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Car Cooling System

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Abstract:- A vehicle's cooling system is responsible for maintaining an optimal operating temperature in the engine. System components include the radiator, water pump, thermostat, and ventilation fans. A coolant Recovering Tank is a reservoir that stores extra fluid in the event of an engine overheating. The coolant should be at the "cold" mark when the engine is cold. Adding an expansion tank to a standard radiator only requires a little increase in total coolant volume.

High-quality radiator hoses need to be regularly inspected and maintained. Extreme heat causes the rubber in the hoses to harden and fracture. Core plugs are used to fill the holes created during production. They are spherical pieces of metal sheeting with holes in the center. When the heater core fails, the rest of the cooling system can't function properly.

The gearbox cooler acts similarly to an internal radiator, only it transfers heat to the radiator's coolant rather than the surrounding air. The fan will be installed in the space between the radiator and the motor to ensure optimal cooling airflow for a vehicle's engine. Engine water pumps are susceptible to cavitation, which increases the likelihood that air bubbles may enter the antifreeze. Cavitation is less likely to occur in a well-designed engine cooling system as the coolant temperature decreases.

The thermostat prevents unnecessary engine wear and emissions by facilitating a rapid warm-up. The thermostat's primary function is to allow the engine to reach operating temperature rapidly and maintain that temperature. The opening temperature for most thermostats is 180 degrees Fahrenheit or 82 degrees Celsius. Overheating may result if the airflow is blocked, as in this scenario. The efficiency of a car's engine depends heavily on its cooling system.

I. INTRODUCTION

The engine cooling system is responsible for regulating the temperature of the engine. This is achieved by directing the engine's heat away from the environment via the fins. This mechanism ensures that the engine reaches operating temperature as rapidly as possible and stays there, improving the vehicle's performance (E.I. du Pont de Nemours & Company. Automotive Products Department, 1971). It is crucial to maintain the greatest possible engine temperature at all times and in all situations. The combustion of gasoline in the engine produces heat. To prevent damage to the engine's components, some of the heat must be dissipated. This is one of the functions of the air conditioner. More fuel will be used if the engine is kept at a low temperature, and it will overheat if left in a high-temperature environment for too long.

- *Aim:*

This article aims to provide information on the car cooling system and to highlight the importance of keeping it in good working order.

II. CONTENT

A vehicle's cooling system is responsible for maintaining an optimal operating temperature in the engine. System components include the radiator, water pump, thermostat, and ventilation fans. The radiator is a big metal tank used to store the coolant (water and antifreeze). Coolant is circulated through the engine by the water pump, and the thermostat regulates how much coolant is introduced into the engine. The radiator's temperature may be regulated with the aid of the car's computer, which also regulates the cooling fans (Selection and use of engine coolants and cooling system chemicals, 2019).

