

Engine Cooling Systems



- During the power stroke, 2200°C or more, is generated by the burning air/fuel mixture.
- This heat needs to be controlled so the engine is not damaged!





Purpose of the Cooling System...

- Both air & liquid type cooling systems have 3 main jobs...

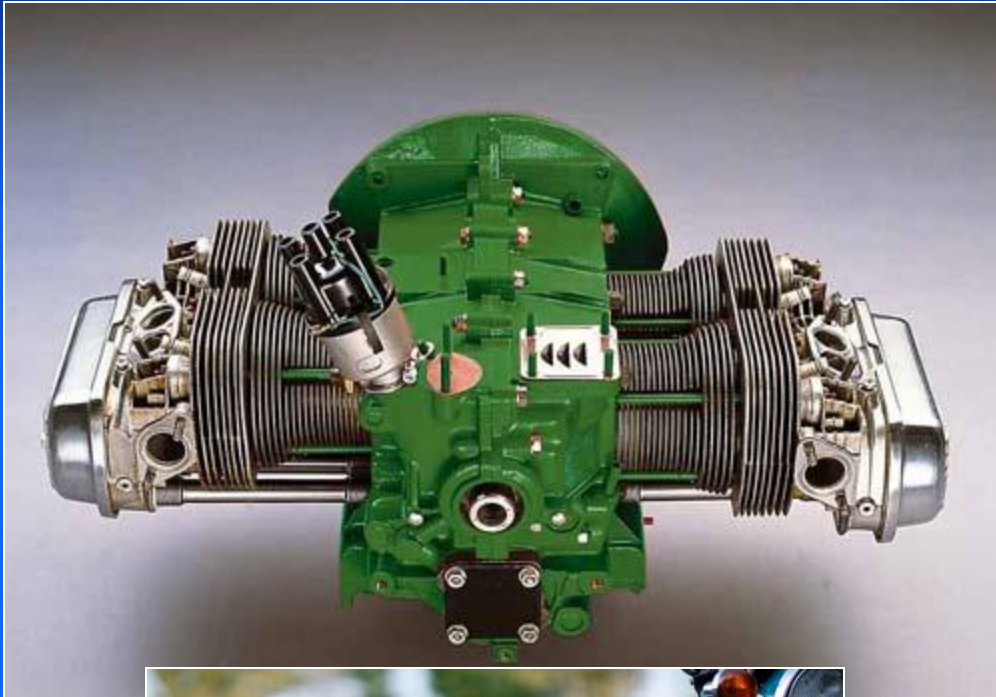
1) remove excess heat from engine parts

2) maintain a consistent operating temperature

3) allow the engine to reach normal operating temperature as quickly as possible

Air Cooling

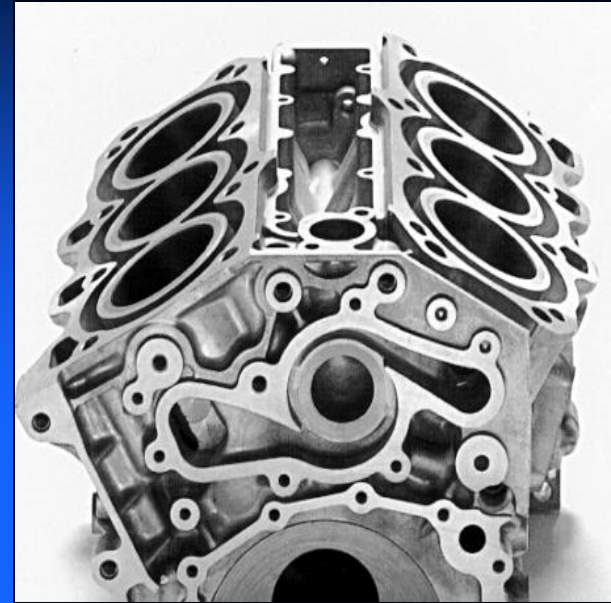
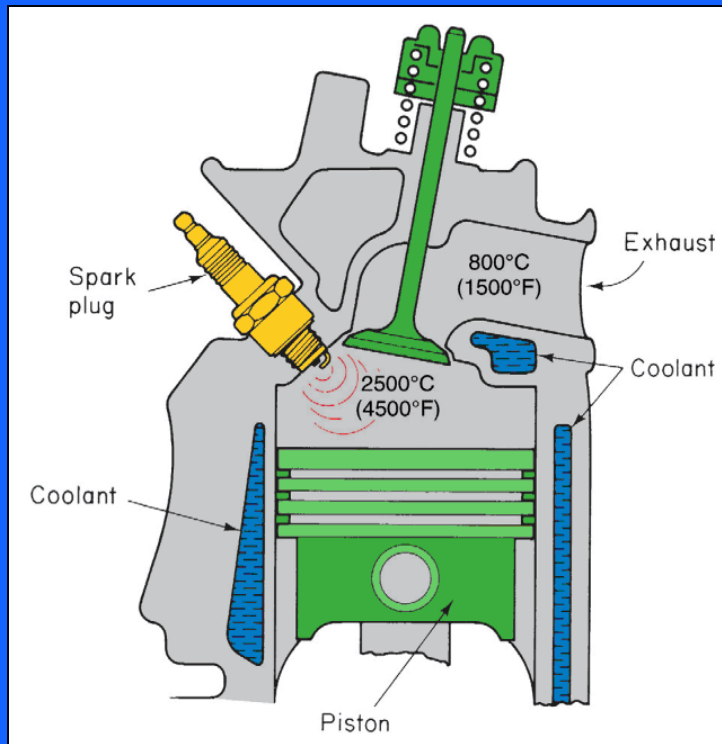
- not used in vehicles any longer

