



SURFACE VEHICLE INFORMATION REPORT

J1297™

OCT2017

Issued 1980-04
Revised 2007-07
Stabilized 2017-10

Superseding J1297 JUL2007

Alternative Automotive Fuels

RATIONALE

The standard was last reviewed in 2007. No members of the current TC7 Committee have expressed interest in being a sponsor to review and revise as necessary the standard.

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FOREWORD

Relevant SAE documents that may be useful in dealing with alternative automotive fuels include: SAE J312, SAE J313, SAE J1498, SAE J1515, SAE J1616, and SAE J1829.

An alternative automotive fuel is a general term for any automotive fuel other than conventionally refined gasoline and diesel fuel found in the commercial marketplace. Additionally, an alternative fuel is any other fuel determined to be substantially not petroleum that yields energy security benefits and environmental benefits.

Other than gasoline, the alternative fuels commonly used in spark-ignition engines in various parts of the world are compressed or liquefied natural gas (CNG or LNG), primarily methane; propane, frequently referred to as LPG (liquefied petroleum gas); hydrous ethyl alcohol (ethanol), particularly in Brazil; gasohol (Reference 1) — a blend, as typically used in the United States, of 90% by volume gasoline and 10% by volume denatured, nominally anhydrous ethanol which is now referred to as E10; fuel methanol (M70-M85) containing small percentages of hydrocarbons; fuel ethanol (E75-E85) containing small percentages of hydrocarbons and reformulated gasolines containing methyl tertiary butyl ether (MTBE), ethanol, ethyl tertiary butyl ether (ETBE), diisopropyl ether (DIPE), or tertiary amyl methyl ether (TAME). E85 is commonly used to cover high-content ethanol blends ranging from 75 to 85% by volume denatured fuel ethanol and 25 to 15% by volume gasoline. The term Ed75-Ed85 is sometimes used since denatured ethanol is used in the blend, but in this report E85 will be used to cover the blend range. Although gasohol and reformulated gasoline are not considered as alternative fuels but contain blending components that individually are considered as alternative fuels, they have been included in this report for completeness. Gasoline containing tertiary butyl alcohol (TBA) and mixtures of methanol and higher molecular weight alcohols had been used briefly during the early 1980s. In the gasoline blend applications, the ethers and the alcohols have been used as octane improvers and as fuel extenders, particularly in the United States, Western Europe, Canada, and Brazil. Ethers have been banned in a number of states because of concern over ground water contamination. Ethers and alcohols commonly are referred to as oxygenates, because they contain chemically bound oxygen. Applicable documents from ASTM International are: ASTM D 975¹, ASTM D 1655, ASTM D 1835, ASTM D 3699, ASTM D 4806, ASTM D 4814, ASTM D 4815, ASTM D 5797, ASTM D 5798, ASTM D 5845, ASTM D 5983, ASTM D 5986, ASTM D 6615, ASTM D 6751, and ASTM D 6839.

Other possible alternative fuels for either spark-ignition or compression-ignition engines include Biofuels such as Biodiesel, Fischer-Tropsch (F-T) or Gas-to-Liquid/Coal-to-Liquid/Biomass-to-Liquid Synthetic Fuels, Water-in-Fuel or Fuel-in-Water Emulsions, other ethers such as Diethyl Ether (DEE) or Dimethyl Ether (DME), and other alcohols, particularly methanol, which was widely used as a racing fuel but has now been replaced by ethanol or high

¹ References to ASTM Standards in this document are to most recent publications.

ethanol/gasoline blends. The use of such fuels is being encouraged in the United States by federal and state legislative and regulatory activities including the U.S. Alternative Motor Fuels Act of 1988, the U.S. Clean Air Act Amendments of 1990, environmental regulations adopted by California in 1990, the U.S. Energy Policy Act of 1992, the U.S. Energy Conservation Reauthorization Act of 1998, and the U.S. Energy Policy Act of 2005.

The near-neat alcohols have been evaluated extensively in many countries in vehicles equipped with engines which have been retrofitted or specifically designed to use these alternative fuels. From these efforts, a mixture of 85% by volume methanol or denatured ethanol and 15% by volume hydrocarbons or gasoline, referred to as M85 or E85, respectively, have evolved as the preferred fuels for spark-ignition engines by some. Gasoline or a hydrocarbon mixture is used in either M85 or E85 to enhance vehicle startability and, as a safety feature, to increase the visibility of burning methanol or ethanol. So-called flexible fuel vehicles (FFVs) have been developed which can be fueled by both M85 and gasoline alone or, E85 and gasoline alone (Reference 2). Fuel methanol and fuel ethanol without added hydrocarbon or gasoline (that is, M100 or E100, often referred to as neat alcohols, have also been evaluated in many countries in vehicles equipped with modified compression-ignition (CI) type engines (Reference 3) as well as those equipped with spark-ignition engines. Both the FFVs and at least one M100 CI engine have reached the commercial production stage of development (References 4, 5). Blends of natural gas liquids, ethanol, and biomass derived co-solvents are also being evaluated for both spark-ignition and compression-ignition engine applications.