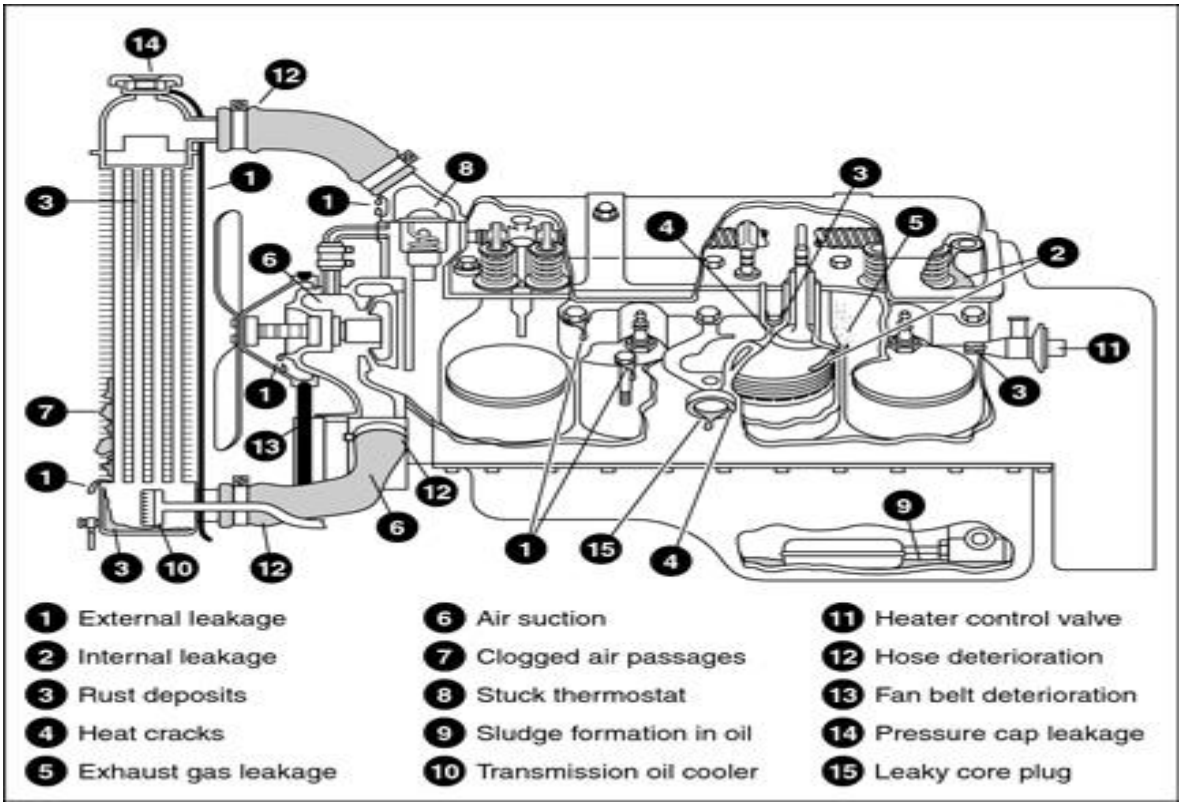

Fig 1 potential malfunction places in car cooling system

➢ *Coolant Recovering Tank*

Often referred to as an "overflow reservoir," the coolant recovery tank is a reservoir that stores extra fluid in the event of a radiator overflow. Tanks may be set up to automatically replenish the radiator whenever the engine cools down so that it is constantly at the optimal temperature. The coolant expands as the engine temperature rises because it, too, is heating up. When the temperature increases, so do the pressure. The radiator's fill hole is kept shut by a spring inside the pressure cap. A pressure of around 15 psi will overcome the tension of the spring and cause the cap to rise. The top of the tube becomes visible as the cover is raised. The coolant is forced through the tube and into the recovery tank under pressure.

The procedure is reversed as soon as the engine cools down. To reverse the usual process of coolant being sucked out of the radiator at high pressure, a vacuum is used instead. This ensures that the engine always has the correct amount of coolant ("Engine cooling system: How it works and main components," 2022). It is possible to inspect the coolant level in the recovery tank with a dipstick. The dipstick works just as well with cold as it does with hot liquids. The coolant should be at the "cold" mark when the engine is cold. You should fill it up to the "hot" line when the engine is running.

The pressure cap on the recovery tank will release any surplus coolant from the system. In the event of an internal pressure build-up in the radiator and recovery tank, the coolant will expand, forcing the cap open. Using a catch basin instead of a sewer is more eco-friendly ("Most common car cooling system problems," 2021). It prevents water from spilling out of the radiator if it is overfilled by a small amount. Adding an expansion tank to a standard radiator only requires a little increase in total coolant volume. If adding this little bit of coolant is all that's needed to cool down a hot engine, then there must be another issue with the cooling system.

➢ *Cooling Fan*

Only when the engine temperature reaches a specified threshold or the cooling system is put under increased strain is the cooling fan activated (as when running your air conditioner). Since leaving the fan on all the time is a waste of energy, it is turned off when it is not in use. Most modern rear-wheel drive cars and newer front-wheel drive vehicles with transversely placed engines rely on electric cooling fans. Electric fans are used in FWD vehicles because they are not dependent on a belt drive and may be installed independently of the engine's location. Electric fans have several advantages over their mechanical counterparts, including increased efficiency, less noise, and finer temperature regulation.

➢ *Hoses*

Properly sized, high-quality radiator hoses should be regularly inspected and maintained. The upper and lower radiator hoses need to be large enough to accommodate the maximum flow of coolant when the thermostat is completely open. Smaller hoses connected to the heater core carry some of the coolants to and from the core. The hoses in such systems must be constructed from materials that can withstand extreme heat and pressure. As part of any cooling system maintenance, you should inspect the hoses for wear and tear. Extreme heat in the engine compartment causes the rubber in the hoses to harden and fracture.

➢ *Core plugs*

Core plugs are used to fill the holes created during production. The plugs are spherical pieces of metal sheeting with holes in the center that are forced into the water jackets on the side of the engine block. These plugs might leak or come loose if the morning cooling system freezes up or is not properly maintained. The core plugs are designed to dislodge in the event of a frozen block.

At first, it was believed that these plugs served to release pressure on the block, so preventing it from splitting. For this reason, they are sometimes commonly referred to as "frozen plugs," although this is technically inaccurate.

➢ *Heater core*

Since the heater core is more commonly associated with the heating system, you might be surprised to learn that it is also a part of the cooling system. However, the heater core can only communicate with the cooling system through the heating hoses. When the heater core fails, the rest of the cooling system can't function properly. The heater's core serves as a heat exchanger and is constructed in a manner analogous to that of a radiator.

