

The role of High-Temperature High-Shear (HTHS) viscosity testing in assessing engine oil performance



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The High-Temperature High-Shear (HTHS) viscosity test is one of the critical high-temperature tests in SAE J300 that measures the viscosity of an engine oil under conditions of high temperature and high shear rate by simulating severe engine operating conditions. This demonstrates the ability of the oil to protect the engine in high-temperature, high-load environments by determining how well the oil maintains an adequate lubricating film in critical engine components during operation.

The test achieves this by subjecting the oil to a temperature of 150 °C and a controlled high shear rate representative of the conditions found in highly stressed engine parts, such as bearings, cam followers, and piston rings, where oil film strength is essential to prevent metal-to-metal contact.

This shearing effect is particularly relevant for multigrade engine oils formulated with viscosity index improvers (VII). These polymeric components expand at higher temperatures to increase viscosity; however, under high shear conditions they may align with the direction of flow or undergo mechanical stress. This can result in a temporary viscosity reduction or, in cases of insufficient shear stability, permanent loss of viscosity due to polymer degradation.

If the lubricant is unable to maintain sufficient viscosity under these conditions, the oil film may thin to a point where it no longer provides adequate separation between moving surfaces. This increases the risk of metal-to-metal contact, accelerated wear, and reduced component durability. The HTHS viscosity test is therefore critical in assessing an oil's ability to resist shear-induced viscosity loss and to maintain effective

lubrication under severe engine operating conditions.

Engine lubricants which perform poorly during the HTHS test may result in severe damage to the engine in field conditions, such as increased wear, reduced oil film thickness, higher friction losses, and long-term durability issues. Selecting the correct base oil quality, viscosity index improver (VII), and additive technology combination is part of the lubricant developer's tools to limit these risks. The shear stability of the VII and the intrinsic viscosity characteristics of the base oil are critical to maintaining the required HTHS viscosity throughout the oil drain interval.

In addition to other rheological measurements, the HTHS viscosity test (ASTM D4683 and CEC L-36-90) has been developed by the American Society for Testing and Materials and Coordinating European Council to simulate the extreme high-temperature and high-shear conditions under which the automotive lubricant must continue to provide effective engine protection.

This test helps the Original Equipment Manufacturers (OEMs) to guarantee lubricant behaviour in critical engine components during high-load operation, in conditions where oil temperatures are elevated and hydrodynamic lubrication margins are reduced.

The Society of Automobile Engineers (SAE) J300 sets the required test limits to qualify both multigrade as well as monograde lubricants, ensuring a balance between fuel economy and engine protection through defined minimum HTHS viscosity requirements for specific viscosity grades.

The Technical Association of the European Lubricants Industry (ATIEL) has delegated its product compliance monitoring programme to Services to Associations and Industry in the Lubricants sector (SAIL) to evaluate lubricant performance as part of the European Engine Lubricant Quality Management System (EELQMS). To ensure that lubricants marketed with ACEA engine oil sequence claims meet the required performance standards, SAIL surveys lubricant samples from the marketplace and conducts chemical and physical testing in independent laboratories to ensure compliance.

If any sample fails to meet the ACEA sequences, including the applicable HTHS viscosity limits, SAIL issues a report to the marketer, inviting them to comment on the findings. The marketer is then required to outline corrective actions to address the non-compliance.

In 2024, SAIL managed over 3,100 individual tests as part of the compliance programme. These efforts help to maintain high-quality standards

in the lubricants market and provide consumers with confidence in the products they use. SAIL's compliance monitoring programme has identified that HTHS non-compliance remains a significant risk area, particularly for lower-viscosity engine oils designed to deliver improved fuel economy.

The correct selection of viscosity index improver (VII) with adequate shear stability is essential to avoid high-temperature engine protection failures. VII interchange is **not permitted** within the ATIEL Code of Practice unless substitution of the VII in the original final formulation with an alternative VII is supported by a Viscosity Index Improver interchange programme. VII interchange guidelines developed by ATIEL are clearly defined in the Code of Practice. Unsupported VII interchange is likely to affect the balance of key component interactions, which may lead to sub-optimal protection under high-temperature, high-shear operating conditions.

If in doubt, please consult your reputable technology provider.

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