Install the condenser mounting bolts and tighten them down.
Step 15: Install the radiator mounting bolts. Install the radiator mounting bolts using a wrench or ratchet and socket of the appropriate size.
Step 16: Connect the transmission cooler lines. Connect the transmission cooler lines to the radiator using a flare nut wrench to prevent rounding off the fittings.
Step 17: Mount the fan. Mount the cooling fan in position.
Step 18: Install the cooling fan mounting bolts. Install the cooling fan mounting bolts using a ratchet, extension and socket of the appropriate size.
Step 19: Reinstall the connector. Reconnect the cooling fan electrical connector.

Step 20: Install the lower radiator hose. Slide the hose onto the connection. Using either pliers or a screwdriver (depending on the clamp design), slide the hose clamps into position and tighten them down.
Step 21: Install the upper radiator hose. Slide the hose onto the connection. Then, using either pliers or a screwdriver (depending on the clamp design), slide the hose clamps into position and tighten them down.
Step 22: Connect the radiator reservoir hose. Slide the hose onto the connection. Then, using either pliers or a screwdriver (depending on the clamp design), slide the hose clamp into position and tighten it down.
Step 23: Fill the radiator with coolant. Close the drain petcock as needed. Then fill the radiator with coolant.
Step 24: Bleed the air from the cooling system. Air can be bled from the cooling system either by opening the bleeder valve if equipped, or using a cooling system vacuum fill tool attached to shop air. On some vehicles, it is possible to bleed the cooling system of air by running the engine with the radiator cap off and allowing coolant to puke out.
Step 25: Lower the vehicle. Jack up the vehicle and remove the jack stands. Then lower the vehicle and remove the wheel chock.

- Belt

Visual Inspection of Belts

- Search for clear indications of damage (cracking, glazing, softening, or peeling)
- Test for correct tension
- Test for correct alignment
- Record belt condition for future reference

- water pump

The water pump is a vital part of the engine. When you have a water pump that's driving by a timing belt, it takes a special process to install. In some vehicles, the water pump is driven by the timing belt, so it makes sense to replace them at the same time. In this video, you'll get a basic understanding of car timing belt driven water pumps and the features and benefits of the kits that AutoZone offers to help you do the job right.

- Fan

Fan Belt' is the term loosely applied to the drive belt that turns the cooling fan in an engine. This same belt often also drives the alternator, and the water pump.

This belt plays a very important role in the cooling system as well as the charging system. It operates at engine speed, and often under heavy load - it is quite difficult to drive a cooling fan, a water pump, and an alternator supplying all the electrical needs of a plant vehicle.

Depending on the type of cooling fan arrangement, if this drive belt were to fail, the vehicle would very quickly overheat. In all probability, the vehicle's electrical system would also cease to charge, and the battery would discharge in a very short period of time. It is vital that you pay close attention to the

condition and tension of this drive belt when you are inspecting both the cooling and charging systems.

Sometimes, you may be able to inspect the condition of the belt while it is in place, but often, you have to remove it to give it a thorough inspection. Here are some suggestions for when you are inspecting, servicing, replacing and tensioning 'fan belts'.

- thermostat

✓ With a normal top-mounted thermostat you need drain only part of the cooling system .
✓ Do not drain it while the engine is hot you may be scalded. Wait for the engine to cool.
✓ Drain the coolant from the radiator tap, or from the bottom hose, until it is below the level of the thermostat housing.
✓ Drain it into a clean container if you want to reuse it, and filter it through muslin before pouring it back.
✓ Disconnect the top hose from the thermostat housing by loosening the hose clip and carefully easing the hose off.

✓ Lift off the housing and remove the thermostat.
✓ Remove the nuts securing the housing.
✓ If the housing does not lift off easily, tap it free with a piece of wood.
✓ Do not prise it off with a screwdriver which might damage it and cause it to leak later.
✓ Lift out the thermostat. If the engine is cold but the thermostat is open, it is stuck and must be renewed. Otherwise, test it in a pan of water.

