

SURFACE VEHICLE INFORMATION REPORT

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Biodiesel in Automotive Application; Lessons Learned

RATIONALE

This new J document provides a general summary of the experience with biodiesel in the automotive industry where significant research has been conducted over 20 years. Recently, the railroad industry and the locomotive manufacturers have experienced similar concerns. The purpose of this document is to provide them and other practitioners dealing with biodiesel, with the knowledge and a tool to evaluate if additional research is warranted regarding their specific application. Engine performance, emissions, material compatibility, fuel storage, and long term effects are discussed. Users of any fuel including biodiesel blends should contact their engine manufacturer for advice regarding fuel/equipment compatibility.

1. OBJECTIVE

Provide the railroad industry and the locomotive manufacturers a summary of lessons learned in the automotive industry regarding use of biodiesel. Close the knowledge gap between those who have been participating at ASTM International over the last two decades and those who have not. Merge the activities of the two groups, bring the railroads to ASTM, and eliminate duplication of efforts. Lack of participation by any group in standard setting efforts can result in fuel specifications that lack components for a particular application.

1.1 BACKGROUND

The Energy Independence & Security Act of 2007 mandated the use of renewable fuels. This was in addition to other state and local requirements that had been in place prior to 2007. Before that the Energy Policy Act (EPACT) of 1992 required the federal government to procure large numbers of alternative fuel vehicles (AFVs) in the coming years as a means of fostering energy security and a cleaner environment. Energy Conservation Reauthorization Act (ECRA) of 1998 required modification of EPACT, which allowed the use of biodiesel fuel to meet requirements of federal and state fleets to purchase AFVs.

ASTM diesel specification, D975, allows the use of up to 5 volume % biodiesel in conventional diesel. Conventional diesel in this document refers to biodiesel-free diesel fuel defined by ASTM D975 prior to allowance of up to 5 volume % biodiesel. ASTM D7467 provides fuel specification for blend from 6 volume % to 20 volume %. The automotive industry and a number of other groups were intimately involved in this process for developing specifications for B100 blend stock and Bxx blends (xx designates the volume percent biodiesel in the blend) for many years, and addressed many concerns while continuing to resolve additional issues. Railroads/locomotives were not a part of this process at ASTM.

Knowing that biodiesel blends will be used in their equipment, the railroads and locomotive engine manufacturers expressed concern regarding a number of similar issues that were investigated on the automotive side but were either unknown to them or would not apply since locomotive and automotive applications have differences.

An SAE subcommittee was formed to discuss, identify, and address these concerns. The Subcommittee charter was defined as follows:

Identify issues of concern to the railroads, engine and equipment manufacturers, and fuel suppliers upon introduction of biodiesel blends in the diesel pool in North America. Formulate and propose a practical path forward.

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There was general agreement at the first meeting that from a practical point of view, use of up to 5 volume % biodiesel in conventional diesel as specified by ASTM D975, as long as the biodiesel blend stock meets ASTM D6751, was acceptable and unavoidable in most cases. However, continued monitoring of potential long term concerns are warranted.

Members also stated that many performance issues common to other diesel engine applications have been addressed but information has not been provided to the railroad/locomotive community. They agreed that they would benefit from having a practical information package containing a summary of the automotive experience. This document is intended to compile this experience.

2. REFERENCE & RESOURCE DOCUMENTS

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.

Mittelbach, M. & Remschmidt, C., "Biodiesel: The Comprehensive Handbook", Mittelbach, 2004

Knothe G., Krah, J., Van Gerpen, J., "The Biodiesel Handbook", 2nd Edition, AOCS Press, 2010

ASTM D975 "Standard Specification for Diesel Fuel Oils", Section 5, Volume 05.01, 2013

ASTM D6584 "Standard Test Method for Determination of Total Monoglycerides, Total Diglycerides, Total Triglycerides, and Free and Total Glycerin in B-100 Biodiesel Methyl Esters by Gas Chromatography", Section 5, Volume 5.04, 2013

ASTM D6751 "Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels", Section 5, Volume 5.03, 2013

ASTM D7501 "Standard Test Method for Determination of Fuel Filter Blocking Potential of Biodiesel (B100) Blend Stock by Cold Soak Filtration Test (CSFT)", Section 5, Volume 5.04, 2013

ASTM D7467 "Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)", Section 5, Volume 5.04, 2013

"Biodiesel Handling and Use Guide" 4th Edition, National Renewable Energy Laboratory, TP-540-43672, December 2009

Bacha, J.; Freil, J.; Gibbs, L.; Hemighaus, G.; Hoekman, K.; Horn, J.; Ingham, M.; Jossens, L.; Kohler, D.; Lesnini, D.; McGeehan, J.; Nikanjam, M.; Olsen, E.; Scott, B.; Sztenderowicz, M.; Tiedemann, A.; Walker, C.; Lind, J.; Jones, J.; Scott, D.; Mills, J. "Diesel Fuels Technical Review," Chevron Global Marketing, 2007.

3. ENERGY CONTENT:

In addition to carbon and hydrogen, biodiesel contains a certain amount of oxygen. This, along with a lack of aromatics, is responsible for lower particulate matter (PM) emissions. However, this also contributes to lower energy content. Thermodynamic theory and experimentally measured net heats of combustion indicate that a given volume of biodiesel will not deliver the same level of energy as that of the same volume of conventional diesel lacking oxygen.

The volumetric energy content can be approximately 10% lower for pure biodiesel (B100) compared to conventional diesel. However at blend levels up to 5 volume %, the difference in fuel economy is generally considered to be too small to measure and not significant statistically.