

Biodiesel Usage in Cummins Engines: Standby Power Genset Applications

WHITE PAPER

by Jeff Klopfenstein and Justin L. Hohn



INTRODUCTION

Decarbonization efforts worldwide have driven demand for biodiesel in recent years. Lifecycle, or cradle to grave greenhouse gas (GHG) emissions analysis demonstrates that biodiesel usage enables reductions of around 40 – 86% vs. fossil diesel fuel. These environmental as well as other regulatory factors are driving the use of biodiesel into applications that traditionally saw little to no usage. One such application is standby power generation. Historically, standby power generation equipment makers avoided recommending biodiesel due to the intermittent operation of the equipment and unstable nature of the fuel for long term storage. The purpose of this document is to detail some considerations and risks surrounding the use of biodiesel blend fuels in standby power generation applications. There are no new requirements set forth by this document. For fuel specification information and approved fuels for use in specific Cummins engines, please refer to Fluids for Cummins® Products Service Manual, Bulletin 5411406.

DIESEL FUEL AND BIODIESEL COMPOSITION

Biodiesel is considered a low carbon fuel and is comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats. Pure biodiesel fuel is designated B100 (100% by volume biodiesel) and must meet the requirements of ASTM D6751 or EN14214. The most common feedstocks used for synthesis of biodiesel are soybean oil (SME), rapeseed oil (RME) and palm oil (PME). Other feedstocks include a variety of other vegetable oils and used cooking oils. Biodiesel is commonly blended with conventional ultralow sulfur diesel (ULSD) fuel in a percentage by volume ratio. For example, a 20% biodiesel in 80% convention diesel blend would be known as B20. In North America, biodiesel blend physical and chemical properties are covered by ASTM D7467. North American ultralow sulfur diesel fuel is covered by ASTM D975. Users of ASTM D975 fuel should note that up to 5% biodiesel can be blended in ULSD without any special labeling or disclosure.

In Europe, biodiesel blends (B20 and B30) are covered by EN16709. Conventional diesel fuel or ULSD in Europe is specified by EN 590 and it should be noted that biodiesel can be blended with this fuel at up to 7% per this specification.

BIODIESEL AND RENEWABLE DIESEL COMPARISON

As with biodiesel, renewable or paraffinic diesel is another type of low carbon fuel that can be made from renewable sources. Many of the feedstocks used to make paraffinic diesel are common to biodiesel but the chemical, physical, and combustion properties of this fuel are different when compared to biodiesel. Renewable diesel is also synonymous with other terms such as R99, HVO, RD, and paraffinic fuel. As of August of 2023, Cummins has recently approved further use of renewable or paraffinic diesel to now cover virtually all of Cummins engine products. See the following link for more information:

[Cummins Announces Approval of Unblended Renewable Diesel Use in all Industrial High-Horsepower Engines | Cummins Inc.](#)

FUEL PROPERTY COMPARISON

#2 grade ULSD and Biodiesel fuels share many similar properties, but some key properties differ. We'll discuss some of the major differences here and point out the impact to operation in diesel engines.

Property	Typical ULSD #2 fuel range	Typical biodiesel range	Operational notes
Cloud point	-14 °F to +15 °F	+21 °F to +60 °F	Biodiesel displays worse performance versus ULSD when comparing cloud point and other cold temperature properties such as cold filter plugging point and low temperature flow. This could cause accelerated filter plugging, restrictions in the fuel system and low power in engines using biodiesel blends in cold weather.
Energy content (heating value)	The energy content for a 20% diesel blend (B20) is around 3-4% lower compared to ULSD.		To get the same power output, more fuel will have to be consumed. As the biodiesel % increases, the energy content difference increases versus ULSD.
Dissolved water	0-200 ppm (varies by temperature)	Up to 1000 ppm (varies by temperature)	Higher water content causes issues such as microbial growth, sludge formation, fuel property changes, fuel system corrosion, or solubilizing fuel additives.
Oxidation stability (thermal or long-term storage effects)	Oxidation Stability is typically much worse with biodiesel and is highly dependent on fuel quality and fuel additive usage.		Storage stability is one of the biggest concerns with biodiesel. Over time fuel oxidation will occur quicker than with ULSD. Biodiesel degradation products can accumulate as sludge in the fuel tank, sludge / sediment in fuel filters and gummy deposits in the fuel system causing potential seizing of various fuel injector and fuel pump parts. Cummins strongly recommends that fuel containing biodiesel should be consumed within 3 months of purchase. Efforts to mitigate impacts to biodiesel storage are discussed in the recommendations section.
Material compatibility	Differences in molecular structure between biodiesel and ULSD cause a variety of effects on engine materials.		Some elastomers will swell when exposed and some plastics will soften. Reactive metals such as copper and zinc will corrode in degraded biodiesel and dissolved metals could precipitate as deposits in other locations within the fuel system. Modern fuel systems fitted on Cummins engines are tested extensively with biodiesel and should be resistant to material degradation.
Distillation range	The point where 90% of the biodiesel fuel is boiled off or evaporated is on average 30-50 °C higher than with #2 ULSD.		Biodiesel fuel could potentially build up in crankcase oil (fuel dilution) in units that run low duty cycles. This could affect oil drain intervals (ODI).