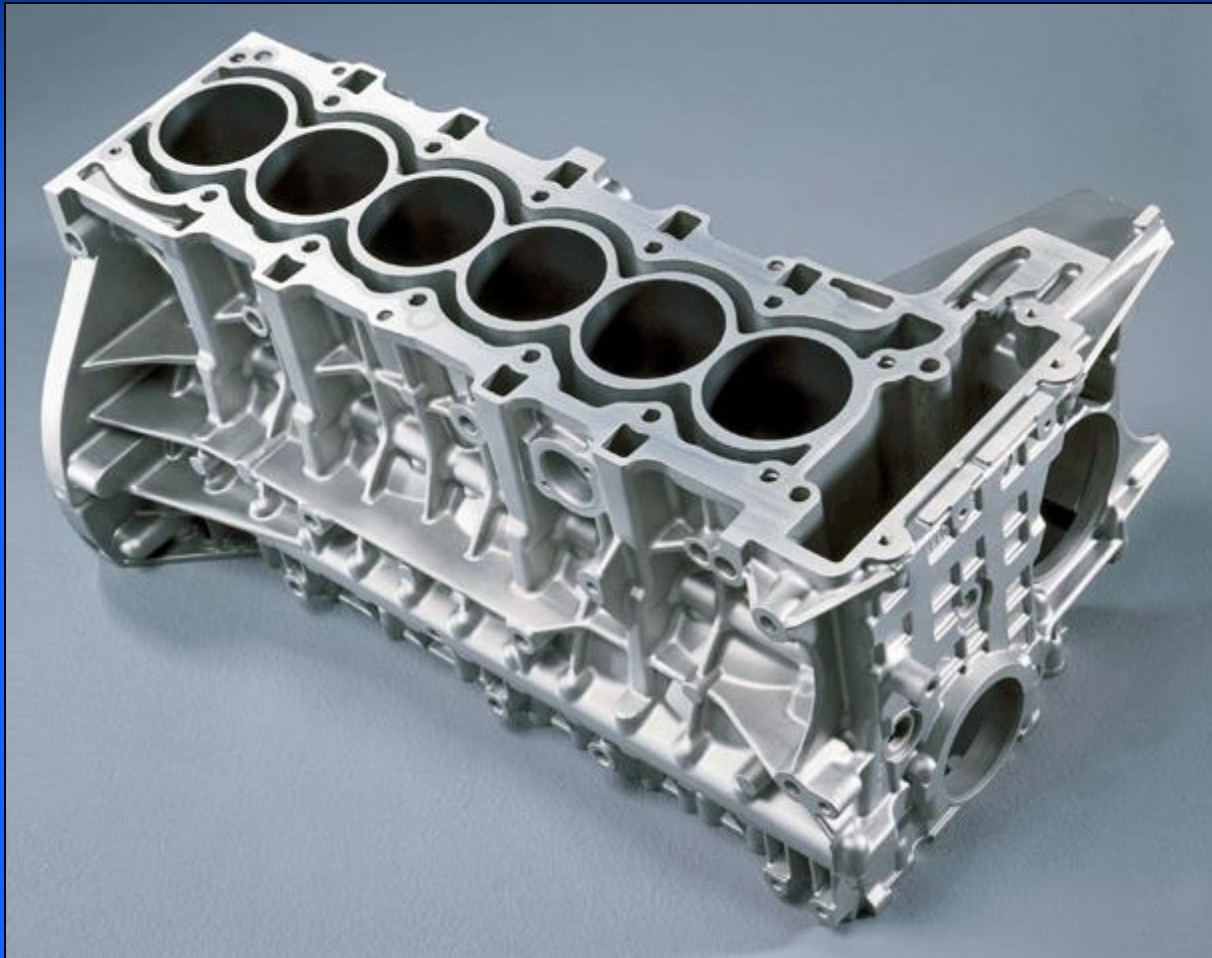




Controlling the Heat

- Hollow passages called **water jackets** surround the cylinders and valve chambers.
- The water jackets are filled with a 50% mixture of water and antifreeze.
- The engine coolant absorbs the excess heat from the cylinders, valves & combustion chamber area.

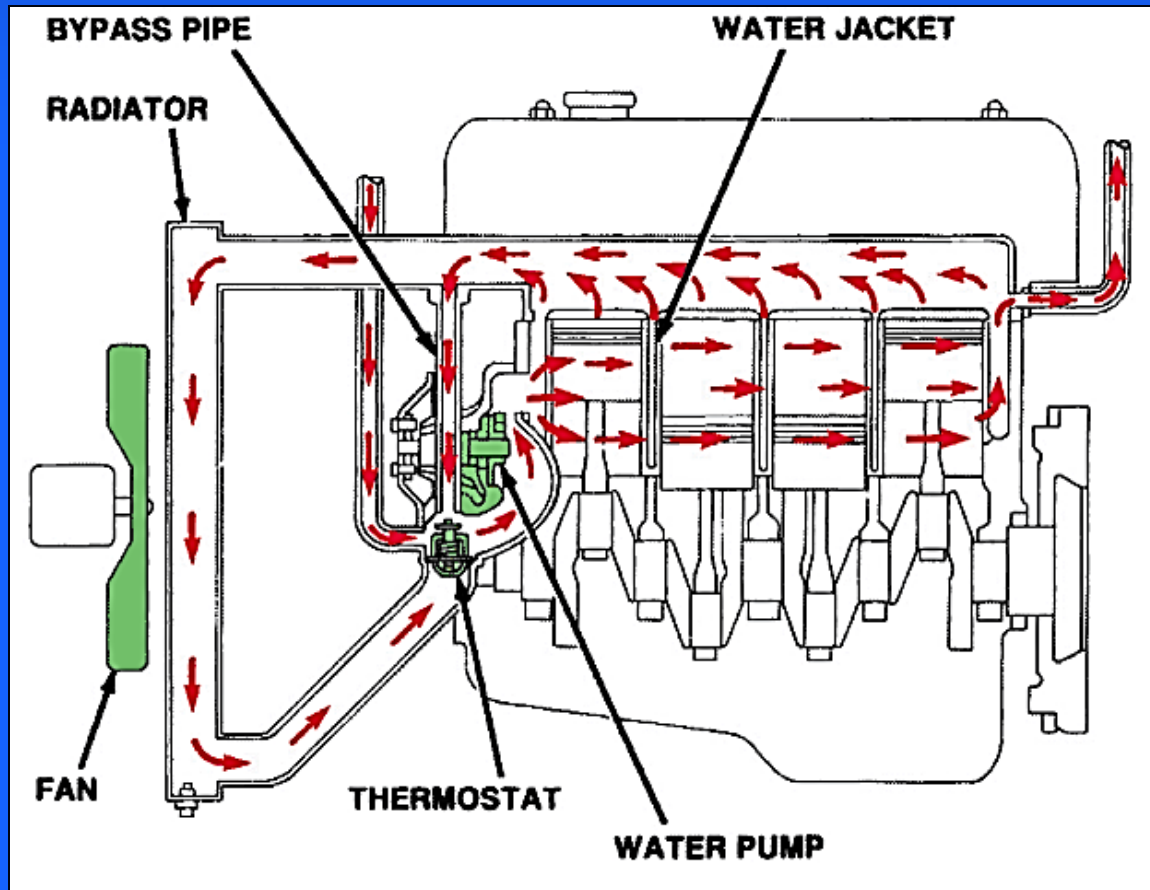






Cooling the Coolant

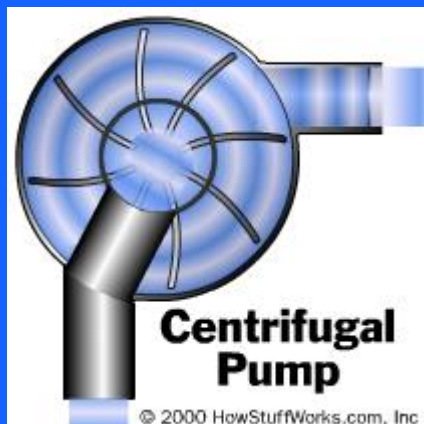
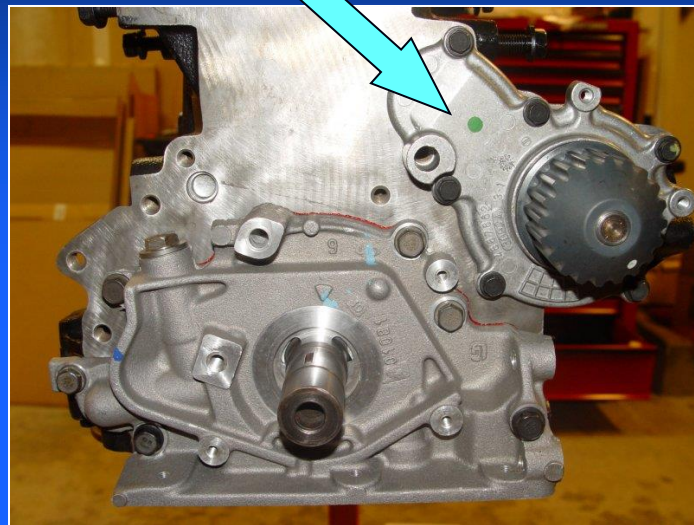
- Once the engine coolant reaches $\approx 100^{\circ}\text{C}$ or more, it must be re-cooled so that it can continue to remove excess heat from the engine.
- The radiator and water pump work together to lower coolant temperature



