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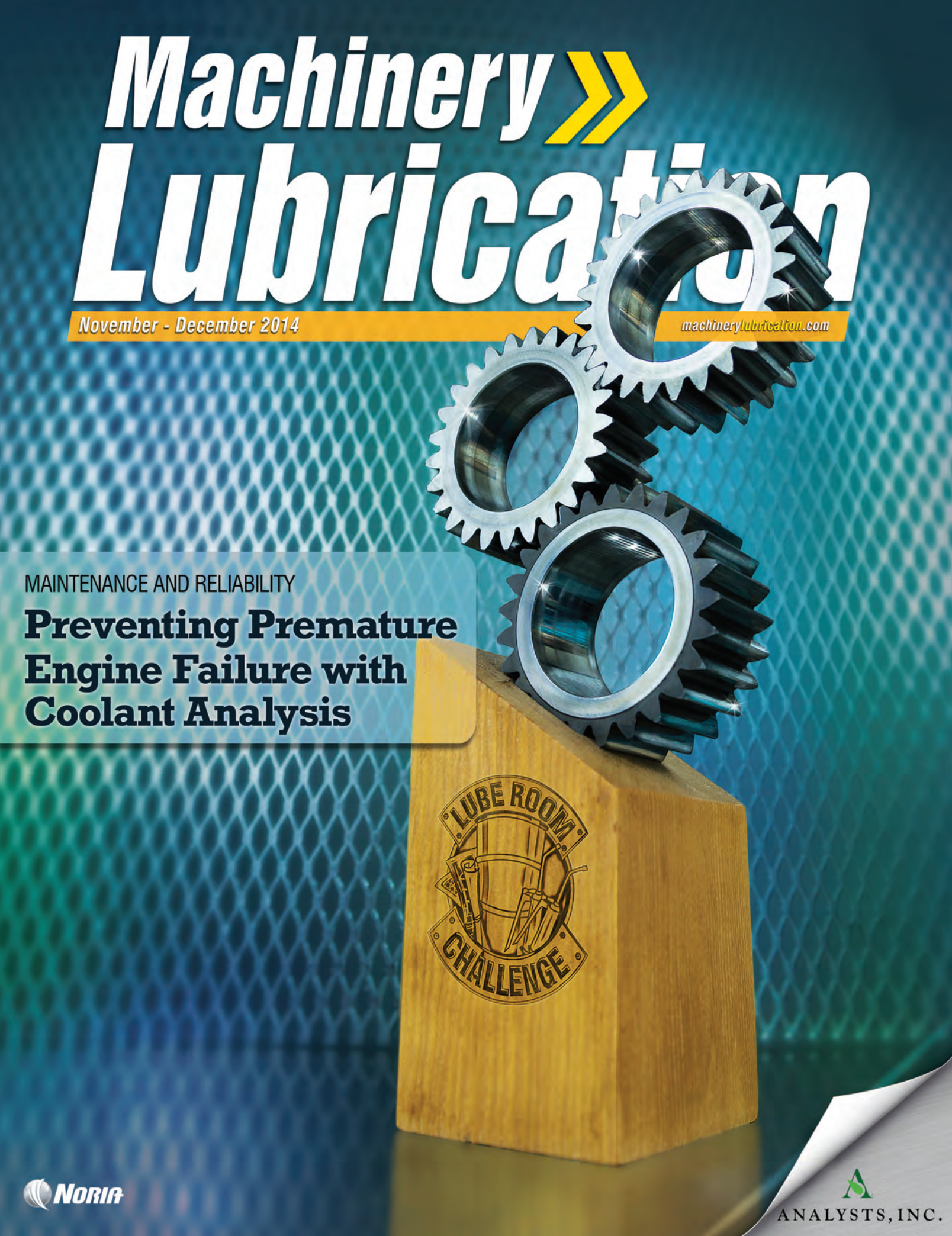


MAINTENANCE AND RELIABILITY

Preventing Premature Engine Failure with Coolant Analysis

Preventing Premature Engine Failure with Coolant Analysis

By Elizabeth Nelson, Analysts Inc.

Almost everyone knows how important a properly maintained lubrication system is to optimum engine health, but what most people don't understand is that engine coolant and the cooling system are just as critical to engine design, maintenance and optimum performance.

The demands of today's Tier-4 engines have dramatically changed cooling system design and coolant formulation. These heavy-duty diesel engines produce a tremendous amount of power from a relatively small package, placing greater demands on the cooling system to absorb heat transferred from the engine, transmission and hydraulic fluids. At the same time, cooling systems have become smaller and operate at higher temperatures, pressures and flow rates, making efficient heat removal and adequate metal protection even more challenging.

