ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 9 , September 2021

Study on Car Antifreeze and Coolant: Main Problems, Maintaining, Repairing and Diagnosing Services

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ABSTRACT: In this article, we explained diagnosing, maintaining and repairing the cooling system problems. The cooling system is quite dependable. However, they do require periodic maintenance. Cooling system service is one of the best values for the customer in terms of preventive maintenance.

KEYWORDS: Cooling system, radiator, diagnosing, corrosion, cavitation.

I.INTRODUCTION

The engine is designed to run at a predetermined temperature. There are several possible causes of incorrect engine temperature, including leaks, over-heating and over-cooling. If an engine does not get warm enough, emissions rise, fuel economy suffers, the heater does not work and the engine can suffer excessive wear [1,2,3]. Overheating will cause serious damage to an engine. But also, there are some other serious issues related to the cooling system which is occurred usually not choosing proper liquid (antifreeze/coolant) for the cooling system or corrosion problems in the radiator.

II. MATERIALS AND METHODS

Industry experts estimate that about 40% of engine downtime is caused by cooling system problems. Comprehending and understanding the common problems and implementing proven preventative maintenance practices allows fleet managers to significantly reduce their operating costs. Cooling system engineers have specific terms that they use to discuss cooling systems, their components, and system maintenance. The four major problems relating to cooling systems are:

- Corrosion
- Cavitation-erosion
- Scaledeposits
- Green-gooordrop-out

In this article, we are going to discuss these problems in detail. However, we inform that the fourth, Green-goo or drop-out, has nearly been eradicated by the introduction of low-silicate, phosphate-free fully-formulated antifreeze. Silicate and phosphate, while valuable as corrosion inhibitors in engine coolant, have limited solubility. That meant that if the antifreeze or additives got too concentrated in the coolant, then the excess phosphate and/or silicate would “dropout” of the coolant. These “drop-out” problems caused premature water pump failures, radiator blockages, and heater core problems and were a headache to clean up.

One of the most common and costly results of improper cooling system maintenance is the perforation of wet-sleeve cylinder liners [4,5]. The perforation is caused by repetitive pitting of the liner resulting from liner vibration. As the fuel inside ignites, the liner vibrates within the block. The outside wall of the liner moves away from the coolant causing a near-vacuum for an instant. This low-pressure causes the surrounding coolant to boil, forming tiny bubbles. The liner then returns to its position with extremely high velocity, pressing against the bubbles with a violent force. The bubbles implode (collapse) against the liner wall surface at pressures up to 60,000 PSI. The collapse of these bubbles blasts small holes in the steel liner. This pitting process will repeat, digging tiny tunnels through the liner. Eventually, the liner wall will be perforated all the way through, allowing coolant to enter the combustion side of the cylinder [6,7,8].“Fully formulated” coolant contains nitrite. The nitrite will form a thin protective oxide film on the coolant side

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of the liner wall. This oxide film, which is formed by the reaction of the nitrite with the liner wall, acts as a protective barrier to prevent corrosion and cavitation from occurring.

In a properly protected system, the imploding bubbles attack the protective film. The film quickly heals over the liner by drawing nitrite from the coolant. In an improperly protected system, the bare metal surface area is immediately exposed to cavitation forming a corroded pit in the metal.

If coolant enters the combustion side of the cylinder, and expensive in-frame overhaul is required. Liquid coolant doesn't compress; when a piston fires with coolant in the combustion chamber, it can be blocked by the coolant, preventing it from making an entire stroke. This usually results in a bent rod and can cause a cracked block. Secondly, coolant can leak down into the engine oil. This results in overheating of lubricated moving parts and can destroy an engine.

Coolant One major factor in the corrosion rate of the metals is the coolant's pH. Shifts in coolant pH will affect the metals that corrode and the rate of each metal's corrosion. The pH scale runs from 0 to 14. A coolant becomes more acidic closer to zero; and more alkaline toward 14. Coolant pH should always be maintained between 8.5 and 11. If a coolant's pH drops below 8.5, it will become aggressive to ferrous metals (cast iron and steel), aluminium, copper and brass. If it increases above 11, it will become aggressive to aluminium and solder in a cooling system. Maintaining optimum pH in a coolant is a critical function of a quality coolant additive (SCA). It is important to use a coolant additive package containing a pH buffer to insure the optimum pH range of the coolant [9,10].

