ALS TRIBOLOGY
Engine Coolant Reference Guide

Engine coolants are a mixture of glycol, inhibitors, and water. Each formula is designed for specific protection and engine requirements. Mixing different coolants is not recommended and can compromise the coolant's general overall protective capability, resulting in decreased coolant life and damage to the cooling system and/or engine. The following is a reference guide to assist in understanding engine coolant data.

Appearance Assessment

The visual appearance of a coolant sample can say a lot about the condition of the coolant. In-service coolants should appear clear and bright, with no solid residues or sediment. Four visual assessments are conducted and reported.

Appearance Assessment	Target	Observation	Possible Result	Corrective Action
Clarity	Clear	Appears hazy or opaque	Degraded or contaminated engine coolants or a mixture of incompatible coolant types	Check shelf life of the coolant; check coolant handling practices
Color	Clear, bright, and representative of the original engine coolant color	Brown could indicate improper mixing of different coolants	Decreased coolant protection	Verify original coolant color of product in use; if brown was reported, check coolant handling practices
Visible Sediment	None	Presence of sediment is typically indicative of additive fallout, corrosion, rust, scale buildup, or other contaminants	Water pump and seal deterioration, liner pitting, copper and aluminum corrosion, plugged oil cooler and radiator; poor sampling technique.	Add a non-SCA filter for ELC coolants; add an SCA filter to conventional coolant systems
Visible Petroleum Layer	None	Indication of fuel or oil contamination will be observed usually in the form of a separated layer	Combustion gas blow-by into the coolant, leaking oil cooler; poor sampling technique	Check for any seal failures and system integrity

pH

Indicates the level of acidity (low pH) or alkalinity (high pH). Typical baseline pH values of a coolant can vary but remain relatively consistent unless the coolant and/or cooling system has been compromised. Allowing the coolant to become acidic will lead to metal corrosion in the cooling system, so it is critical to monitor. One key item that can affect coolant is age; review storage practices and make sure coolant stock is properly rotated.

pH	Target	Observation Low pH	Observation High pH	Corrective Action
ELC Engine Coolant and Conventional Engine Coolant	Extended Life 7.5 – 9.5pH Conventional 8.5 – 11.0pH	**ELC Low pH (< 7.5) Conventional Low pH (< 8.5)** Low pH can lead to metal corrosion Air leaks will lower pH Improper coolant volume Shelf life of coolant, age will lower the pH Under additized SCA concentration (conventional coolant)	**ELC High pH (> 9.5); Conventional High pH (>11.0)** Mixed coolant types Over additized SCA concentration	Check coolant volume Check for air leaks Pressure check radiator cap Check SCA filter and replace if needed (conventional coolant only) Electrical grounding issues (if coolant has a burnt smell) Combustion gas leak if pH is below 7.0 Remove SCA filter when ELC coolants are in use, this will add pH buffer and raise the pH Drain, flush, refill then resample

Freeze Point / Percent Glycol Concentration

Freeze point is a critical element in coolant analysis. If improper glycol concentration is maintained, it can lead to decreased protection or over concentration of the inhibitor, both of which can lead to cooling system problems and engine damage. Coolants are typically available as a concentrate or as pre-diluted with several different ratios of concentrations. However, freeze points in North America should be maintained between -15˚F and -60˚F (equivalent to 40% – 60% glycol concentration). Glycol concentration (ethylene or propylene) is used to suppress the freeze point and elevate the boiling point of the coolant. The ratio required depends on the environment in which the equipment is operating. Always ensure that equipment and environmental requirements are met.

Glycol Concentration	Target	Observation Low Glycol Concentration	Observation High Glycol Concentration	Corrective Action
Percent Glycol	40% to 60%	**Low Glycol (< 40 %)** **Freeze Point (> -15 F)** Confirm adequate protection requirements for application Improper adjustment with water	**High Glycol (> 60 %)** **Freeze Point (< - 60 F)** Too high indicates over use of concentrate or water is boiling off This can reduce heat transfer properties resulting in cavitations and liner pitting	Check proper coolant volumes Pressure check radiator cap Confirm bulk source of coolant for inadequate concentration If the coolant has been over diluted or under diluted, by manufacturer's guidelines, take corrective action by adjusting the glycol or water level following the manufacturer's recommendations. The use of deionized or distilled water is recommended when needing to utilize water to adjust concentration.

Conductivity / Total Dissolved Solids (TDS)

This is a concern in heavy duty, conventional coolants because of the practice of adding Supplemental Coolant Additives (SCAs), which can lead to overloading of these, resulting in water pump failures and cooling system corrosion. It measures the coolant's ability to resist carrying an electrical charge.