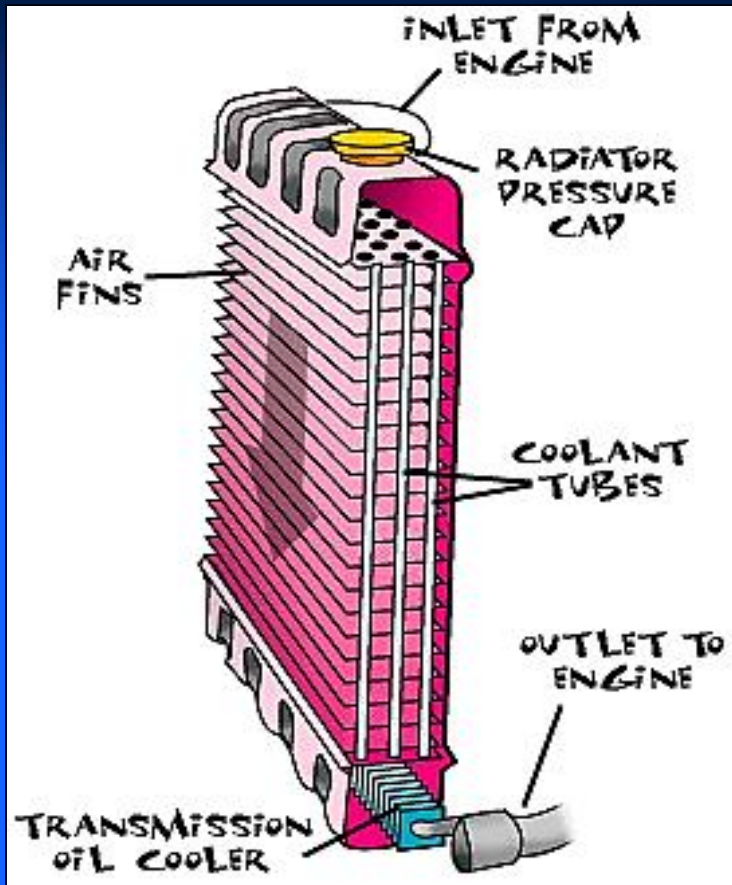


Coolant Circulation

- The **water pump** pushes engine coolant out of the water jackets and into the radiator so that excess heat from the coolant can be removed.