- Most cooling system water contains calcium and/or magnesium from drinking water supplies. Water that contains over 100 ppm of these minerals is considered "hard water". It is wonderful to drink, but these minerals can form scale in engine cooling systems. As the concentration of these minerals increases, so does the probability that you will have cooling system scale problems. The level of dissolved solids in coolant water is generally referred to as the "total hardness" reported in parts per million (ppm). Cooling system additives that contain anti-scale chemicals can allow the use of moderately hard water. It is best to use water that is at least as good as the recommended water quality listed in the ASTM standards.
- The potential for scale formation on hot metal cooling system surfaces is affected by several dynamic conditions. Some of the mechanisms and parameters that affect the formation of these deposits:
- Water hardness – the harder the water being used in an engine coolant, the greater the amount of scale formation.
- Temperature – as coolant temperatures increase, hardness salts (calcium and magnesium) in solution become less soluble and increase their propensity to plate out on hot metal cooling system surfaces Flow characteristics – scale generally forms on the hot side of a cooling system and in areas of low or turbulent flow. Entrapped air – any air bubble formation in a coolant area (bubbling around a hot source) increases the tendency for scale to form in that area. pH – increases in pH will increase the potential for scale deposits. Damage to water pumps seals.
- Calcium and magnesium have the tendency to combine with the phosphates found in old-fashioned antifreeze and some additive packages. They form calcium and magnesium phosphate scale on heat transfer surfaces, especially on water pump seal faces. These deposits can destroy the flatness of a seal face, preventing the water pump seal from sealing. The result can be the destruction of the water pump bearings [5,6].
- Cooling system problems that result from overheating caused by scale:
- Cracked heads and warped engine blocks.
- Oil temperature running abnormally high.
- Failure of the cooling system fan to turn on.
- Scale deposits on cooling system block heaters

III. ISSUES AND COMMENTS

Comment: In these given fig. 1 tells us about damaged automobile radiator due to overheating. Cooling system liquid antifreeze was reached nuclear boiling point and as a result, seriously damaged automobiles radiator.

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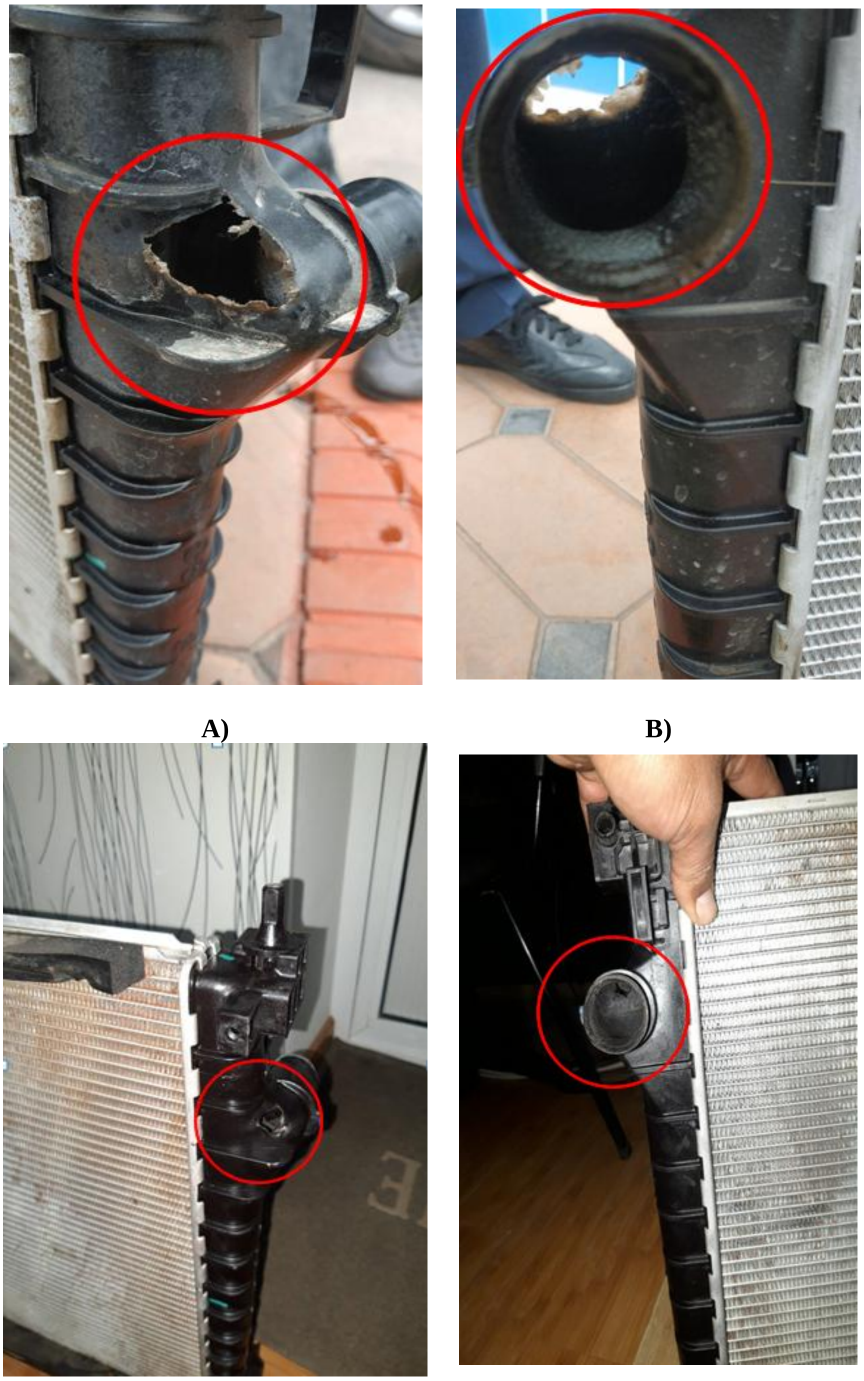

