



# SURFACE VEHICLE INFORMATION REPORT

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## Physical and Chemical Properties of Engine Oils

### RATIONALE

Updating method to more current industry needs. Document may contain material that is out of date.

### FOREWORD

This document discusses a number of the physical and chemical properties of new and used engine oils. Where appropriate, standardized methods of test for these properties are indicated and a detailed listing included in the references section. This document provides those concerned with the design and maintenance of internal combustion engines with information relative to the terms used to describe engine lubricants.

This document may be used as a general guide to engine oil properties and as an outline for establishing oil quality inspection and maintenance programs.

### 1. SCOPE

This SAE Information Report reviews the various physical and chemical properties of engine oils and provides references to test methods and standards used to measure these properties. It also includes general references on the subject of engine oils, base stocks, and additives.

### 2. REFERENCES

#### 2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

##### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

SAE J183 Engine Oil Performance and Engine Service Classification (Other than "Energy Conserving")

SAE J300 Engine Oil Viscosity Classification

SAE J304 Engine Oil Tests

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Documents

Document Sharing Hub

SAE J1423 Classification of Energy-Conserving Engine Oil for Passenger Cars, Vans, and Light Duty Trucks

SAE J2227 International Tests and Specifications for Automotive Engine Oils

#### 2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org)

|             |                                                                                                                                                   |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM DS 39b | Viscosity Index Tables for Celsius Temperatures                                                                                                   |
| ASTM D56    | Test Method for Flash Point by Tag Closed Cup Tester                                                                                              |
| ASTM D 91   | Test Method for Precipitation Number of Lubricating Oils                                                                                          |
| ASTM D92    | Test Method for Flash and Fire Points by Cleveland Open Cup Tester                                                                                |
| ASTM D93    | Test Methods for Flash Point by Pensky-Martens Closed Cup Tester                                                                                  |
| ASTM D95    | Test Method for Water in Petroleum Products and Bituminous Materials by Distillation                                                              |
| ASTM D97    | Test Methods for Pour Point of Petroleum Products                                                                                                 |
| ASTM D156   | Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)                                                                  |
| ASTM D189   | Test Method for Conradson Carbon Residue of Petroleum Products                                                                                    |
| ASTM D287   | Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)                                                         |
| ASTM D322   | Test Method for Gasoline Diluent in Used Gasoline Engine Oils by Distillation                                                                     |
| ASTM D341   | Viscosity-Temperature Charts for Liquid Petroleum Products                                                                                        |
| ASTM D412   | Test Method for Vulcanized Rubber and Thermoplastic Elastomers-Tension                                                                            |
| ASTM D445   | Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)                                      |
| ASTM D471   | Test Method for Rubber Property – Effect of Liquids                                                                                               |
| ASTM D482   | Test Method for Ash from Petroleum Products                                                                                                       |
| ASTM D 524  | Test Method for Ramsbottom Carbon Residue of Petroleum Products                                                                                   |
| ASTM D664   | Test Method for Acid Number of Petroleum Products by Potentiometric Titration                                                                     |
| ASTM D874   | Test Method for Sulfated Ash from Lubricating Oils and Additives                                                                                  |
| ASTM D892   | Test Method for Foaming Characteristics of Lubricating Oils                                                                                       |
| ASTM D893   | Test Method for Insolubles in Used Lubricating Oils                                                                                               |
| ASTM D974   | Test Method for Acid and Base Number by Color-Indicator Titration                                                                                 |
| ASTM D1160  | Test Method for Distillation of Petroleum Products at Reduced Pressure                                                                            |
| ASTM D1298  | Test Method for Density, Relative Density (Specific Gravity) or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method |