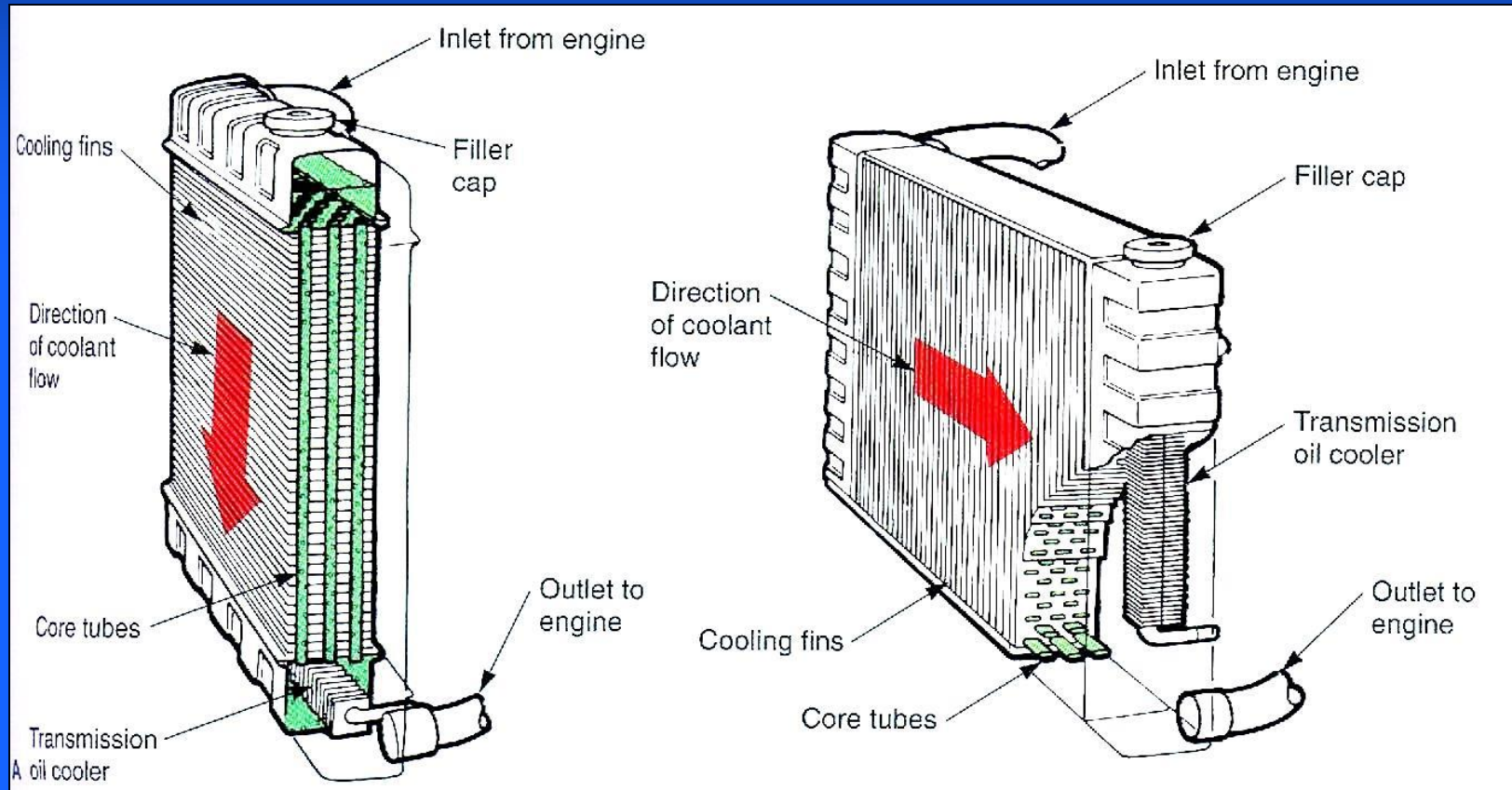
Radiator Operation





Radiator coolant flow designs

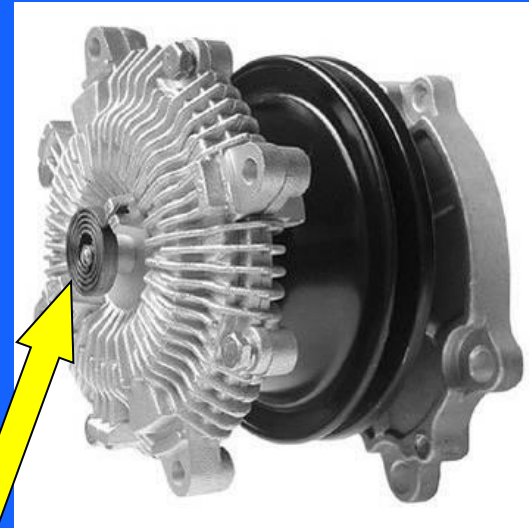
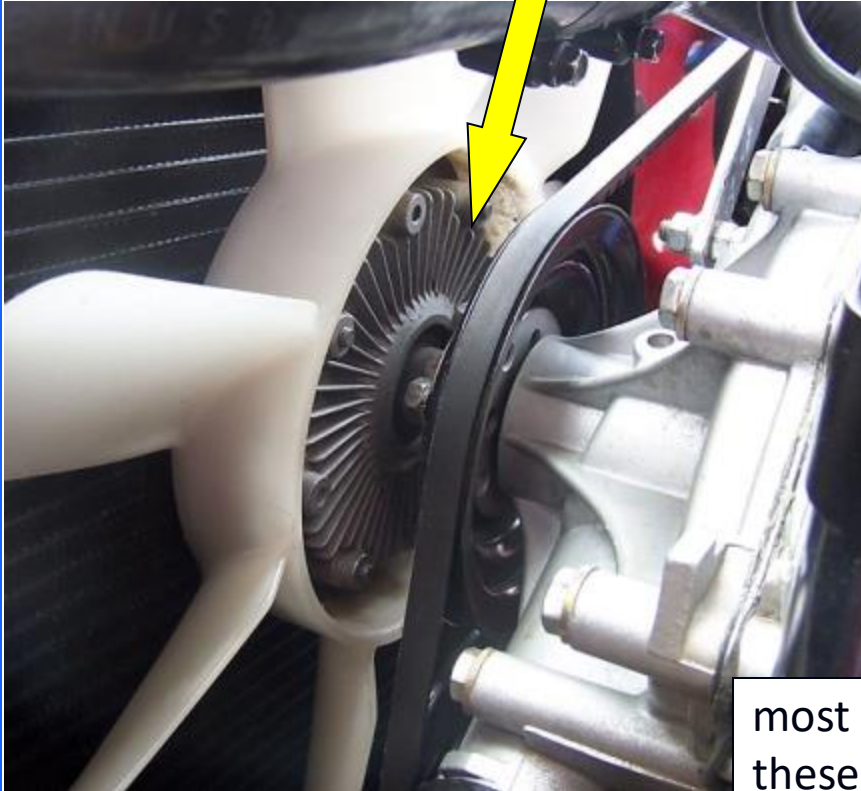
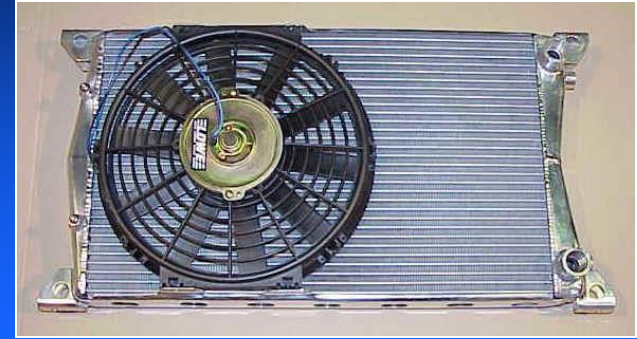
Down-flow & Cross-flow





Air Flow

- Air flow through the radiator at low vehicle speeds, is the job of the radiator fan
- 2 types of fans are belt driven and electric

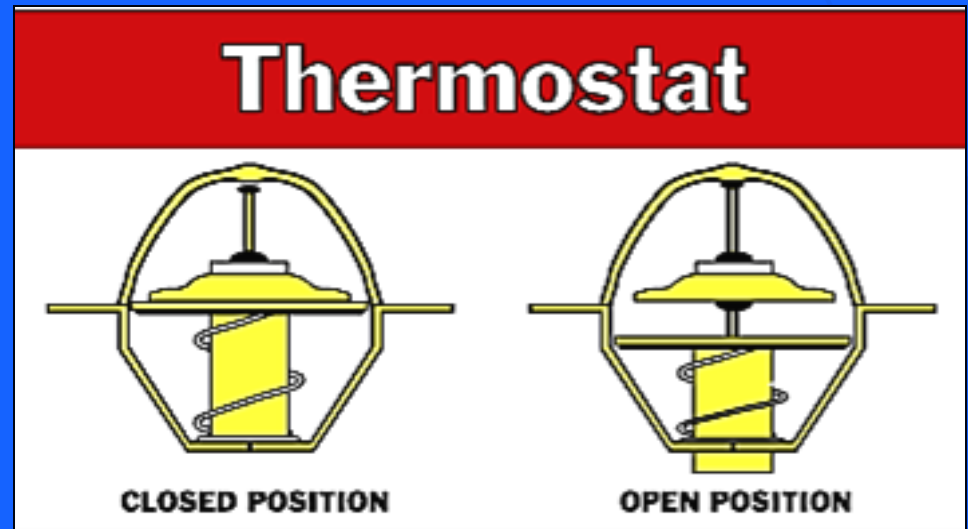


most belt driven fans have thermostatic clutches – these spin the fan only when the air temp thru the rad reaches a predetermined level



Consistent Operating Temperature

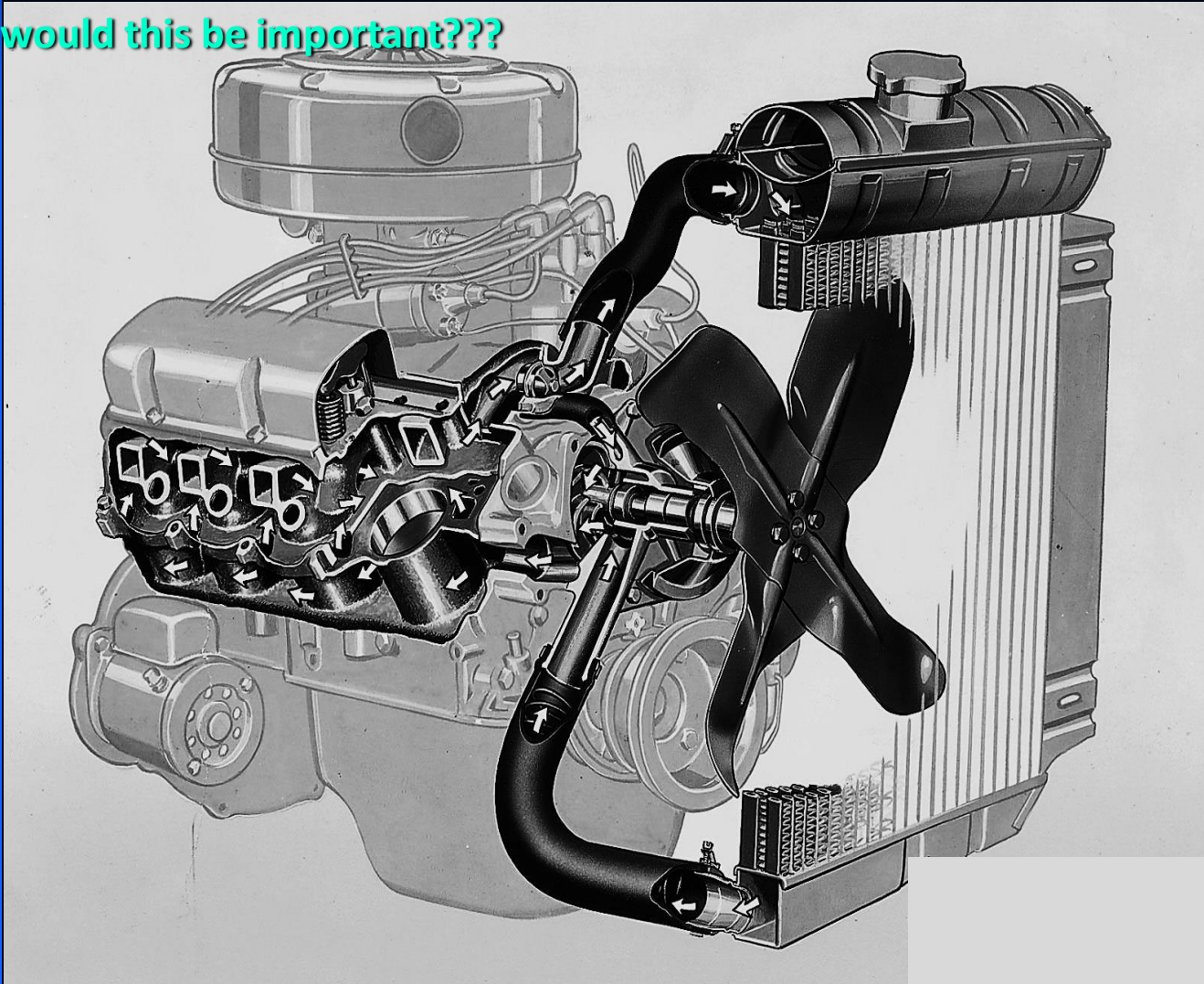
- normal operating temperature of the coolant for most cars and trucks is $\approx 100^{\circ}\text{C}$ or $\approx 210^{\circ}\text{F}$
- to maintain an even operating temperature, a thermostat is used