A) B) C) D)

Figure 1. Defects in cooling system equipment, below we can see damaged radiator.

P.S: in this cooling system, hot liquid flows from engines to the right side of the radiator and the cooling system pump circles liquid to the left side of the radiator (Fig.2).

ISSN: 2350-0328

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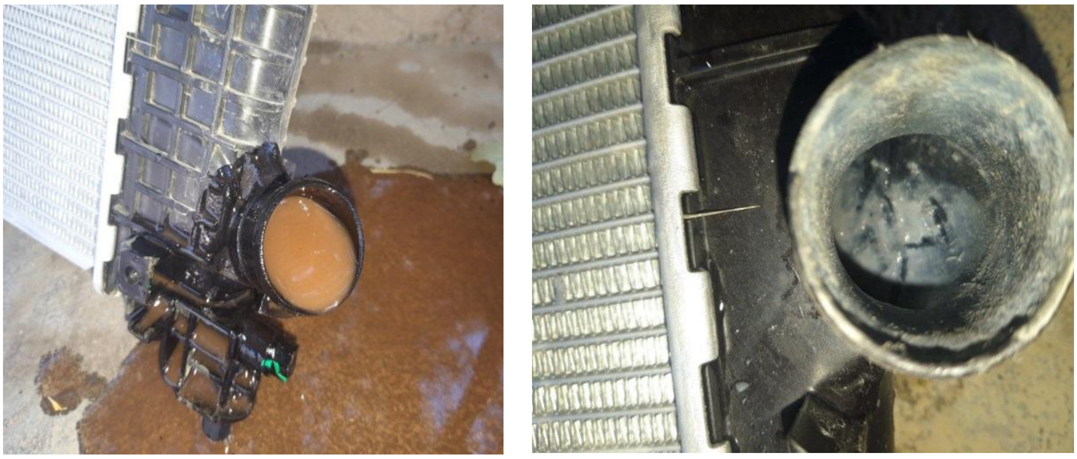

Figure 2.Cooling system

Comment: On the above, you can see overheated antifreeze, its chemical content changed and lost its followability. It comes from the cooling system could not properly work and engine and radiator equipment destroyed liquid. The main reason for this issue is that thermostat could not identify hotness and lets liquid flow to the engine in a hot manner.
P.S: According to our research such kinds of situations happened in our country six times in different cities. And it happened 6 times with Nexia 3, 3 times with Gentra, but we have to take it into consideration that it only happened with brand new cars with a total mileage of around 3,000 km.
Comment: As we explained before liquid in the cooling system lost its flowness and stopped in some more cooling system working mechanics (Fig.3).

Figure 3.

IV.CONCLUSION AND FUTURE WORK

This report covered the main cooling system problems and now some recommendations to use proper coolant for a cooling system. Remember to follow the manufacturer's specifications when you replace coolant. Check the label to see that it meets a particular manufacture's standards. Sodium silicate is an excellent aluminium protection additive. Many coolants contain this additive, although HOAT coolants contain a lesser percentage than IAT coolants. Heavy-duty truck manufacturers and some automotive manufacturers specify the use of coolants without silicates.

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