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|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM D1310 | Test Method for Flash Point and Fire Points of Liquids by Tag Open Cup Apparatus                                                                                                |
| ASTM D1500 | Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)                                                                                                             |
| ASTM D2240 | Test Method for Rubber Property – Durometer Hardness                                                                                                                            |
| ASTM D2622 | Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry                                                                           |
| ASTM D2270 | Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100 °C                                                                                     |
| ASTM D2500 | Test Method for Cloud Point of Petroleum Products                                                                                                                               |
| ASTM D2887 | Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography                                                                                         |
| ASTM D2896 | Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration                                                                                   |
| ASTM D2982 | Test Method for Detecting Glycol-Base Antifreeze in Used Lubricating Oils                                                                                                       |
| ASTM D2983 | Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield Viscometer                                                                                       |
| ASTM D3244 | Standard Practice for Utilization of Test Data to Determine Conformance with Specifications                                                                                     |
| ASTM D3524 | Test Method for Diesel Fuel Diluent in Used Diesel Engine Oils by Gas Chromatography                                                                                            |
| ASTM D3525 | Test Method for Gasoline Diluent in Used Gasoline Engine Oils by Gas Chromatography                                                                                             |
| ASTM D3607 | Test Method for Removing Volatile Contaminants from Used Engine Oils by Stripping                                                                                               |
| ASTM D3828 | Test Methods for Flash Point by Small Scale Closed Cup Tester                                                                                                                   |
| ASTM D3829 | Test Method for Predicting the Borderline Pumping Temperature of Engine Oil                                                                                                     |
| ASTM D4052 | Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter                                                                                  |
| ASTM D4055 | Test Method for Pentane Insolubles by Membrane Filtration                                                                                                                       |
| ASTM D4485 | Standard Specification for Performance of Engine Oils                                                                                                                           |
| ASTM D4530 | Test Method for Determination of Carbon Residue (Micro Method)                                                                                                                  |
| ASTM D4628 | Test Method for Analysis of Barium, Calcium, Magnesium, and Zinc in Unused Lubricating Oils by Atomic Absorption Spectrometry                                                   |
| ASTM D4683 | Test Method for Measuring Viscosity at High Shear Rate and High Temperature by Tapered Bearing Simulator                                                                        |
| ASTM D4684 | Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature                                                                          |
| ASTM D4739 | Test Method for Base Number Determination by Potentiometric Titration                                                                                                           |
| ASTM D4741 | Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered Plug Viscometer                                                                          |
| ASTM D4927 | Test Methods for Elemental Analysis of Lubricant and Additive Components—Barium, Calcium, Phosphorus, Sulfur, and Zinc by Wavelength-Dispersive X-Ray Fluorescence Spectroscopy |
| ASTM D4951 | Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry                                               |

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|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM D5002 | Test Method for Density and Relative Density of Crude Oil by Digital Density Analyzer                                                                                                                                                 |
| ASTM D5133 | Test Method for Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature-Scanning Technique                                                                                          |
| ASTM D5185 | Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in Base Oil by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)    |
| ASTM D5275 | Test Method for Fuel Injector Shear Stability Test (FISST) for Polymer Containing Fluids                                                                                                                                              |
| ASTM D5293 | Test Method for Apparent Viscosity of Engine Oils Between –5°C and –35 °C Using the Cold-Cranking Simulator                                                                                                                           |
| ASTM D5481 | Test Method for Measuring Apparent Viscosity at High-Temperature and High-Shear Rate by Multicell Capillary Viscometer                                                                                                                |
| ASTM D5773 | Test Method for Cloud Point of Petroleum Products (Constant Cooling Rate Method)                                                                                                                                                      |
| ASTM D5800 | Test Method for Evaporation Loss of Lubricating Oils by the Noack Method                                                                                                                                                              |
| ASTM D5864 | Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants or Their Components                                                                                                                                          |
| ASTM D5949 | Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)                                                                                                                                                  |
| ASTM D5950 | Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)                                                                                                                                                              |
| ASTM D6022 | Standard Practice for Calculation of Permanent Shear Stability Index                                                                                                                                                                  |
| ASTM D6045 | Test Method for Color of Petroleum Products by the Automatic Tristimulus Method                                                                                                                                                       |
| ASTM D6082 | Test Method for High Temperature Foaming Characteristics of Lubricating Oils                                                                                                                                                          |
| ASTM D6278 | Test Method for Shear Stability of Polymer Containing Fluids Using a European Diesel Injector Apparatus                                                                                                                               |
| ASTM D6335 | Test Method for Determination of High Temperature Deposits by Thermo-Oxidation Engine Oil Simulation Test                                                                                                                             |
| ASTM D6417 | Test Method for the Estimation of Engine Oil Volatility by Capillary Gas Chromatography                                                                                                                                               |
| ASTM D6443 | Test Method for Determination of Calcium, Chlorine, Copper, Magnesium, Phosphorus, Sulfur, Zinc in Unused Lubrication Oils and Additives by Wavelength Dispersive X-ray Fluorescence Spectrometry (Mathematical Correction Procedure) |
| ASTM D6557 | Test Method for Evaluation of Rust Preventive Characteristics of Automotive Engine Oils                                                                                                                                               |
| ASTM D6616 | Test Method for Measuring Viscosity at High Shear Rate by Tapered Bearing Simulator Viscosity at 100 °C                                                                                                                               |
| ASTM D6794 | Test Method for Measuring the Effect on Filterability of Engine Oils After Treatment with Various Amounts of Water and Long (6 h) Heating Time                                                                                        |
| ASTM D6795 | Test Method for Measuring the Effect on Filterability of Engine Oils After Treatment with Water and Dry Ice and a Short (30 min) Heating Time                                                                                         |
| ASTM D6922 | Test Method for Determination of Homogeneity and Miscibility in Automotive Engine Oils                                                                                                                                                |
| ASTM D7097 | Test Method for Determination of Moderately High Temperature Piston Deposits by Thermo-Oxidation Engine Oil Simulation Test – TEOST MHT                                                                                               |