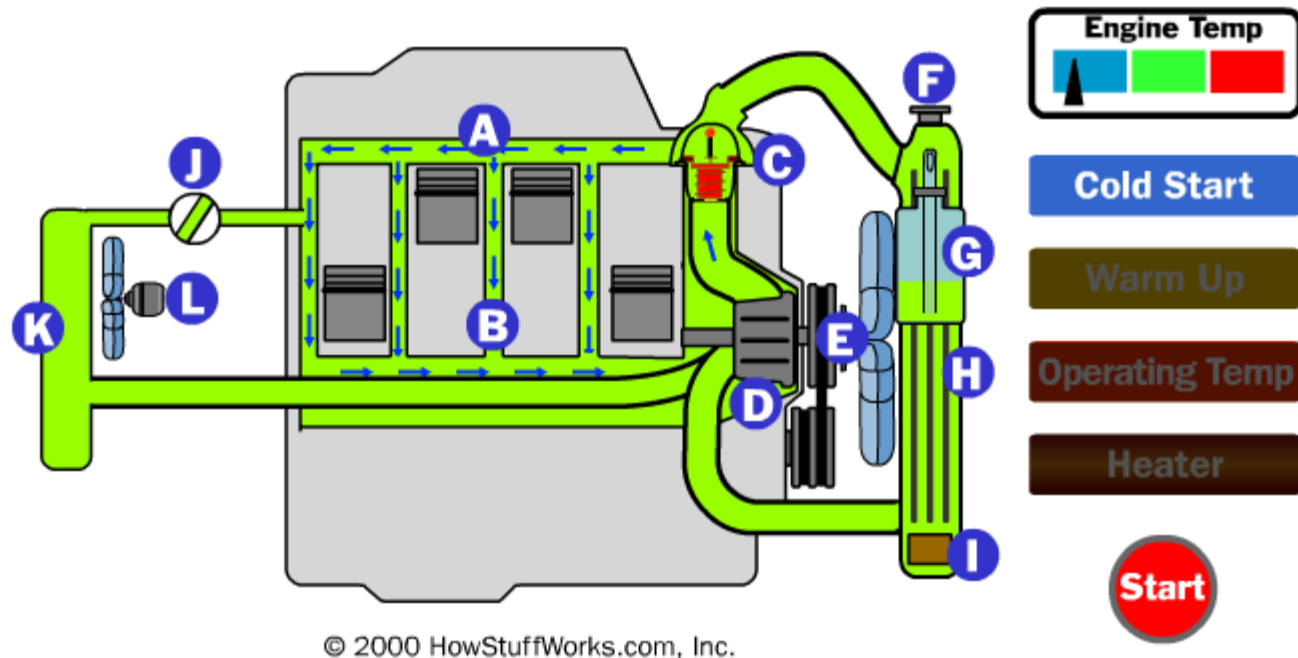


Thermostat Operation

- the thermostat senses coolant temperature and controls the flow of coolant back to the radiator for re-cooling
 - on a cold engine, no coolant is allowed to enter the radiator
 - this allows the engine to reach normal operating temperature as quickly as possible
- ❖ Why would this be important???



Coolant Circulation

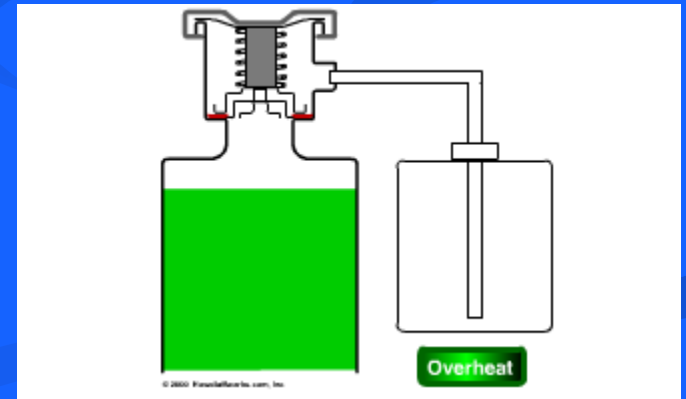
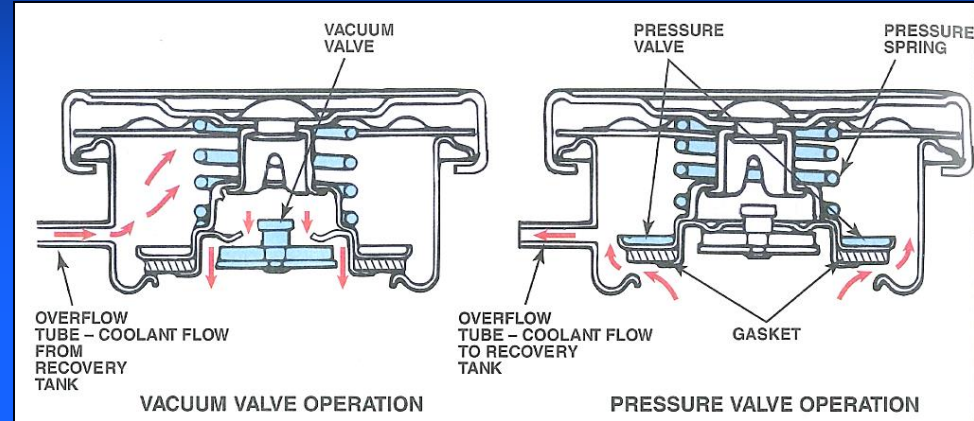


- | | | |
|------------------------|------------------------|------------------------------|
| A Head cooling | E Cooling fan | I Transmission cooler |
| B Block cooling | F Radiator cap | J Heater valve |
| C Thermostat | G Overflow tank | K Heater core |
| D Water pump | H Radiator | L Heater fan |