	Target	Observation Low TDS	Observation High TDS	Corrective Action
TDS	20000 max	Normal	Improper source water, over concentration of SCAs	Confirm water source; distilled or deionized is recommended Check for improper SCA filter drain, flush and refill

Nitrites

For many years, heavy duty coolants contained nitrites to protect against cavitation and corrosion. However, with the advancements in technology, there are now many coolants that are nitrite-free because the organic acid based technology provides protection without the need for nitrites. Conversely, engine manufacturers require either nitrites or nitrite-free coolants, so it is important to ensure the proper coolant formula is in use to meet the equipment manufacturer's requirements. For proper diagnostic review, always provide the coolant in use in order to properly diagnose the nitrite level of the coolant.

Nitrites	Target	Observation Low Nitrites	Observation High Nitrites	Corrective Action
Nitrite	Initial coolant concentration typically: > 1200 PPM Nitrite only formulas > 300 PPM for nitrite/ molybdate formulas < 25 for nitrite free	Verify coolant type in use Under concentrated with glycol Improper coolant mixing Under concentration of SCAs for conventional coolants	Verify coolant type in use Over concentration of glycol Improper coolant mixing Over concentration of SCAs for conventional coolants	Check the coolant mixture, if under or over concentrated, this will impact the nitrite level when present If low, look at nitrate level; if pH has dropped, check for head gasket leaks, low coolant volumes, and pressure check radiator cap Rapid depletion could indicate overheating of the cooling system and localized hot spots, check; this will occur along with an increase in glycolates Rapid depletion could also indicate electrical shorts; check grounding, coolant will have a burnt smell If using ELC, check for a pre-charged SCA filter and replace with a non-pre-charged filter If nitrites are low, but carboxylate acid inhibitor passed, resample at next service interval Drain 50% of system and add 50/50 coolant, resample

Carboxylate Acid Technology

In extended life coolants, the previous mineral based additives have been replaced with carboxylic and fatty acids, allowing the coolant life to be greatly extended and enhancing coolant system protection. However, not all formulas are the same! There are a variety of signature formula's available on the market today, each formulated for equipment requirements and/ or longevity differences. Because there are a variety of formulas available on the market, it is wise to confirm that the right coolant for your equipment was chosen. Most, if not all, coolants allow for some acceptable dilution without compromising the inhibitor's capability to protect. If the coolant inhibitor has been compromised by diluting, mixing, etc., beyond the manufacturer's recommended allowable dilution, follow the manufacturer's corrective action and adjust the inhibitor concentration. Maintaining proper inhibitor levels is key to maintaining proper cooling system protection.

Carboxylate Acid	Target	Observation Low OAI	Observation High OAI	Corrective Action
OAI	Passing level depends on the initial extended life coolant's inhibitor level formula	Verify coolant type in use Under concentrated with glycol Improper coolant mixing Coolant is brown – possible improper conversion from conventional to extended life	Verify coolant type in use Over concentrated with glycol Improper coolant mixing	Adjust coolant concentration; if over concentrated, add proper source water; if under concentrated, add glycol concentrate; check freeze point and resample at next service interval If the inhibitor level has been under-diluted, by manufacturer's guidelines, take corrective action by adjusting the inhibitor level following the manufacturer's recommendations. If the coolant was improperly mixed with conventional and extended life coolant, significantly affecting the inhibitor level's protection capability, either drain and flush or contact your OEM for corrective action.

Other Ion Chromatography Data

If the coolant has been over-diluted, by manufacturer's guidelines, take corrective action by adjusting the inhibitor level following the manufacturer's recommendations.

Ion Chromatography Results	Source
Chlorides	Outside contaminants and can come from improper source water or air leaks. It has the potential to form acids and cause corrosion. It can also come from coolant degradation due to aging.
Glycolates	Is among a group of acids that form as coolant degrades. This will also increase when overheating or hot spots are occurring. As this acid increases, iron corrosion is at risk.
Molybdate	Provides protection of cast iron corrosion and cavitations.
Nitrates	Provides protection of light alloys also provides aluminum and solder protection. If nitrites are being exposed to air, they will chemically transform to nitrate – when this occurs look for air leaks.
Phosphates	pH buffer utilized in some coolant brands and provides iron corrosion protection. Over treating the cooling system can lead to sediment detection resulting in possible plugged oil cooler or radiator. Some engines that are aluminum must be phosphate free, check OEM requirements before using a phosphate coolant.
Sulfates	This contaminant can combine with calcium to create scale. This can also indicate coolant degradation due to aging or improper source water is being used.

Coolant Spectrochemical Data

A series of specific elements are measure for additive, wear, and improper source water contamination.

Coolant Spectrochemical Data	Aluminum (Al)	Boron (B)	Calcium (Ca)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Magnesium (Mg)	Molybdenum (Mo)	Phosphorus (P)	Potassium (K)	Silicon (Si)	Sodium (Na)	Silver (Ag)	Tin (Sn)	Zinc (Zn)
Additive Elements		•						•	•	•	•	•			
Wear Elements	•			•	•	•							•	•	•
Water Elements			•				•								