While oil analysis is an invaluable condition monitoring tool, it tells you very little about what is happening inside the cooling system. Coolant analysis provides the rest of the story by pinpointing coolant and cooling system issues that can lead to premature engine failure.

Cooling System Criticality

An estimated 50 percent of all engine failures are associated with problems in the cooling system. Once initiated, these problems can spread through the lubrication, hydraulic and transmission systems, damaging components, causing scale, clogging passages and forming deposits. Yet the cooling system is the least understood and most neglected of these systems.

Cooling system problems can potentially reduce the life of components within all machinery, which makes maintenance of these systems essential for achieving optimum machine performance and longevity. Coolant analysis takes the guesswork out of maintaining these systems. Implementing a predictive maintenance program that includes analyzing the in-service coolant has proven to optimize reliability, decrease unscheduled downtime, reduce in-service failures and field repairs, establish proper coolant drain intervals, increase component lifespans and control equipment costs.

Conventional vs. Extended-life Coolants

Coolant analysis is recommended for both conventional and extended-life coolants. Fluid design cannot prevent or correct the mechanical issues or chemical reactions that impact cooling system performance. Air and combustion gas leaks, localized overheating, hot spots or electrolysis can chemically alter or destroy the coolant and its inhibitors. Changes in coolant composition may cause chemical reactions that can damage metals and result in premature component failure. Mechanical problems and chemical reactions affect conventional and extended-life coolants equally, and neither fluid formulation can correct the root cause of a mechanical problem.

Inhibitor and glycol levels should be analyzed regularly not only to ensure adequate system protection but also to identify any mechanical issue or chemical reaction that could result in catastrophic engine or component failure.

An effective fluid analysis program should address the four primary goals of coolant analysis: preventive maintenance, predictive maintenance, root cause analysis and life-cycle management.

Preventive Maintenance

Small problems with the coolant or cooling system can become catastrophic component or system failures if left unchecked. Regular coolant testing and analysis can determine:

- If the coolant is suitable for continued use or needs to be replenished or replaced (a laboratory can identify proper fluid change recommendations).

- If coolant mixing has occurred.
- If contaminants are present that can cause the formation of scale or acids.
- If additive depletion is compromising metal protection.

