A World of Lubrication Understanding®

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TEOST Turbo® Test Method - The Evolution

Now at ASTM Ballot Stage

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For the last 50 years, the Savant Group has been an industry leader in developing, manufacturing, and implementing bench tests used to determine lubricating fluids' physical properties or performance characteristics. Two examples of several key industry bench tests developed and manufactured by Savant Group companies are the Thermo-Oxidation Engine Oil Simulation Tests (TEOST®) used to predict the deposit forming tendencies of internal combustion engines. The original turbocharger bench test, TEOST® 33C, was developed in the early 1990s to screen engine oils by their tendency to form coking deposits within the elevated temperature zones of the turbocharger. Following that, the TEOST MHT® test was developed with the objective of characterizing the tendency of engine oils to form deposits at moderately high temperatures, resulting in the correlation with deposits in the piston ring area. Both of these TEOST® tests have been included in the various ILSAC GF-series engine oil specifications over the decades.

As engine designs have evolved, particularly turbochargers, the need for an additional modification to the TEOST® platform became evident. Engine design improvements have largely mitigated the high temperatures that drove the design of the 33C protocol, yet turbocharger deposits persist, so a lower temperature test was desirable. The TEOST Turbo® Test was then developed for this need.

One of the primary goals of any bench test is to simulate field conditions accurately. This allows us to correlate test results with field data more easily. This was the most critical step in developing TEOST Turbo®. The Turbo protocol combines features of the 33C and MHT methods to better target conditions of updated turbocharger designs.

The Thermal Model - Modern turbochargers have significantly reduced coking tendencies. Specifically, turbo-idling continues to cool the turbocharger after shut-down, eliminating the high-temperature zones integral to deposit formation in earlier generations of turbos.

However, field reports have shown that redesigned turbos continue to form oxidative deposits at lower operating temperatures (around 290°C).

The TEOST Turbo® test operates at the same temperature (290-320°C) that modern turbos operate within. The resulting deposits that are formed are oxidative in nature.

Flow Path Geometry - Savant engineers had utilized a wire wound depositor rod with a top-down flow path when designing the TEOST MHT® method, which examines the oxidative deposit tendencies in the piston ring area of the engine. This allows for a thin film to form as the oil flows down over the heated depositor rod.

This better simulates the oil wicking behavior in today's turbos and increases the reaction kinetics of the oxidation reaction, increasing test sensitivity and thereby reducing the total test time needed to distinguish oil performance regarding deposit formation.

Volatile Retention - In the MHT test, any portion of the test oil that is volatilized is swept out of the system. There is significantly less headspace to allow volatilization within the turbocharger, so in the design of TEOST Turbo®, the volatile fraction is retained and recycled back to the reservoir. This improved correlation to field results. The revised heating mantle zone is shown in Figure 1.

Molybdenum Sensitivity - TEOST® 33C has a high sensitivity to Molybdenum, an additive used in some oil formulations. In some cases, this has yielded higher than expected deposit values when compared to engine sequence test data. During the development of TEOST Turbo®, this sensitivity to oils containing Molybdenum was not apparent.

Figure 1.

TEOST® Test Comparisons

While there are some similarities between these three test protocols, the results and relative sensitivities to oil formulations are clearly different as exemplified by Figure 2, which shows comparative results for these three test methods on oils with field performance.

