Coolant Analysis Vital to Optimizing Equipment Performance and Longevity

TECHNICAL BULLETIN

An estimated 50% of all premature engine failures can be associated with problems in the cooling system – problems that can cause scale deposits or acid formation and eventually damage to other components.

Today's diesel engines are smaller in size than those manufactured prior to 2007 but produce an even greater amount of power. This, along with higher engine operating temperatures in excess of 225°F, places a much larger burden on the cooling system to absorb heat transferred from the engine oil and transmission and hydraulic fluids.

As engine operating temperatures continue to increase to meet EPA emissions regulations, the cooling systems for these new designs must also operate at much higher temperatures making careful cooling system maintenance necessary to avoid engine damage from boiling, deposits or pitting. As a result, the cooling system is becoming an even more critical component in the health and well-being of both the engine and the vehicle.

Coolant analysis has four primary goals:

- To determine if a coolant is in a suitable condition for continued use
- To identify component or system failure – blown head gaskets, grounding problems, blocked coolant passageways, localized overheating
- To predict failure by monitoring trends and abnormal changes in the coolant
- To affect change in outdated or insufficient maintenance practices and procedures

Proper cooling system maintenance is essential to achieving optimum equipment performance and longevity. Coolant analysis is critical to maximizing both and highly recommended for both conventional and extended life systems. The following cooling system guidelines are designed to help operators and fleet maintenance personnel maintain and control cooling system maintenance procedures and identify problems before engine failure occurs. If failure does occur, they can provide valuable insight as to the cause.

At increased operating temperatures, improperly maintained coolants will become acidic with time. The hotter the system, the more acidic the coolant will become. This turns the engine into a wet cell battery. The coolant becomes the electrolyte between dissimilar metals in the engine and cooling system.

Pressure raises the boiling point of the coolant about 2.7ºF (1.6ºC) per pound of pressure at sea level.

- Coolant boiling points drop about 3ºF (1.7ºC) per every 1000 feet of elevation. About 80% of preventable engine failures caused by a cooling system problem are due to one of the following:
  - Water mixed with the coolant doesn't meet ASTM engine manufacturer specifications for use in engine coolants
  - The coolant isn't designed for the goal intended
  - Internal or external air is entering the coolant, system pressure is insufficient or dissolved gases are present from air-pitted metals
  - There is an electrical ground problem – one half volt of current grounding through a coolant can destroy the engine, regardless of the coolant's inhibitor levels
- One-tenth of an inch of calcium silicate scale has approximately the same insulating potential as three quarters of an inch of fire brick. The greatest amount will form at the point where the greatest heat transfer is needed.
- Coolant will expand to 4.7% of its total volume at 180ºF. Newer higher operating temperature engine coolants expand about 6%. Distilled water vapor is always given off through the overflow. Air and its contaminated moisture enter through the overflow unless it's a closed system.

In recent years, equipment and engine manufacturers have begun to change from conventional, heavy duty diesel engine coolants to the organic acid extended life coolants now prevalent in today's markets. Although there are benefits to the newer formulations in terms of cooling system protection and cost of operation, both require cooling system testing and analysis to assure that they are operating adequately.

Conventional coolants are a formulation of an ethylene glycol, propylene glycol or glycerin base and an inorganic inhibitor package composed of nitrites, nitrates, molybdates, phosphates, borates and silicates. These inorganic inhibitors provide corrosion protection by forming a protective layer on the various metals in the cooling system. Regular testing will detect any mechanical problems affecting coolant system operation including, inhibitor depletion rates, when supplemental coolant inhibitors should be added or when the coolant should be changed.

Carboxylate acid-formulated coolants protect against corrosion by chemically interacting with the metal surfaces. This chemical reaction extends the life of the coolant, protects aluminum surfaces at higher temperatures and provides better heat transfer. But it doesn't make the system any less vulnerable to the inevitable. Only regular coolant testing and analysis will detect an air or combustion gas leak, electrical ground problems, localized overheating or operator/maintenance error - all of which can seriously degrade coolant composition and affect performance.

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The most common factors that contribute to the deterioration of any type of coolant are improper top-off with only water or a different coolant formulation, adding SCAs (Supplemental Coolant Additives) to an ELC and an over/under concentration of SCA's or extenders. These factors can cause extensive yet preventable cooling system problems – all of which are identifiable through proper testing and analysis, which should be a consistent part of any cooling system maintenance program.