It is housed in a housing unit that can be located on the engine cover or in the trunk. The fins of the heater core can absorb heat from the circulating heated coolant because of their unique design. Simultaneously, the air is blasted over the core's heated fins by a blower motor. Air is forced over the fins, where it absorbs heat, and the resulting warmth is distributed throughout the cabin.

➢ *Radiator*

A radiator is a heat exchanger. Its purpose is to transfer heat from the hot coolant that runs through it to the air that is blown through it by a fan. Aluminum radiators are standard in current automobiles. These radiators are made by brazing thin strips of aluminum into flattened tubes of metal. To transport the coolant from the intake to the outlet, a series of parallel tubes must be built up. The fins in a radiator transfer the heat from the tubes to the air passing over them.

A turbulator is a fin that may be installed in the tubes to increase the amount of airflow. The result is a more agitated flow of fluid through the conduits. Only the fluid immediately touching the tubes would be cooled if the fluid passed through the tubes at an extremely low resistance. The rate of heat transfer from the fluid in the tubes to the tubes is proportional to the temperature difference between the tube and the fluid. Therefore, if the fluid touching the tube cools down rapidly, heat transmission will be reduced. The turbulence created within the tube ensures that all of the fluid is thoroughly combined. The fluid in contact with the tubes remains at a high temperature, allowing for more efficient heat removal and full use of the fluid within the tubes.

A transmission cooler is housed in the tank on either side of the radiator, which is standard. You can see the entry and exit points for the transmission oil cooler in the image above. The gearbox cooler acts similarly to an internal radiator, only it transfers heat to the radiator's coolant rather than the surrounding air.

➢ *Radiator fan*

By forcing air into the radiator's tubes, the fan helps to reduce the temperature of the hot coolant that runs through it. There are often four or more blades on the fan, and their rapid rotation cools the engine. The fan will be installed in the space between the radiator and the motor to ensure optimal cooling airflow. Vehicles with an additional fan in front of the radiator may draw even more chilly air into the motor. Whenever the vehicle's speed is low enough that the engine isn't being adequately cooled by the flow of cold air via the radiator, this feature comes in handy.

III. PRESSURE CAP

The pressure cap, or radiator cap, increases the boiling point of your coolant by around 25 degrees Celsius. The cap has a pressure release valve that is typically set at 15 psi. Under pressure, the boiling point of the coolant will increase. Because of the engine's continued operation, the temperature and pressure in the cooling system will rise. Only the pressure cap allows the pressure to escape. As a result, the position of the cap's spring determines the system's maximum operating pressure.

When the pressure reaches 15 psi, the valve opens, releasing the coolant. From the overflow tube, the coolant drops to the base of the overflow tank. Air can't enter the system with this configuration. When the radiator cools, a vacuum is created, which triggers a spring-loaded valve to open and draw water from the overflow tank's bottom into the radiator to replace the water that was previously pushed out.

➢ *Water pump*

The sole purpose of the water pump is to circulate the coolant in the engine's cooling system. This implies that the coolant enters the system at the lowest pressure point and exits at the highest pressure point. When the water engines are running, the pressure decreases dramatically at the pump's input and exit. This pressure change is proportional to the angular velocity. The water pump uses centrifugal force to circulate the cooling liquid. It has a spherical chamber with curved inlets and outputs and an impeller in the style of a fan. This space is known as a "scroll" because of the sloping walls. The centrifugal design causes the engine to rev higher when the coolant temperature rises.

Engine water pumps are susceptible to cavitation, which increases the likelihood that air bubbles may enter the antifreeze and reduce the performance, reliability, and longevity of the engine. To cavitate means to create bubbles or holes in the fluid being pushed. These flaws manifest on the suction side of the pump, the low-pressure side. Cavitation is less likely to occur in a well-designed engine cooling system as the coolant temperature decreases. The cooling system fails, however, once the cavitation temperature is achieved and the water pumps lose pressure.

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IV. THERMOSTAT

Between the engine and the radiator in each vehicle with a liquid-cooled engine is a little component called the thermostat. The thermostat on a typical automobile is roughly 2 inches (5 cm) in diameter. When the engine is cold, it prevents the coolant from flowing to the radiator. No coolant is sent through the engine when it is cold. When the engine achieves its optimal working temperature—typically approximately 200 degrees Fahrenheit—the thermostat opens (95 degrees C) (Kershaw, 2019). The thermostat prevents unnecessary engine wear, deposits, and emissions by facilitating a rapid warm-up. The valve magically opens approximately an inch as it heats up. If you want to give it a go yourself, you can pick one up for a few bucks at any auto parts store. The thermostat's tiny cylinder on the side that faces the engine is the most important part of the device. There is wax in this cylinder, and it might melt if the temperature gets above 180 degrees Fahrenheit. The opening temperature for most thermostats is 180 degrees Fahrenheit or 82 degrees Celsius.