- **cap**

A radiator cap generally contains a spring loaded plunger, and this plunger serves two purposes in your cooling system. First, should internal pressures exceed the spring pressure of the plunger, coolant will be diverted to an overflow reservoir. This is important because if this simple feature did not exist, pressure would simply continue to build, causing sudden leaks or even explosions as the building pressure desperately tries to find a way to relieve itself. Second, this spring pressure helps to maintain a specific pressure inside your cooling system. As atmospheric pressure rises, the boiling point of a fluid also rises. Boiling fluid isn't very good at transferring heat, so by increasing the pressure inside the system, you increase the amount of heat the cooling system can remove before it begins to boil.

Diagnosing a Faulty Cap

- ✓ A faulty radiator cap will show a few common symptoms that are usually easy to see if you are looking for them. Coolant should move back and forth between the overflow reservoir and cooling system as pressure dictates.
- ✓ If you are overheating and coolant is not moving effectively between these two areas, the spring loaded plunger may be stuck or jammed in place. A cap that is unable to maintain pressure will often show coolant boil at normal operating temperatures.
- ✓ This boiling can be heard quite easily, and witnessed by looking closely at the overflow reservoir. Leaking from around the radiator cap is also a common and easy to notice symptom, but be careful not to confuse this with freshly filled coolant, as slight spillage is common during refills.

- hoses and coolant

Visual Inspection of Hoses

- ✓ Search for leaks, cracks, hardening, or softening.
- ✓ Test cooling system for leaks using state-of-the-art pressure technology
- ✓ Record hose condition for future reference

Notes: Get your vehicle's belts and hoses inspected on a regular basis because damaged pieces can seriously harm your vehicle. Research shows that while most people get regular oil changes, they neglect the condition of their belts and hoses. A leaking hose or a cracked belt will cause you more trouble than an overdue oil change ever will.

- **Content /Topic3_Weld Radiator if damaged**

Car radiators leak, and the easiest way to tell that your radiator has a leak is a consistently low coolant level or simply a green radioactive looking puddle under your vehicle. Though it may seem difficult, repairing this problem is quite easy.

Step 1

Drain your radiator. To do this, make sure your engine has cooled for several hours, your battery is disconnected and the engine is covered with an approved blanket or tarp to prevent splashing from reaching it. Unscrew your radiator cap to provide air flow and place your container below the radiator plug, which is usually located at one of the bottom corners of the radiator. Remove the plug and let the fluid drain until it stops dripping.

Step 2

Clean the area where the leak is located thoroughly. If need be, scrape rust and other debris away, and make sure to remove any grease, grime or dirt with a rag and a solvent if necessary.

Step 3

Mix the J-B WELD. To do this, mix equal parts of the black and red tubes on your disposable plastic surface with your wooden tool. Make sure to work quickly, as the J-B WELD sets very fast.

Step 4

Apply your mixed J-B WELD all over the leak area liberally with the wooden tool. The mixture will set in 4 to 6 hours and be completely cured in 15 to 24 hours.

Step 5

Replace the radiator plug on the bottom of the radiator and refill the fluid to the appropriate level. Replace the radiator cap and remove the engine cover that you placed to keep fluids from reaching your engine. Reconnect your battery and start your vehicle.

LO 3.3 – Install and test cooling system

- **Content/Topic 1 Installation of cooling equipment**
  - Water pump

How to install water pumps in 13 easy steps

STEP 1

Safety first
Always wait until the engine is cool before working on any part of the cooling system.

STEP 2

Remove the belt drive components following the vehicle manufacturer's recommended procedures.

STEP 3

Remove the hose attached to the water pump.
Be aware that a considerable amount of coolant can pour out of the hose when you take it off.

STEP 4

Loosen the bolts and remove the old water pump.

STEP 5

Remove the old seal/gasket or old sealant remains and make sure the mounting surface is clean.

STEP 6

Before installing the new water pump, inspect the other cooling system service parts: coolant hoses, thermostat and pressure cap(s).

STEP 7

Install the new water pump. Do not force the pump on by striking the pump shaft. Old gaskets and seals should be replaced by new ones. Carefully follow installation instructions. Only apply sealant if specifically recommended by the vehicle manufacturer. Put an even bead of sealant along the edge of the part, but don't use too much sealant. If you do get too much sealant on the part, wipe off the excess before mounting the new water pump. Too much sealant compromises the

correct installation and will break off within the cooling system, contaminating it. Sealants are also made with different drying rates, so respect the sealant's printed instructions.

