

# Measuring Apparent Viscosity at High-Temperature and High-Shear Rate (HTHS) by Multicell Capillary Viscometer



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## Overview

Apparent Viscosity at High-Temperature High-Shear Rate (HTHS) is a viscosity measurement of the engine oil that determines standard oil viscosity grades at high temperature and high shear rates. This is accomplished by performing the test under high temperature and high speed, similar to the conditions that engine oil flows through. Our HTHS tests an oil's viscosity at a temperature of 150°C using a multicell capillary viscometer containing pressure, temperature, and timing instrumentation.

## Basic Principles of the Test

The test sample will be introduced into the viscometric cell by opening the plug valve. Any excess test sample will be sucked back out to alleviate gas bubbles. Nitrogen gas will be used to pressurize the system to achieve a nominal flow time. When the operator starts the test, the nitrogen gas will rush into the cell. At this point a timer is started. During this time, the pressure increases to continually push the test sample out of the cell. When the test sample is completely displaced from the cell, the flow of pressurized gas increases in the capillaries causing the timer to stop. The test sample is typically emptied through the oil outlet on the bottom of the instrument. The flow time and pressure are recorded and used to calculate sample's viscosity and shear rate.



## Specifications of Our HTHS

Below are the specifications for using our High-Temperature High-Shear Multicell Capillary Viscometer

**Power:** 800W

**Rated Voltage:** AC 220V 50Hz

**Test Temperature:** 150°C ± 0.1°C

**Gas Source:** Nitrogen Tank

**Ambient Limits:** 5°C - 40°C; Humidity ≤85%

## ASTM D5481

ASTM D5481 uses a multicell capillary viscometer to determine the high temperature shear viscosity of engine oils. This is done at a set temperature of 150°C. The shear rate for the method parallels to an apparent shear rate at the wall of 1.4 million reciprocal seconds. Viscosities are found from calibrations made with Newtonian oils with normal viscosities from 1.4 mPa-s to 5.0 mPa-s at 150 °C. High temperature viscosity is an important characteristic for liquid engine lubricants since it changes depending on the temperature. The viscosity of an engine lubricant is most useful when the measurements are taken at or near the conditions of the lubricant's shear rate. This test method is designed to simulate the conditions in the bearings of automotive equipment at that critical point.

## How Our High-Temperature High-Shear Instrument Works

- Sample Flushing**  
 Inject 5 mL of sample into viscometric cell to filter out the previous sample. Use the system's air flow to exhaust the sample from the outlet tube.
- Sample Wetting**  
 Add another 10 mL of sample into injector and inject the sample into the cell. Allow 15 minutes for the sample to equilibrate to the test temperature. Adjust the pressure to about 2 psi higher than the test pressure.
- Volume Setting**  
 Following the 15 minutes of temperature equilibrium, start the suction of sample from the cell into the injector. Stop the suction when there is continuous bubbles entering the injector.
- Sample Test**  
 Start the test and the apparatus will begin to pressurize. After all the sample exits the cell through the outlet tube, the test will stop automatically and display an efflux time and the set test pressure.
- Calculation**  
 Click on the calculate button to calculate the test results and shear rate.

## Calibration

ASTM D5481 recommends calibrating HTHS instruments using at least four of the following calibration oils.

Calibration Oils for High-Temperature High-Shear Calibration			
Calibration Oil	Approximate Viscosity	Approximate Pressure for Test Method	
HT39	2.0 mPa-s	225 psi	1500 kPa
HT75	2.7 mPa-s	290 psi	2000 kPa
HT150	3.7 mPa-s	375 psi	2500 kPa
HT240	5.0 mPa-s	480 psi	3300 kPa
HT390	7.0 mPa-s	645 psi	4500 kPa

## Conclusion

The HTHS provides a valuable means of determining the viscosity grades of standard oils that are subjected to high-temperature and high-shear conditions. In accordance with ASTM D5481, the HTHS instrument utilizes a multicellular viscometer to simulate real engine operation conditions by pressurizing the system and displacing the sample. In doing so, the sample's viscosity and shear can be determined.

## References

ASTM D5481 "Standard Test Method for Measuring Apparent Viscosity at High-Temperature and High-Shear Rate by Multicell Capillary Viscometer" (ASTM International)

## Acknowledgements

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