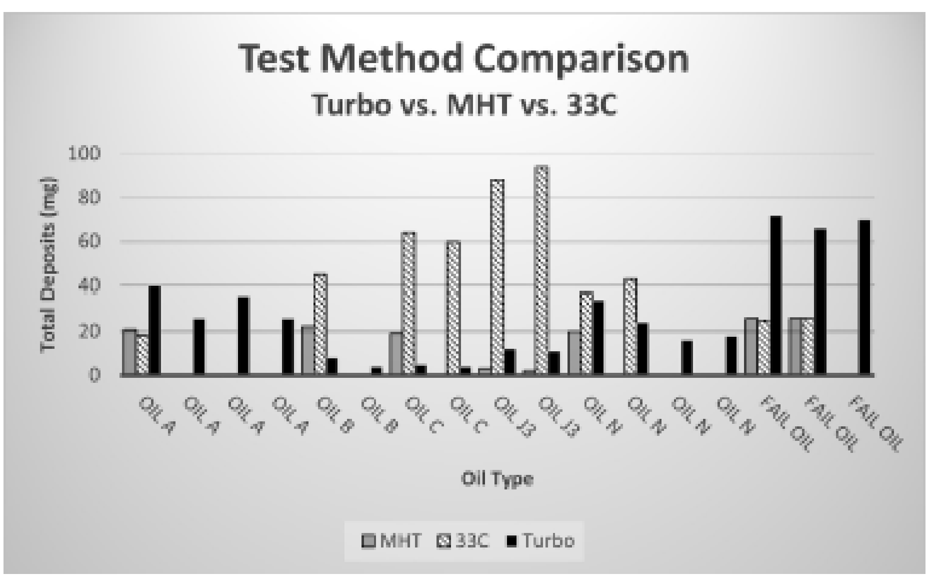

Figure 2. Comparative Test Results on Turbo Pass/Fail Oils

As shown in Figure 2, the Turbo method differentiates the pass/fail oils better while not condemning certain passing oils, such as the 33C method on Oils C and J3. The difference in response between the three methods is clear with selecting the most appropriate test protocol based on the application and specific concerns.

If high-temperature deposits are the concern, the 33C method remains the best choice. For lower temperature deposits that are more related to oxidation, the MHT method would be preferred for areas where volatiles are not likely to accumulate, and the Turbo method is preferred for areas where volatiles are more likely to be retained and participate in these undesirable reactions.

A summary of key test conditions is provided in Table 1.

Parameter	Units	33C	MHT	Turbo
Rod Type	-	Straight	Wire Wound	Wire Wound
Total Oil Volume	mL	116	10	30
Oil flow direction	-	Bottom Up	Top Down	Top Down
Air induction location	-	Reservoir	Upper end cap	Upper end cap
Peak Rod Temperature	deg C	480	285	290
Test Duration	hr	<2	24	18

An Interlaboratory Study (Round Robin) has been completed and TEOST Turbo® is currently in the balloting stage with ASTM International with a goal to publish a new method.

TEOST Turbo® Testing and Research Available Now

Contract testing of the new TEOST Turbo® test is immediately available at Savant Labs to evaluate your engine oil formulations. In addition, the flexibility of the TEOST® test platform is a great research tool so if you have a specific application that falls outside these specific protocols, don’t hesitate to contact Savant Labs as we can assist with your research needs by further modifying a variety of test parameters. Contact us for more information.

Brake Fluid Testing

Whether you are a fleet owner looking to change brake fluid suppliers or a manufacturer of brake fluids, Savant Labs understands the U.S. Department of Transportation specifications for the three main types in use by the automotive and trucking industry. Those types are DOT-3, DOT-4, and DOT-5. Both the DOT-3 and DOT-4 are glycol-based fluids, which absorb water, while DOT-5 is silicon-based so it doesn’t absorb water.

Most brake fluids contain unique properties to protect or enhance the braking system. The tests below may determine if a brake fluid can protect or enhance the braking system:

Wet and dry boiling point – High boiling points protect against overheating, brake fade, and performance decline due to water absorption.

Low-temperature viscosity - At sub-zero temperatures of -40˚C, the brake fluids tend to “thicken” and it becomes difficult to ensure that it can still flow freely.

Corrosion protection - Brake fluid itself does not corrode but when the additive package breaks down, the brake fluid no longer has adequate anti-corrosive inhibitors so corrosion of internal brake hydraulic components may occur.

Compatibility with braking system components - Compatibility is determined by the chemical characteristics of the fluid, so the brake system materials must be compatible with the brake fluid used. The swelling of the rubber components (such as piston/cylinder rubber seals and similar), as well as the friction, is one of the most common issues that cause contamination into the brake system.

Long-term stability - Extended service life while improving the corrosion resistance of the main components of the braking system.

Savant Labs are positioned to assist with the necessary brake fluid testing to meet the specifications now in place for vehicle braking systems. To learn more about the test methods offered, visit our website or download the brake fluid testing list.

Join Us at NLGI's Annual Meeting

Join us at this year's NLGI Annual Meeting on September 27-30, 2021 in Tucson, Arizona. It will be great to see you in person again! We have a lot of information to share around grease testing and your HPM Grease pre-certification needs.

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