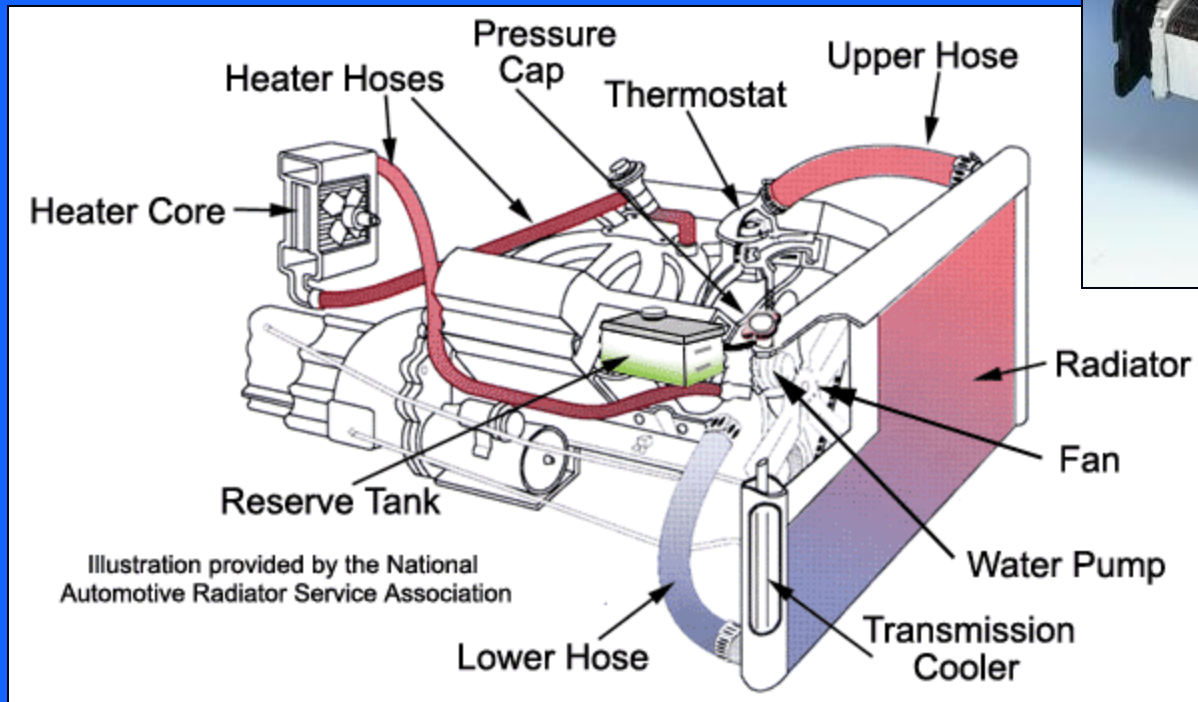
Radiator Cap Operation

- as the coolant **heats up** and expands, a **pressure valve** opens & excess coolant is sent to the expansion bottle
- when the engine is turned off and the coolant begins to **cool**, a **vacuum valve** opens & allows coolant to return back to the radiator
- this is called a closed cooling system



Heating the inside of the car...

- hot engine coolant is sent to the heater core
- the heater fan blows air through the heater core to warm the interior of the car



Cooling System Troubleshooting

- overheating



- overcooling



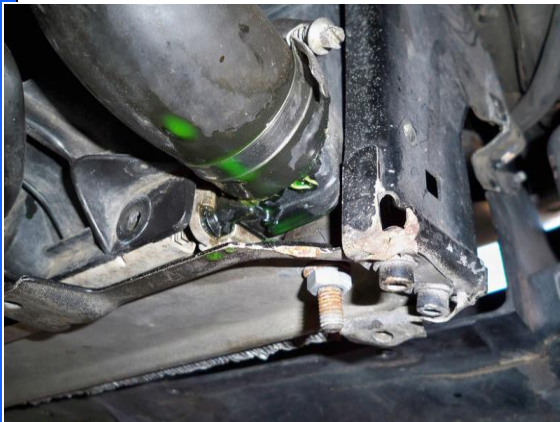
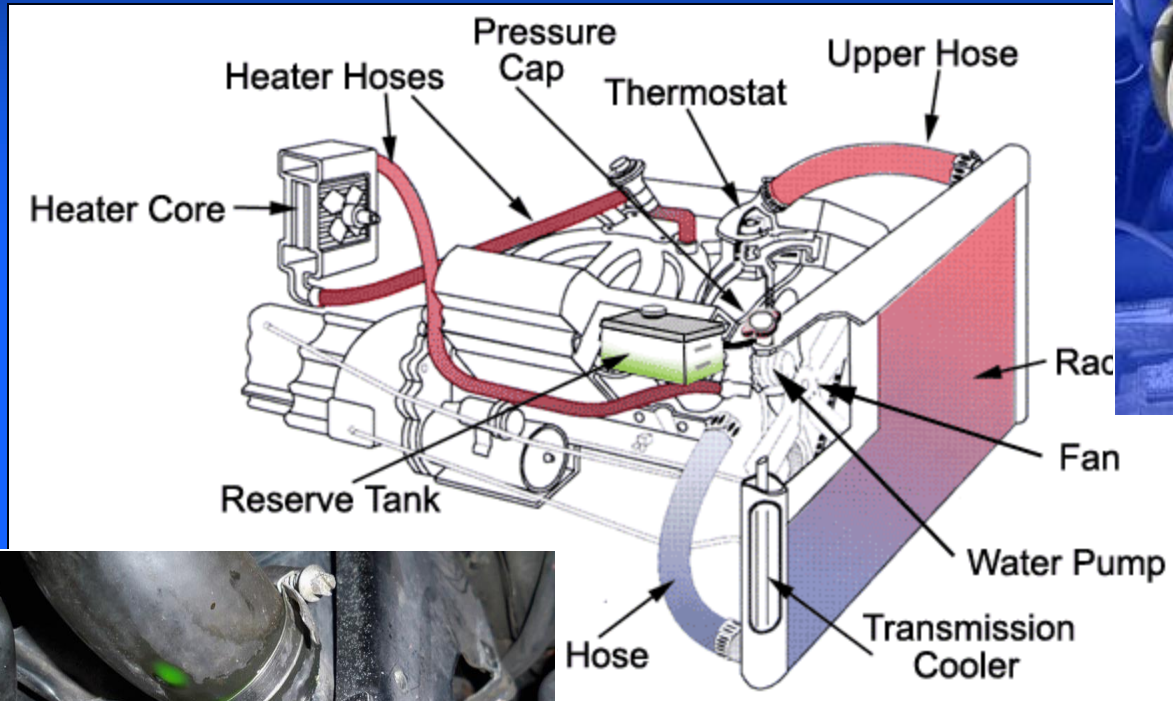
Overheating caused by... leaking radiator