Predictive Maintenance

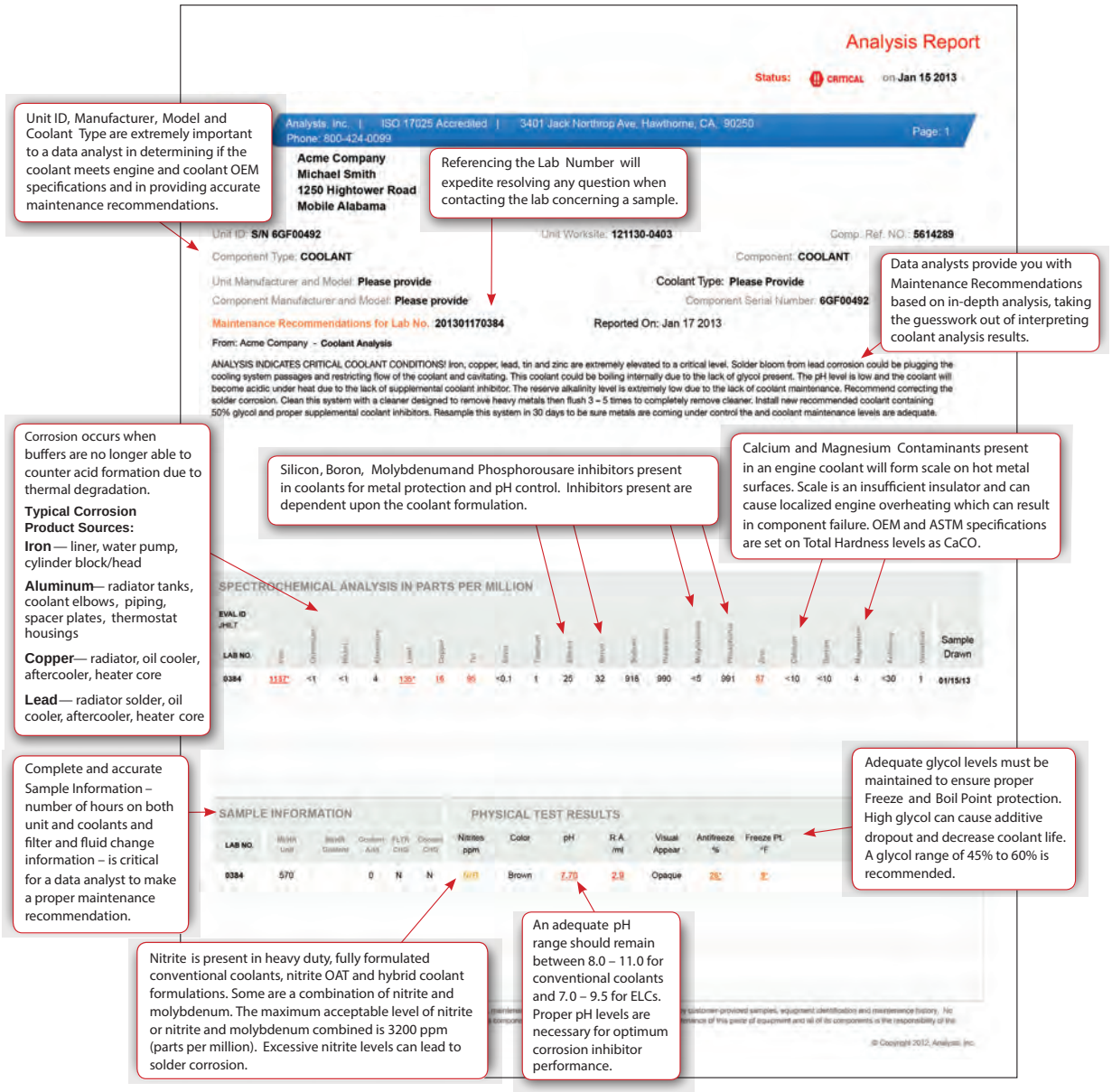
Coolant analysis can help in predicting impending failures by noting abnormalities and trends in test results. Trends can pinpoint mechanical and formulation concerns that may jeopardize the life and longevity of the system and its components. These issues often involve the formation of acids and scale, contamination ingression, electrical ground problems and localized overheating or hot spots.

Root Cause Analysis

When an engine or cooling system component failure does occur, coolant analysis at the proper intervals can identify the root cause of the problem, such as a blown head gasket, electrolysis, a blocked coolant line or an exhaust gas recirculation (EGR) system failure. Once the root cause has been determined, an experienced data analyst can make informed recommendations for correcting the problem and assist in establishing fluid maintenance procedures for preventing a recurrence.

Life-Cycle Management

Coolant analysis not only can detect deficient maintenance practices, but it can also assist you in implementing corrective



actions to ward off issues within the cooling and lubrication systems, as well as provide indications of shortcomings in equipment operational practices and maintenance procedures.

Combining Coolant Analysis and Oil Analysis

When reviewing a coolant analysis report, it is important to evaluate it in concert with the oil analysis performed at the same maintenance interval. The effects of engine overheating may be evident in both oil and coolant samples. Remember, cooling system deficiencies affect all systems, including the engine, transmission and hydraulics.

Engines

High coolant temperatures can cause high oil temperatures, reducing the oil's operating viscosity and thereby its hydrodynamic lubricity. This leads to oil oxidation and eventual engine wear. This could be evident in ring sticking, piston glazing or varnishing, and valve wear, which often masks the fact that a cooling system problem was a contributing factor.

Transmissions

An overheated cooling system can also shorten transmission life. Transmission disc slippage may occur as a result of reduced oil viscosity at elevated temperatures. Transmission slippage creates more heat, which causes oil oxidation, and a vicious cycle is established.

Hydraulics

Hydraulic pumps and motors become less efficient at elevated temperatures and may reduce the life of valves, pump slippers, barrels, plungers and seals due to reduced oil viscosity and oil oxidation.

Engines, transmissions and hydraulics are often repaired with no consideration given to the possibility that a serious cooling system problem may have precipitated the issue. As a result, the same failures happen again and again. Coolant analysis can dramatically improve machine performance, reduce unnecessary repair and replacement costs, and extend the life of equipment by optimizing the condition of the mechanical systems involved and the fluids that keep them running.

About the Author

Elizabeth Nelson is the coolant program manager for Analysts, Inc. She has more than 30 years of experience working with OEMs and coolant manufacturers and training field and reliability engineers and maintenance personnel on the importance of coolant analysis. She can be reached at enelson@analystsinc.com.