Engines made to be capable of using an alcohol as the primary fuel component will require new lubricating oils specifically formulated to provide optimum durability for such engines. Changes in the fuel storage and distribution infrastructure can also be expected to occur to accommodate the alternative fuels.

Fuels derived from biomass sources including, e.g., vegetable oils and their derivatives, have been widely investigated as a means of extending diesel fuels. One such fuel, a biodiesel consisting of 20% by volume soy methyl ester blended with 80% by volume petroleum diesel fuel (B20), has recently been approved under the Energy Conservation Reauthorization Act and is being actively evaluated as an alternative fuel. Since its introduction, biodiesel now consists of not only fatty acid methyl esters made from vegetable oil, but also fatty acid methyl esters made from animal fat, or waste/recycled grease. EPA has since proposed a two-part definition for bio-based diesel fuel, one being Biodiesel (Mono-Alkyl Esters) whereas the other is Non-Ester Renewable Diesel.

In another area, a wide boiling range petroleum fuel, which has been used as a jet fuel, has been considered for gas turbine and stratified-charge engines.

The Department of Defense (DOD) has implemented the Single Fuel on the Battlefield policy which mandates that all combat and tactical diesel fueled ground vehicles and equipment are to use an aviation kerosine (i.e., JP-8 or JP-5) in place of diesel fuel (Reference 69). This policy allows both aviation and ground materiel systems to use the same common fuel which significantly reduces the logistics of fuel supply and distribution. Thus, JP-8 and JP-5 have become alternative fuels for DOD's diesel fueled ground vehicle and equipment fleet. Since implementing the Single Fuel on the Battlefield Policy in early 1990, DOD has initiated the Clean Fuels Initiative in 2004, www.mainstayenergy.com/documents/docman/DOD_CTL-Barna.pdf, which is intended to catalyze the commercial industry to produce clean fuels for the military from secure domestic resources with the initial focus being on utilizing fuels generated by the Fischer-Tropsch process. Additional information on alternative fuels, their properties, storage and dispensing considerations and vehicle facility modifications can be found in a recently published guidebook (Reference 6).

1. SCOPE

This SAE Information Report provides information on certain fuels that are being used or have been suggested as alternatives to motor gasoline (SAE J312) or automotive diesel fuel (SAE J313) for use in spark-ignition or compression-ignition engines. Some of these fuels are derived from petroleum while others are from non petroleum sources.

2. REFERENCES

2.1 Applicable Publications

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

2.1.1 SAE Publications

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

SAE J312	Automotive Gasolines
SAE J313	Diesel Fuels
SAE J1498	Heating Value of Fuels
SAE J1515	Impact of Alternative Fuels on Engine Test and Reporting Procedures
SAE J1616	Recommended Practice for Compressed Natural Gas Vehicle Fuel
SAE J1681	Gasoline, Alcohol, and Diesel Fuel Surrogates for Materials Testing
SAE J1829	Stoichiometric Air/Fuel Ratios of Automotive Fuels

SAE Cooperative Research Report, a Discussion of M85 (85% Methanol) Fuel Specifications and Their Significance, SAE Project Group 3, September 1991

SAE Cooperative Research Report, Gasoline/Methanol Mixtures for Materials Testing, SAE Project Group 2, September 1990

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 975	Standard Specification for Diesel Fuel Oils
ASTM D 1655	Standard Specification for Aviation Turbine Fuels
ASTM D 1835	Standard Specification for Liquefied Petroleum (LP) Gases
ASTM D 2163	Standard Test Method for Analysis of Liquefied Petroleum (LP) Gases and Propylene Concentrates by Gas Chromatography

NOTE: ASTM D 2163 was withdrawn in 2005 without replacement.

ASTM D 3699	Standard Specification for Kerosine
ASTM D 4806	Standard Specification for Denatured Fuel Ethanol for Blending With Gasolines for Use as Automotive Spark-Ignition Engine Fuel
ASTM D 4814	Standard Specification for Automotive Spark-Ignition Engine Fuel
ASTM D 4815	Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, Tertiary-Amyl Alcohol, and C ₁ to C ₄ Alcohols in Gasoline by Gas Chromatography
ASTM D 5797	Standard Specification for Fuel Methanol (M70-M85) for Automotive Spark-Ignition Engines
ASTM D 5798	Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines
ASTM D 5845	Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, Methanol, Ethanol, and Tert-Butanol by Infrared Spectroscopy

- ASTM D 5983 Standard Specification for Methyl Tertiary-Butyl Ether (MTBE) for Downstream Blending for Use in Automotive Spark-Ignition Engine Fuel
- ASTM D 5986 Standard Test Method for Determination of Oxygenates, Benzene, Toluene, C₈ – C₁₂ Aromatics and Total Aromatics in Finished Gasoline by Gas Chromatography/Fourier Transform Infrared Spectroscopy
- ASTM D 6615 Standard Specification for Jet B Wide-Cut Aviation Turbine Fuel
- ASTM D 6751 Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels
- ASTM D 6839 Standard Test Method for Hydrocarbon Types, Oxygenated Compounds and Benzene in Spark Ignition Engine Fuels by Gas Chromatography

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