- use a cooling system pressure tester



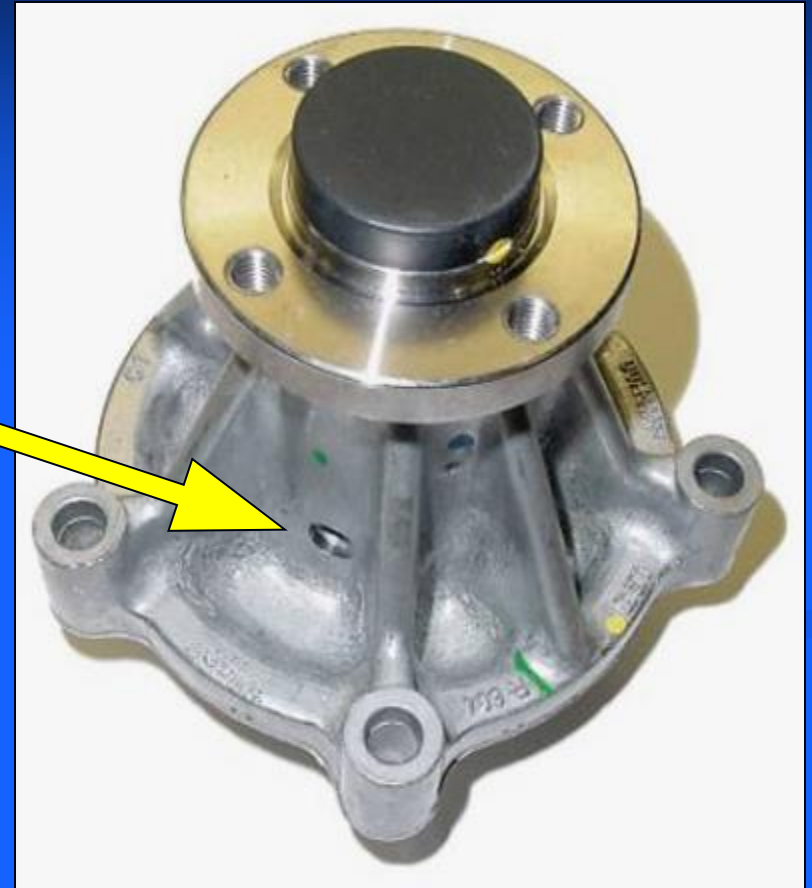
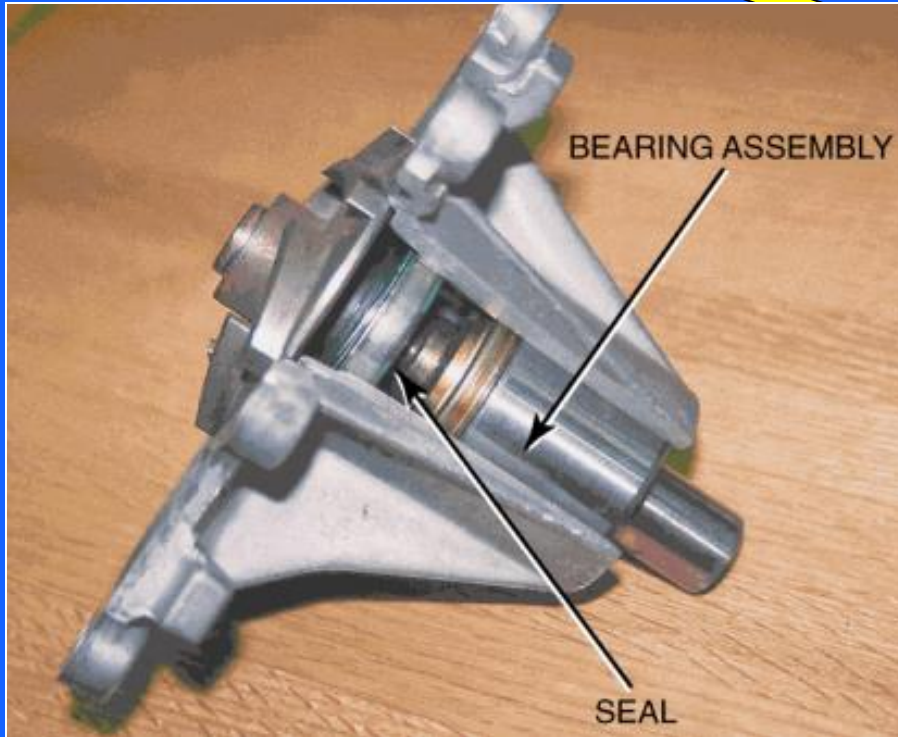
Overheating caused by... leaking radiator hoses