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|---------------|------------------------------------------------------------------------------------------------------------------------------|
| ASTM D7109    | Test Method for Shear Stability of Polymers Containing Fluids Using a European Diesel Injector Apparatus at 30 and 90 Cycles |
| ASTM D7216    | Test Method for Determinating Automotive Engine Oil Compatibility with Typical Seal Elastomers                               |
| ASTM D7528    | Test Method for Bench Oxidation of Engine Oils by ROBO Apparatus                                                             |
| ASTM E1131    | Test Method for Compositional Analysis by Thermogravimetry                                                                   |
| ASTM MNL 1    | Manual on the Significance of Tests for Petroleum Products: 7th Edition                                                      |
| ASTM STP 1068 | High Temperature/High Shear (HTHS) Oil Viscosity: Measurement and Relation to Engine Operation                               |
| ASTM STP 1143 | Low Temperature Lubricant Rheology Measurement Relevance to Engine Operations                                                |

### 2.1.3 Other Publications

American Society of Lubrication Engineers, 1951, "The Physical Properties of Lubricants"

API Publication 1509, latest edition, plus revisions

CEC L-14-A-93, "Evaluation of the Mechanical Shear Stability of Lubricating Oils Containing Polymers" Method

CEC L-36-90, "The Measurement of Lubricants Dynamic Viscosity under Conditions of High Shear"

Federal Test Method Standard No. 791C, Method 203.1, "Pour Stability of Lubricating Oils"

A. J. Caines and R. F. Haycock, "Automotive Lubricants Reference Book," Society of Automotive Engineers, 1996

A. Schilling, "Automotive Engine Lubrication," Broseley, England: Scientific Publications (G.B.) Ltd., 1972

C. M. Georgi, "Motor Oils and Engine Lubrication," New York: Reinhold Publishing Corporation, 1950

Dieter Klamann, "Lubricants and Related Products," Weinheim: Verlag Chemie (F.R.G.) GmbH, 1984

G. J. Schilling and G. S. Bright, "Fuel and Lubricant Additives—II. Lubricant Additives," Lubrication Vol 63, No. 2, 1977

George E. Totten, Steven R. Westbrook, and Rajesh J. Shah, "Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing," American Society for Testing and Materials, ASTM Manual MNL37WCD, 2003

Jacques Denis, Jean Briant, and Jean-Claude Hipeaux, "Lubricant Properties Analysis and Testing," Editions TECHNIP, 2000

M. Campen, D. Kendrick, and A. Markin, "Growing Use of Synlubes," Hydrocarbon Processing, February 1982

N. Benfaremo and C. S. Liu, "Crankcase Engine Oil Additives," Lubrication Vol 76, No. 1, 1990

R. C. Gunderson and A.W. Hart, "Synthetic Lubricants," New York: Reinhold Publishing Corporation, 1962

William A. Gruse, "Motor Oils, Performance and Evaluation," New York: Reinhold Publishing Corporation, 1967