



SURFACE VEHICLE RECOMMENDED PRACTICE

J1681™

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Gasoline, Alcohol, and Diesel Fuel Surrogates for Materials Testing

RATIONALE

SAE J1681 recommends fuels and fluids to be used for materials testing and defines the quality specifications for the recommended test liquids. The test fuels, fluids, and recommendations have been updated to address the variety of potential feedstock sources, the oxidative instability of biodiesel fuels, and the potential mechanisms of chemical and physical attack on fuel system materials. The 2019 revision is completely reorganized to focus on fluid specifications rather than recipes and nomenclature.

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1. SCOPE

This SAE Recommended Practice presents recommendations for test fuels and fluids that can be used to simulate real world fuels. The use of standardized test fluids is required in order to limit the variability found in commercial fuels and fluids. Commercial fuels can vary substantially between manufacturers, batches, seasons, and geographic location. Further, standardized test fluids are universally available and will promote consistent test results for materials testing. Therefore, this document:

- a. Explains commercial automotive fuel components
- b. Defines standardized components of materials test fluids
- c. Defines a nomenclature for test fluids
- d. Describes handling and usage of test fuels
- e. Recommends fluids for testing fuel system materials

The test fluid compositions specified in Section 7 of this document are recommended solely for evaluating materials. They are not intended for other activities, such as engine development, design verification, or process validation unless agreed upon by the contracting parties. Most marketplace fuels contain additives for such purposes as oxidation stability, intake and combustion chamber deposit control, anti-foaming, electrostatics, octane, corrosion mitigation, etc., applied at a parts per million basis. It is not the intention of this document to include a surrogate for the potential effects of these additives. As far as this committee is aware, current additives do not adversely affect fuel system materials. Those contemplating new or improved additives for future applications could use the basic test fluids or fuels from this document, and specify the fuel is to be unadditized in order to inject such additives and use the resulting mixtures to assess whether these new additives might affect fuel system materials.

For the purposes of this document, the term FUEL is used in conjunction with fully blended hydrocarbon or hydrocarbon oxygenate mixtures for use in commercial automotive engines. The term FLUID is applied to mixtures of specific controlled components used to simulate the effects of fuels.

1.1 Purpose

The purpose of this document is to define standardized surrogate gasoline and diesel mixtures to be used in materials testing, and to publish specifications for these fluids. This document also promotes the use of its standardized test fluids to permit consistent results from materials testing and more uniform specification of materials. Formulations in this document are intended to exaggerate the effects of typical severe fuels on materials and simulate fuels at the maximum limits of standard performance specifications, as well as to allow the tests to be conducted in a reasonable amount of time.

2. REFERENCES

2.1 Applicable Publications

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.

SAE J1748 Methods for Determining Physical Properties of Polymeric Materials Exposed to Hydrogen Fuels or Their Surrogates and Their Blends with Oxygenated Additives

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.

ASTM D86	Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
ASTM D93	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
ASTM D445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D471	Standard test Method for Rubber Property - Effect of Liquids
ASTM D613	Standard Test Method for Cetane Number of Diesel Fuel Oil
ASTM D974	Standard Test Method for Acid and Base Number by Color-Indicator Titration
ASTM D975	Standard Specification for Diesel Fuel
ASTM D1319	Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption
ASTM D3703	Standard test Method for Hydroperoxide Number of Aviation Turbine Fuels, Gasoline, and Diesel Fuels
ASTM D4052	Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
ASTM D4806	Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel
ASTM D4814	Specification for Automotive Spark-Ignition Engine Fuel
ASTM D5453	Standard Test Method for the Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
ASTM D6751	Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels
ASTM E203	Standard Test Method for Water Using Volumetric Karl Fischer Titration
ASTM E1064	Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

2.1.3 ISO Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ISO 1817 Rubber, vulcanized or thermoplastic - Determination of the effect of liquids

2.1.4 DIN Publications

Available from DIN, Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, Tel: +49 30 2601-0, <https://www.din.de/en/about-standards/din-standards>.

DIN 51604	FAM-testing fluid for polymer materials - Composition and requirements - Part 2: Testing Fluid B, containing methanol
DIN EN 14214	Liquid petroleum products - Fatty acid methyl esters (FAME) for use in diesel engines and heating applications - Requirements and test methods

2.1.5 Other Publications

Worldwide Fuel Charter, Fifth Edition, September 2013. Alliance of Automotive Manufacturers. www.autoalliance.org.

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 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.

SAE J1747 Recommended Methods for Conducting Corrosion Tests in Hydrocarbon Fuels or Their Surrogates and Their Mixtures with Oxygenated Additives

Harrigan, M., Banda, A., Bonazza, B., Graham, P. et al., "A Rational Approach to Qualifying Materials for Use in Fuel Systems," SAE Technical Paper 2000-01-2013, 2000, <https://doi.org/10.4271/2000-01-2013>

Geng, P., Reichenbaecher, L., Spangenberg, A., Burnett, D. et al., "Testing & Validation Fuels in Vehicle Development," *SAE Int. J. Fuels Lubr.* 1(1):1397-1418, 2009, <https://doi.org/10.4271/2008-01-1764>

Geng, P., Buczynsky, A., and Konzack, A., "US and EU Market Biodiesel Blends Quality Review – An OEM Perspective," *SAE Int. J. Fuels Lubr.* 2(1):860-869, 2009, <https://doi.org/10.4271/2009-01-1850>

Yuen, P., Villaire, W., and Beckett, J., "Automotive Materials Engineering Challenges and Solutions for the Use of Ethanol and Methanol Blended Fuels," SAE Technical Paper 2010-01-0729, 2010, <https://doi.org/10.4271/2010-01-0729>

Cummings, J., "Effects of Fuel Ethanol Quality on Vehicle System Components," SAE Technical Paper 2011-01-1200, 2011, <https://doi.org/10.4271/2011-01-1200>

Alves Fortunato, M. and Starck, L., "Oxidation Stability of Diesel-Biodiesel Blends: Impact of Physical-Chemical Properties Over Ageing into Fuel Injection Systems (FIS) and Storage," SAE Technical Paper 2016-01-2267, 2016, <https://doi.org/10.4271/2016-01-2267>

3. COMMERCIAL AUTOMOTIVE FUEL COMPONENTS AND KNOWN FUEL SYSTEM MATERIAL EFFECTS

3.1 General

Automotive fuels derived from petroleum, natural gas, and biomass contain hundreds of unidentified compounds. Materials that come into contact with fuel components are affected by these compounds in different ways. This document identifies the significant chemical components of commercial automotive fuel with an emphasis on components known to interact with fuel system materials.

3.2 Hydrocarbons in Commercial Fuels

3.2.1 Alkanes

Alkanes are compounds consisting of hydrogen and carbon atoms arranged in a tree structure in which all the carbon-carbon bonds are single. The alkane component group includes straight chain or normal, branched chain or iso, and cyclic or cyclo aliphatic hydrocarbons. Alkanes have the general formula $C_nH_{(2n+2)}$. The alkanes are often referred to as paraffins and are derived from the naphtha fractions of a refinery or gas processing facility.

Many polymeric materials can adsorb alkanes, which can in turn cause swelling.