STEP 8

Tighten the bolts evenly to the manufacturer’s torque specifications.

STEP 9

Re-attach the hose.

STEP 10

Refill the cooling system with the correct vehicle manufacturer’s recommended coolant.

STEP 11

Manually rotate the pump and make sure it rotates freely.

STEP 12

Make sure the belt drive system that will drive the new water pump is in perfect condition and installed following the vehicle manufacturer’s recommended procedures. The belt drive system works hand in hand with the water pump. That is why according to Gates changing the water pump, belt and other drive components at the same time is good preventive maintenance.

STEP 13

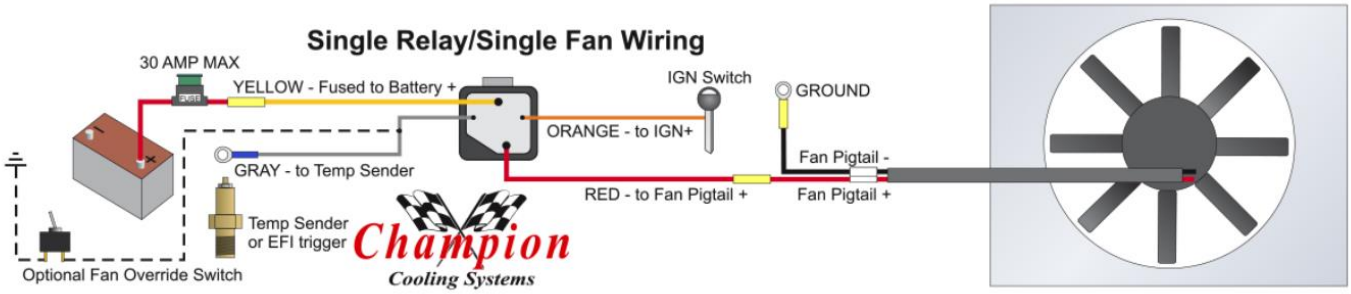
Do a final visual inspection to ensure there are no leaks after the cooling system refill. When a water pump is new, some seepage from the weep hole is normal as it takes about ten minutes of operation for the pump’s internal mechanical seal to properly seat itself (break-in period). More pronounced seepage and drips from the weep hole after this break-in period or leakage from the mounting surface are abnormal and signal part failure or faulty installation.

- **Fan Inspection**

- ✓ Since we know how a car radiator fan works, we are more likely to be able to detect if there is an issue with the fan itself. In order to determine if there are any issues with the radiator fan, we must perform a fan inspection.

- ✓ To check a fan clutch condition, the engine must be off. Turn the ignition off and let your car cool. Next, inspect the clutch for any leaks at the front of the unit. Be sure to check the input shaft and expansion spring, since these are especially-prone spots to leak. Your radiator could be blocked or leaking, which causes your car to run hot.

- ✓ If you found a leak, then the radiator fan clutch has failed and needs to be replaced. The next step is to take your radiator fan blade and turn it. If you can’t turn the fan blade, then the clutch has locked, or there might be an excessive movement that is erroneous to the function. If any of these cases hold true, then a replacement of the radiator fan is required.



The first part of the installation is to install the electric fan to your radiator, and remove the mechanical fan. It's unlikely you would have room for both, but you should never run a mechanical fan with an electrical fan on the same side of the radiator. If your mechanical fan had a fan spacer, it can be removed with the fan. Next, find a suitable location for the relay that is away from excessive heat, and someplace where it's not exposed to the elements, such as water splashing up from the road.

The temperature sender, if used, is designed to provide a ground signal at about 185 degrees, and will shut back off when the temperature drops below 165 degrees. This wire (gray in our kit) supplies the ground signal to trigger the relay. The orange wire on the relay should see a 12 volt signal when the ignition switch is turned on. The other two wires on the relay are the meat and potatoes of the system, with the yellow wire connecting to the battery along with the supplied fuse mounted within 12 inches of the battery. For a remote battery, it can be connected to a power port in the engine compartment, but it should be fused.

