Technical Service Information

Cooling System Maintenance for Heavy Duty Engines

There are many cooling system problems and failures. Most of these problems occur due to incorrect information and maintenance practices. The following will address these problem areas by correcting the erroneous information and listing the proper maintenance practices. The chart shown below is a list of the six most common problems seen in today's cooling systems. Along with each problem is a description of how it occurs, how it affects your engine, and most importantly, how to prevent it.

PROBLEM	HOW IT HAPPENS	WHAT IT CAN DO	PREVENTION
Rust*	Oxidation within the system.	Clog the system. Cause accelerated wear.	The inhibitors in a quality Supplemental Coolant Additive prevent the oxidation for rust to occur.
Scale (Water Hardness)	Present in all tap water are salt minerals, especially calcium and magnesium. These minerals can solidify and adhere to hot metal surfaces.	1. Clog system passages. Deposit on high temperature areas and reduce the heat transfer rate causing hot spots. This results in uneven metal expansion, scuffing, scoring, accelerated ring wear and, eventually, cracked heads and/or blocks.	The Supplemental Coolant Additive keeps salt minerals in suspension so they cannot deposit on engine metal surfaces or clog passages.
Acidity (pH)	Ethylene glycol antifreeze reacts with oxygen in the air and forms acid. A loose head gasket or other leakage can allow sulfuric acids formed by the burning of fuel to leak into cooling system.	Corrode iron, steel and aluminum.	A quality Supplemental Additive neutralizes acids to prevent corrosion. Coolant pH should be 8.5 to 10.5.
Pitted Cylinder Liners	Constant vibration of the cylinder liner causes a momentary vacuum to form on its surface. Coolant boils into the vacuum and vapor bubbles implode on the surfaces of the liner, digging into unprotected liners.	Cause pits which can extend over time, through the thickness of the liner and allow coolant to enter the combustion chamber or crankcase.	The Supplemental Coolant Additive coats the liner with a thin film to protect it from erosion without impeding heat transfer.
Foam	Foam - The aeration of coolant - occurs from air leakage into the system.	Adds to the cavitation erosion problem, particularly in the areas of water pump impellers.	A quality Supplemental Coolant Additive has an anti-foam agent to prevent formation of air bubbles. This foam prevention agent is effective at all temperatures, even during startup.
Pitted Water Pump Impellers	Flow rates and turbulence are high at the impeller blade. This causes cavitation. In addition, there is a possibility that abrasive particles are present in the system.	Cause loss of pump efficiency and total pump failure.	The Supplemental Coolant Additives protect the impeller from cavitation erosion and the filter holds particulate matter to reduce abrasive wear on cooling system components.

*It should be noted that rust can appear even within a chemically protected system when oil is present in the coolant. If you do notice the presence of rust, the oil cooler should be inspected for possible leaks.

STARTING RIGHT

Before changing the coolant, the system should be thoroughly flushed to remove any contamination. A clean system is free of solid and liquid contaminates including oil.

MAKE-UP WATER

Proper coolant system maintenance requires a quality make-up water. All make-up water is corrosive but water with high mineral content cannot be made fit for use. As soft of tap water as possible should be used. Tap water that has been softened by some type of salt or chloride process should not be used. Most engine manufacturers have set up specifications for water used in their engines. The following chart shows some of these specifications.

	Caterpillar	**Cummins**	**Detroit**
Hardness	100ppm	300ppm	170ppm
Chlorides	50ppm	100ppm	40ppm
Sulfates	50ppm	100ppm	100ppm
Total Dissolved Solids	250ppm	500ppm	340ppm

Note: When contacted, Mack informed us that there were no limits on water used in their engines.
(PPM - Parts Per Million)

ANTIFREEZE

Antifreeze, ethylene glycol, propylene glycol or long life / extended life, should be used in the cooling system year around. The glycol in the antifreeze provides freeze protection. It also provides a stable environment for gaskets and seals. These same gaskets will shrink in straight water and leakage could occur. Some of the major problems we see in cooling systems today occur due to antifreeze related problems. One of the most publicized problems is silicate gelation/dropout. Silicate gel problems have increased in frequency since the early 1980's. The two major causes of this problem are:

1. High Silicate Antifreezes

2. Over concentration of antifreeze and/or Supplemental Coolant Additives.

All antifreezes used in today's heavy duty engines should meet GM 6038M or ASTM D-4985 specifications for silicate content. The antifreeze concentration should be held between 40% and 60% (40% antifreeze and 60% water to 60% antifreeze and 40% water). A 50% / 50% blend is ideal.

Another problem caused by over concentration is water pump leakage. In a study by Cummins Engine Company, 54% of the water pump failures they examined occurred due to over concentration. 78% of the total pumps examined showed over concentration regardless of the cause of the failure.

SUPPLEMENTAL COOLANT ADDITIVES

Using the proper amount of a high quality Supplemental Coolant Additive is very critical in preventing the problem mentioned in the chart

On the previous page. When filling a newly cleaned system with fresh antifreeze and water, a Supplemental Coolant Additive is required. These additives contain many inhibitors not found in today's antifreezes or if present in the antifreeze, they are at very low concentration levels (unacceptable for engine protection).

When precharging, be sure to use the proper precharge filter for your size cooling system or 4 ounces(120ml.) of liquid Supplemental Coolant Additive per gallon(3.8 ltr.) of coolant (4 oz.(120ml.) requirement based on the most common Supplemental Coolant Additives). In either case, be sure to follow the Supplemental Coolant Additive manufacturer's specifications.

SERVICE

Supplemental Coolant Additives are used up (depleted) while in the process of protecting the metal surfaces which are in contact with the coolant. These additives must be replenished through the use of filters containing SCA's or a liquid SCA at specified service intervals to maintain the proper concentration levels.

PERIODIC DRAINING AND FLUSHING

Antifreeze breaks down to corrosive acids due to temperature cycles within the cooling system . The coolant can also become contaminated by dirt, oil, combustion gases and spent inhibitors. While a high quality coolant filter will remove the solid contaminants, it will not remove the oil or combustion gases. Due to the breakdown of the antifreeze, all engine manufacturers recommend periodic draining and flushing. Caterpillar and Detroit Diesel recommend annually draining and flushing while Cummins and Mack recommend a maximum of two years.

There are many specialized products on the market today which can help you develop a quality cooling system maintenance program. The antifreeze concentration level is a key area which could lead to silicate gelation and water pump leakage. The recommended range is 40-60% based on ambient temperature. The use of a refractometer or hydrometer will insure the glycol concentration levels are maintained properly.

There are several different types of Supplemental Coolant Additive test kits on the market. The primary types check one of the following:

1. Sodium Nitrite

2. MBT

3. pH

Use the test kit recommended by your Supplemental Coolant Additive supplier. CAUTION: Test strips or testers which register the pH as the sole determining factor in adding your Supplemental Coolant Additive should not be used. For further information regarding antifreeze, refer to TSB-96-6.