The thermostat's primary function is to allow the engine to reach operating temperature rapidly and maintain that temperature. Water pressure in the radiator is adjusted to adjust this. When the water jackets begin to warm, the coolant in the cooling system goes to work. Hot coolant flows out of the engine and into the radiator or a bypass tunnel due to a pressure differential in the coolant circuit. The thermostat begins to open when the coolant hits 80 degrees Celsius. To allow fluid to flow through the radiator, various thermostats must be set to open at specific temperatures.

V. COOLANT

The coolant used in the cooling system is made by combining antifreeze and water. The most widely used de-icer is ethylene glycol. This liquid will be circulated through it by the cooling system. Through the radiator hose, it will transfer excess heat from the engine to the cooling system. Since water freezes at temperatures below 0 °C, it cannot be used as liquid cooling ("How car cooling systems work," 2000). Overheating may result if the airflow is blocked, as in this scenario. When the water freezes, it expands by 9 percent, cracking the radiator and shattering the cylinder block and head. A more adaptable cooling system regulation can reduce fuel consumption in spark ignition (SI) engines.

The temperature of the coolant and the temperature of the air coming into the engine are two of the essential aspects in minimizing pollution and ensuring a trouble-free engine operation, as has been learned through studies on cold starts. For the cold start tests, coolant temperatures of 15 and 80 degrees Celsius were used. The piston surface temperature increased to 110 degrees Celsius and then to 150 degrees Celsius when the engine started operating. The increase in coolant temperature resulted in a 25% decrease in HC emissions and a 7% increase in NOx emissions ("Engine cooling system: How it works and main components," 2022). It appears to demonstrate, via the temperature of the cylinder walls, that there is a connection between the coolant temperature and the emissions.

To enhance fuel economy, modifications to the engine cooling system generally reduce frictional losses in the engine when the oil temperature rises. This is achieved by gradually increasing the coolant temperature, which in turn increases the engine's working temperature. When the temperature of an engine is raised, both hydrocarbon (HC) and carbon monoxide (CO) emissions decrease. A higher cylinder block temperature is said to reduce friction between the piston and ring pack, leading to improved fuel efficiency. The quantity of nitrogen oxide (NOx) produced in the combustion chamber, however, can be extremely temperature-sensitive, especially at higher working temperatures ("Automobile - Cooling system," 2020).

Fig 2 A picture of car cooling system (top view)

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VI. CONCLUSION

The efficiency of a car's engine depends heavily on its cooling system. It aids in maintaining an optimal engine temperature and preventing the engine from overheating. The cooling system consists of the radiator, the water pump, the thermostat, and the fans. Maintaining a healthy cooling system requires routine checks for low coolant levels. The radiator is a large metal box where the coolant is stored. The coolant consists of water and antifreeze. The engine's temperature is regulated by a thermostat, and the water pump circulates coolant throughout the engine. Most automobiles feature a button on the dashboard that operates the cooling fans, which assist in cooling the radiator.

The engine might overheat if the cooling system isn't functioning properly. This might cause serious damage to the engine and potentially cause the vehicle to break down. It is crucial to routinely check the coolant level to prevent any malfunctions in the cooling system. The radiator cap should be removed, and the coolant level should be checked when the engine is cold. It is recommended that the coolant level in the radiator falls somewhere between the "full" and "low" indicators. If the coolant level is low, fill it up to the "full" line. The hoses and clamps that hold the cooling system together should be inspected often. Leaks should be looked for, and damaged ones fixed or replaced.

RECOMMENDATION

It is recommended that the coolant level in a vehicle be checked regularly and maintained at the correct level. Additionally, the coolant in the system should be cleaned and replaced every two years. This ensures that the engine will be adequately cooled by the coolant and prevents rust and corrosion from forming in the system.

When inspecting the cooling system, make sure the coolant level is at an appropriate level. Correct coolant levels are essential. Both too little and too much would be undesirable. The engine might overheat if the coolant level is too low. An overheated engine can be severely damaged. The coolant should be inspected to ensure it is in good working order. A clean, debris-free coolant is essential. Overheating might result from contaminated coolant because of a clogged radiator.

Using a compatible coolant is crucial for cleansing the cooling system. The vehicle may be damaged if improper coolant is used. Furthermore, be sure you use the correct amount of coolant by reading the label carefully.

The cooling system must be refilled with fresh coolant after being flushed. You want to make sure the coolant level isn't too low or too high. The engine might overheat if the coolant level is too low. An overheated engine might be severely damaged.

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