The red wire from our relay connects directly to the cooling fan, and the black wire from the cooling fan connects to ground, both wires will utilize our supplied fan harness. If you purchase our relay kit, all required connectors are included to splice wires together. We highly recommend using a proper crimp connector, and following the directions in our instructions for a trouble free installation. Our video, below, will also help guide you through the installation

- Radiator

1. Take care not to damage the new radiator during the installation procedure.

2. Before flushing the cooling system conduct a thorough inspection of all components including hoses, clamps, water pump, thermostat housing and pressure cap. If there are signs of leaking, or the hoses are cracked, swollen or spongy, then they should be replaced at this time.

3. Before removing the old radiator, thoroughly flush the entire cooling system with the Radiator Wholesalers.com.au Radiator Flush. Failure to do so may leave harmful contaminants in the system which could lead to blockage of the new radiator or even cause it to fail prematurely.

4. Add the flushing fluid to the cooling system and run the engine for 15 minutes (with the heater switch turned fully on).

5. Drain the cooling system completely (including the overflow reservoir), then flush again using fresh water, ensuring to collect all the fluid for correct environmental disposal. (The drain plug

is located at the bottom of the radiator tank, and it helps to have the pressure cap removed when you do this).

6. Release the bottom hose clamp. If the hose will not come loose by hand, use a long handled screwdriver to break the seal between the hose and the radiator connection. Drain any remaining fluid from the cooling system. Use the same procedure for the top hose.

7. If your vehicle has an automatic transmission, the transmission oil lines will need to be removed from the bottom tank of the radiator. Carefully remove the couplings without bending the oil pipes. It is advisable to secure the lines upwards to avoid oil loss.

8. If your vehicle has an engine driven fan, disconnect the fan shroud and fan sensor from the radiator. If your vehicle has electric fans, these should be disconnected from the wiring relay, and remove still attached to the radiator.

9. Locate and release the radiator mounts. These are normally located on the ends of the top radiator tank, or if it is a cross flow radiator, on the sides of the radiator.

10. Lift the radiator from the engine compartment.

11. At this point we recommend inspection of the thermostat for signs of wear or sticking, and if evident, the thermostat should be replaced. A faulty thermostat could jam in the closed position, and as well as blowing out the new radiator, could cause serious damage to your engine.

12. Compare the new radiator to the old one to ensure correct selection. Remove fans and any other fittings (such as sensors, mounting rubbers, clips etc) from the old radiator and transfer to the new radiator. If hoses or clips appear worn, they should be replaced.

13. Install the new radiator using the reverse of the above instructions. Once all fittings have been tightened, fill the system with either demineralised, distilled or rainwater, and add the Radiator Wholesalers.com.au Radiator Coolant.

14. Leave the radiator cap off and let the engine idle for approx. 15 minutes to ensure that the fans are working and that the thermostat is operating correctly and allowing the coolant to flow. Re-inspect the cooling system including under the vehicle, for any leaks. Examine the rubber seal underneath the radiator cap and replace cap if the seal is cracked or swollen.

15. Check for air locks, and bleed the system via the designated bleed points if necessary. If your vehicle has bleed points, ensure that they are open whilst filling the cooling system. You should refer to your owner's manual to confirm if your vehicle has these and needs to be purged.

16. Monitor the temperature gauge for the next few days to ensure that it is operating within the normal range for the vehicle. After the vehicle has been driven, and when the cooling system is cold, recheck the coolant level and top up if required (we recommend doing this the next day). If your vehicle's radiator does not have a pressure release cap, the coolant needs to be added through the overflow reservoir.

- Thermostat

How to install thermostats in 10 easy steps

STEP 1

Safety first
Always wait until the engine is cool before working on any part of the cooling system.

STEP 2

Remove the hose attached to the thermostat.
Be aware that a considerable amount of coolant can pour out of the hose when you take it off.

STEP 3

Look at how the thermostat is positioned. Before proceeding, make sure you are familiar with the configuration and remember to put the new thermostat back the same way.

STEP 4

Loosen the bolts and remove the old thermostat.

STEP 5

Remove the old seal/gasket or old sealant remains and make sure the mounting surface is clean.

STEP 6

Before installing the new thermostat, inspect the other cooling system service parts: coolant hoses, water pump and pressure cap(s).

STEP 7

Install the new thermostat so the copper heat-sensing element is toward the coolant flow coming from the engine. If installed upside down, it won't function. Old gaskets and seals should be replaced by new ones.