- inspect the hoses for bulges & soft/mushy sections

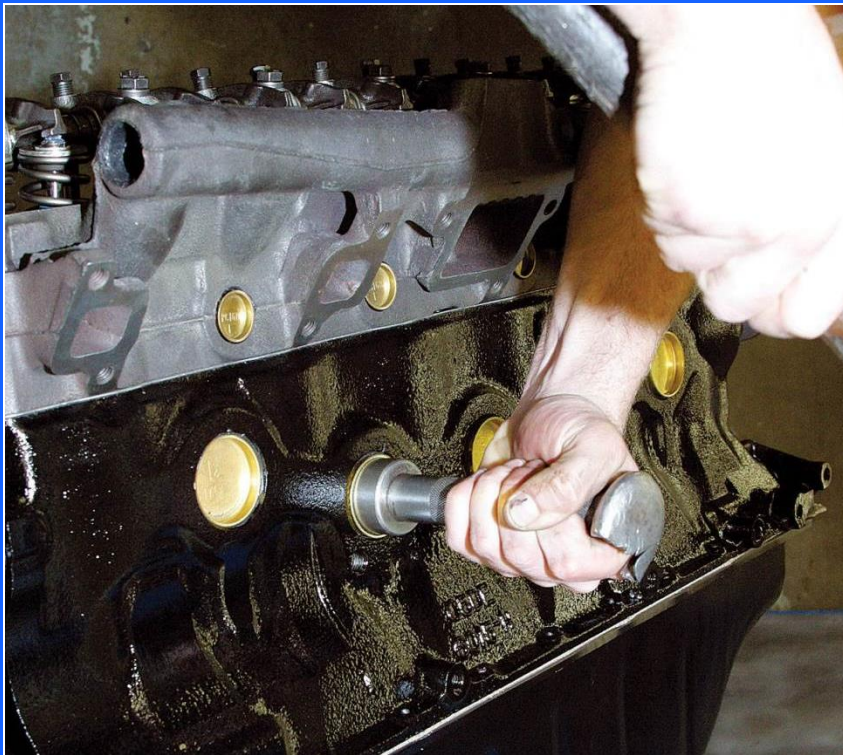


Overheating caused by... leaking water pump

- water pump
 - check bleed hole

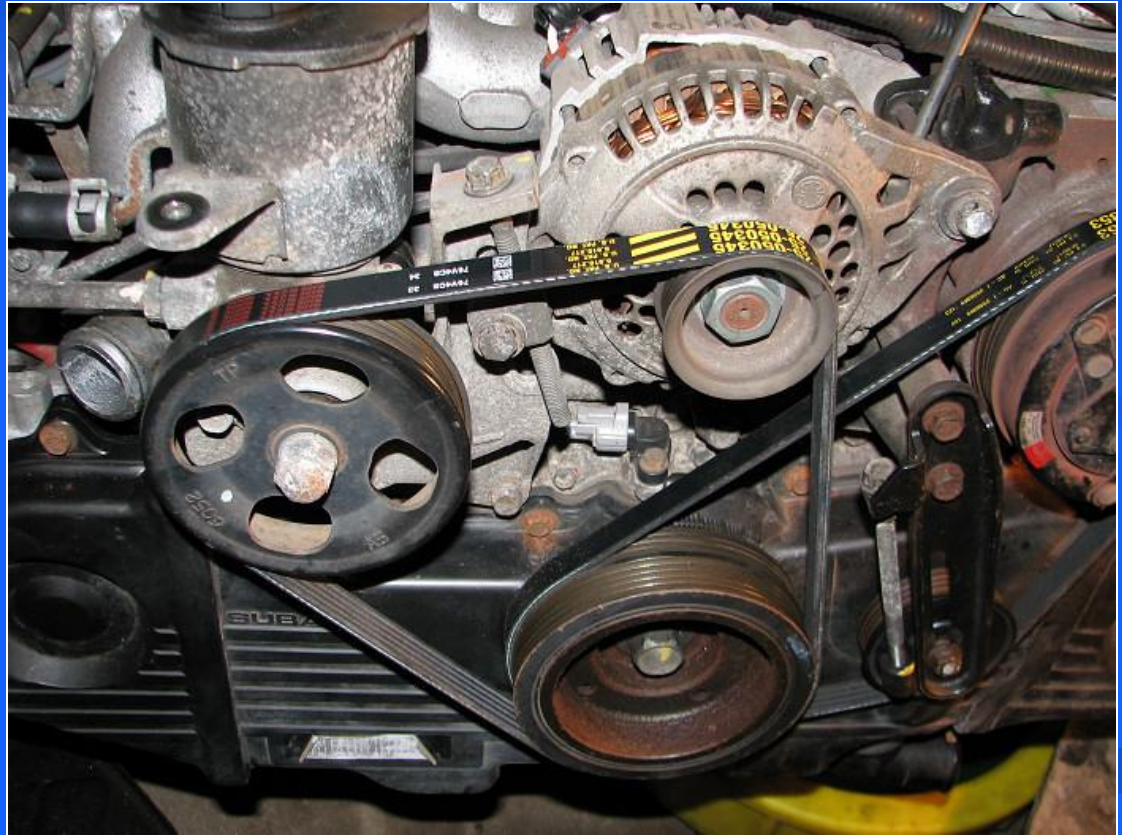


Overheating caused by... leaking frost (core) plugs



Overheating caused by... slipping drive belts

- drive belt(s)
 - check for damage or excessive play





Overheating caused by... a stuck (in the closed position) thermostat

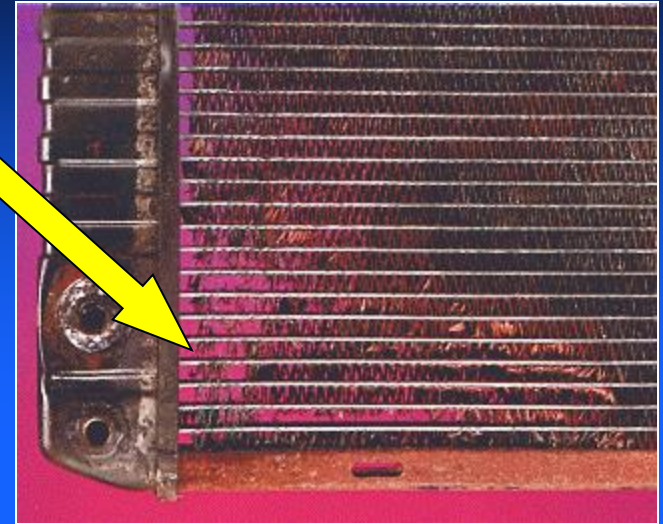
- old thermostat can be tested in a pot of boiling water using a temperature gauge





Overheating caused by... plugged radiator tubes or fins

- check for loose or deteriorated fins
- check for blockage of the tubes





Testing Radiator

- to check the radiator for blockage (restricted flow), run your hand over the core
 - engine off & warmed up
- temperature should be consistent
- cold areas indicate plugged tubes





Overcooling

- Does the temperature read lower than normal?
 - normal coolant operating temperature is $\approx 80^{\circ}\text{C} - 100^{\circ}\text{C}$
- Is the heat coming out of the heater not as hot as it should be?



- Thermostat is stuck in the open position!

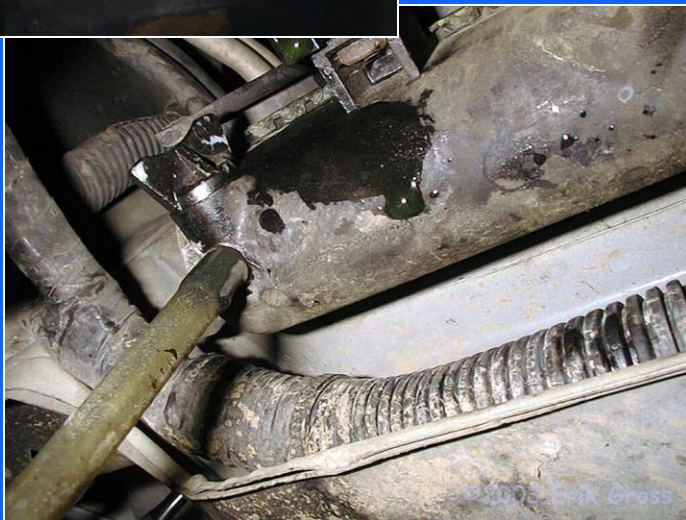
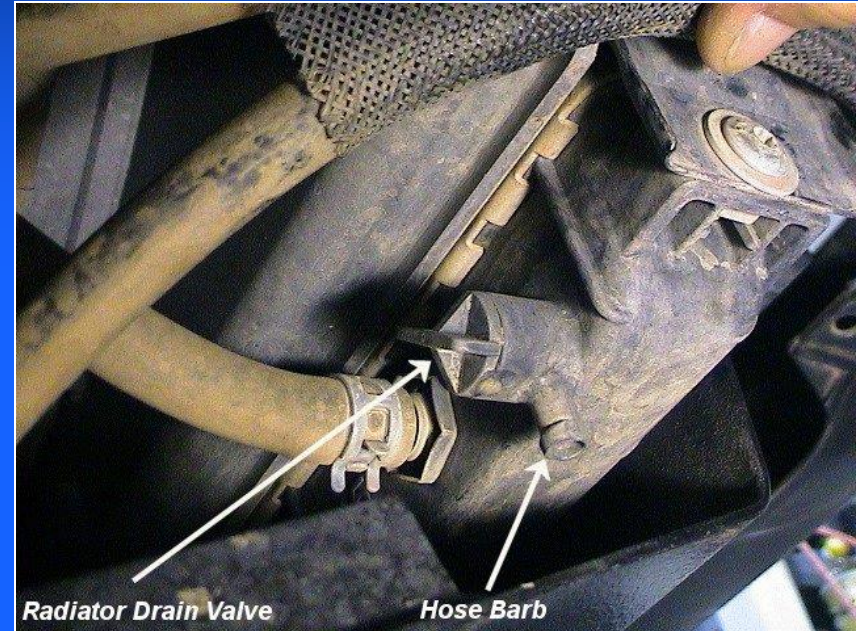
Coolant Service

- The coolant should be tested for freeze point protection with an antifreeze tester.
- The coolant should be bright green, light blue or pink in color and should not be murky/cloudy.
- **Tech Tip:** Some cars use long-life coolant & this type needs to be replaced every 4 to 5 years (or longer).



Replacing Coolant

1. Wait until the engine is cool.
2. Remove the radiator cap.
3. Loosen the radiator drain plug (if equipped) or remove one end of the lower radiator hose.





4. Refill the radiator with a mixture of clean water and new antifreeze at 50% each.

- ensure you are using the correct type of antifreeze for that vehicle

5. Start the engine and keep the radiator cap off until the engine is completely warmed up (at least 10 minutes)

- if the engine has a bleed screw (yellow circles in diagrams) to remove trapped air, loosen it to remove trapped air, then retighten it

6. During this time keep the radiator full & watch the temperature gauge!!!

7. Reinstall the radiator cap & align any markings with the overflow tube.

8. Fill the expansion bottle to the appropriate level as well.

