Filter Manufacturers Council
Filter Knowledge, Unfiltered

Technical Service Bulletin 88-1R3

Cooling System Maintenance for Heavy Duty Engines

Improper cooling system maintenance can result in various cooling system problems and failures.

The chart shown below is a listing of the six most common problems seen in heavy duty cooling systems. Along with each problem is a description of how it occurs, how it affects the 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 (SCA) 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. 2. 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.	A quality supplemental coolant additive (SCA) helps to keep salt minerals in suspension so they cannot deposit on engine metal surfaces or clog passages.
Acidity (pH)	1. Glycol antifreeze reacts with oxygen in the air and forms acid. 2. 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 coolant additive (SCA) neutralizes acids to prevent corrosion.
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.	A quality supplemental coolant additive (SCA) coats the liner with a thin film to protect it from cavitation erosion without impeding heat transfer.
Foam	Foam (the aeration of coolant) occurs from air leakage into the system or low coolant levels.	Adds to the cavitation erosion problem, particularly in the areas of water pump impellers.	A quality supplemental coolant additive (SCA) has an antifoam 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.	A quality supplemental coolant additive (SCA) protects the impeller from cavitation erosion and the coolant filter removes 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. Therefore, it is recommended that distilled water be used. Water softened by some type of salt or chloride process should not be used. Most engine manufacturers have established specifications for water used in their engines. The following chart shows some of these specifications.

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

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 both freeze and boil-over protection. It also provides a stable environment for gaskets and seals. These same gaskets may shrink using water-only systems and leakage could occur.

Some of the major problems in cooling systems occur due to antifreeze-related problems. One of the most publicized problems is silicate gelation/dropout. The two major causes of this problem are:

1. High silicate antifreeze
2. Over-concentration of antifreeze and/or SCA.

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% blend is ideal. The use of a refractometer or hydrometer will insure the glycol concentration levels are maintained properly.

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. Seventy-eight percent of the total pumps examined showed over-concentration regardless of the cause of the failure.

SUPPLEMENTAL COOLANT ADDITIVE (SCA)
Using the proper amount of a high quality SCA is very critical in preventing the problems mentioned in this bulletin. When filling a cleaned system with fresh antifreeze and water, an SCA is required. These additives may contain inhibitors not found in today's antifreeze.

When pre-charging, be sure to use the proper pre-charge filter for the cooling system or 4 ounces of liquid SCA per gallon (30ml per liter) of coolant. The 4 ounces per gallon (30ml per liter) requirement is based on the most commonly used SCA. In either case, be sure to follow the SCA manufacturer's instructions.

SERVICE
SCAs are depleted during 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 SCAs or a liquid SCA at specified intervals to maintain the proper concentration levels.

PERIODIC DRAINING AND FLUSHING
Antifreeze breaks down 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 may not remove the oil or combustion gases.

There are several types of SCA test kits on the market. The primary types check one or more of the following:

1. Sodium Nitrite
2. Molybdate
3. pH
4. Freeze point

Use the test kit recommended by your SCA supplier. **CAUTION:** Test strips or testers which register the pH as the sole determining factor in adding your SCA should not be used.
For further information regarding antifreeze, refer to TSB-97-2 and TSB-05-2.

For additional information, contact:
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