STEP 8

Tighten the bolts evenly to the manufacturer's torque specifications.

STEP 9

Re-attach the hose.

STEP 10

Do a final visual inspection to ensure there are no leaks after the cooling system refill.
Keep in mind that some leaks will become obvious when the engine is cold, but others only when it is hot.

- Hoses

1. Before you begin, make sure you aren't running the engine without proper ventilation. (Safety note: If you need to raise your vehicle, use safety stands under the frame or drive-on ramps.)

2. Remove the hoses being replaced. Drain the cooling system. Most hoses should gently twist off after you loosen the clamp.

3. Make sure the fitting is not distorted or corroded. It's best to clean the fitting neck with a wire brush before installing a new hose.

4. Changing a coolant hose also means installing new hose clamps. When installed properly, these clamps maintain a constant tension so they never need to be retightened.

5. Make sure the hose is shouldered well-beyond the fitting edge and the clamp is positioned between the hose end and edge of the fitting.

6. Slip the clamp onto the hose end and then slide the hose onto fitting.

7. Make sure the hose clamp is positioned so the tightening device is easy to reach.

8. Slight twisting or bending of hose may be required. However, make sure the hose does not become pinched, or put into an abrasive or high heat situation without a protective sleeve. Proceed and tighten the hose clamp.

9. Re-fill the coolant system. Be sure to check the strength of the engine coolant and replace it if it isn't strong enough. Start the engine and let it run until the engine has heated up. Additional coolant may need to be added.

10. Do a final **visual inspection** to ensure there are no leaks. (For detailed instructions pertaining to your specific vehicle, consult an appropriate repair manual.)

- **Content/Topic 2 Testing of cooling system**

- **Leakage**

The most common causes for exhaust gasses to be present in the radiator is a blown head gasket. Replacing a bad head gasket requires a major disassembly of the engine and can be quite expensive. Other causes include a cracked head or a cracked block; both are even more undesirable than having to replace a head gasket.

- **Pressure**

Pressure testing the cooling system is a simple process to determine where a leak is located. This test is only performed after the cooling system has cooled sufficiently to allow you to safely remove the pressure cap.

- **Pressure cap test**

A radiator pressure cap is designed to maintain pressure in the cooling system at a certain maximum pressure. If the cooling system exceeds that pressure, a valve in the cap opens to bleed the excessive pressure into the reserve tank. Once the engine has cooled off, a negative pressure begins to develop in the cooling system. When this happens, a second valve in the cap allows the coolant to be siphoned back into the radiator from the reserve tank. If the cap should fail, the engine can easily overheat. A pressure test of the radiator cap is a quick way to tell if the cap is doing its job. It should be able to hold its rated pressure for two minutes. Since radiator caps are quite inexpensive, I would recommend replacing it every 3 years or 36,000 miles, just for added insurance. Make absolutely sure that you replace it with one that is designed for your vehicle.

- **Coolant concentration test**

a) Check coolant level
b) Checking coolant antifreeze strength testing the thermostat
c) Checking the hose and hose connection
d) Testing the water pump
e) Checking for the exhaust gas leakage into the system
f) Checking the fan belt or belt for wear and tension
g) Pressure testing the system and cap
h) Checking the system for accumulation of rust and scale

- **Temperature test**

The radiator cooling fan is an important part of the cooling system operation. While a fan is not really needed while a vehicle is traveling down the highway, it is extremely important when driving slowly or stopped with the engine running. In the past, the fan was attached to the engine and was driven by the fan belt. The speed of the fan was directly proportional to the speed of the engine. This type of system sometimes caused excessive noise as the car accelerated through the gears. As the engine sped up, a rushing fan noise could be heard. To quiet things down and place less of a drag in the engine, a viscous fan drive was developed in order to disengage the fan when it was not needed.

Concentration test

After any coolant has been added, run the engine for a few minutes to mix the coolant. Check the coolant concentration. Make sure the engine is off and cool before removing the coolant pressure relief cap (see proceeding [sic] steps on cap removal). Check the concentration per the Checking Engine Coolant section. If the concentration is not 50/50 (protection to -34 F / -36 C), drain some coolant and adjust the concentration. It may take several drains and additions to obtain a 50/50 coolant concentration.

References

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