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GENERATOR SET STARTUP AND FUEL STORAGE

Although fuel may be purchased in North America which is labeled as “ULSD”, “diesel” or “ASTM D975 fuel,” it’s possible that up to 5% biodiesel could be in the blend. It is recommended that upon commissioning of the generator set, fuel loaded into the system should be tested to determine if any biodiesel is present. If any biodiesel is present, follow the directions in the Recommendations section below. As fuel is consumed and re-filled during the service life of the Cummins generator, it is advisable to periodically test the fuel for biodiesel content and follow directions in the Recommendations section. Fuel in the generator set will likely remain in the supply tank for long durations as the equipment is exercised only for short periods of time at a certain frequency. If poor quality or degraded biodiesel is present in the tank, the fuel could circulate through the fuel system and sit stagnant in between generator exercise periods. Poor quality or degraded fuel can easily form deposits on tight tolerance fuel system components causing damage to the system.

BIODIESEL AND ENGINE EXHAUST EMISSIONS

Engine exhaust emissions are impacted by using biodiesel. Regulated emissions such as NO_x increase as biodiesel blend percentage increases. Other regulated emissions such as PM, HC and CO decrease by using biodiesel. The US EPA studied these impacts and documented findings in the following report:

[A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions](#)

Owners/operators of Cummins generator sets should consult with regulatory authorities regarding engine exhaust emissions regulations when using biodiesel as appropriate.



RECOMMENDATIONS

The following recommendations will not guarantee trouble free operation of Cummins generator sets but may mitigate the risk of fuel related issues. It is critical that the user understands what fuel is supplied to the generator set as biodiesel mandates are present in certain localities. Use of fuel that does not conform with Fluids for Cummins® Products Service Manual, Bulletin 5411406 requirements, such as degraded fuel, or fuel that is not approved for specific engines or applications does not constitute a defect in workmanship or mechanical failure of the Cummins generator set and will not be covered by warranty.

- The recommended fuel types supplied to Cummins generator sets are: ASTM D975 #2 S15 grade with no biodiesel content (B0). Another alternative is unblended EN 15940 Paraffinic diesel (HVO) fuel.
- Cummins does not recommend any biodiesel blends be used in standby generator set applications but given ASTM D975 fuel could contain up to 5% biodiesel and EN 590 fuel up to 7% biodiesel without special labeling or disclosure, the fuel should be tested per ASTM 8274 to determine biodiesel content. If biodiesel blends are used it should be noted that as biodiesel content increases, the risk for fuel degradation and deposit formation detrimental to the engine fuel system increases.

If biodiesel content >0% is confirmed the following actions are strongly recommended:

- Fuel should be consumed within 3 months of purchase.
- NOTE: If fuel cannot be consumed within 3 months, testing of a representative fuel sample from generator sets should be performed monthly according to the following test methods:

Property	Test method	Limit	Reference
Biodiesel content	ASTM 8274	5% maximum	Cummins Service Manual 5411406
Oxidation stability	EN 15751	6 hours minimum	ASTM D7467
Acid number	ASTM D664	0.3 mg KOH/g maximum	ASTM D7467
Water	ASTM D6304	200ppm maximum	Cummins Service Manual 5411406
Water & sediment	ASTM D2709	0.05 % by volume	ASTM D7467

- Fuel maintenance should be strictly followed to keep fuel clean, and dry according to the requirements of Fluids for Cummins® Products Service Manual, Bulletin 5411406, ASTM D975 and conform to the oxidation stability requirements of ASTM D7467. Any required treatment with fuel additives should be according to the direction of the fuel supplier.
- Degradation of fuel can take place in the fuel system as well as the fuel tank. It is recommended to exercise the generator set with fuel conforming to requirements from the previous bullet point to mitigate the risk of fuel system contamination.
- The following website provides details about generator testing/maintenance with fuel testing options: cummins.com/parts-and-service/generators/planned-maintenance-program.

USEFUL LINKS

- cummins.com/generators/white-papers
- cummins.com/generators/alternative-fuels
- cummins.com/engines/biodiesel-faqs

About the authors



Jeff Klopfenstein

Liquid Fuels SME, Corporate R&T
Chemical Technology Group

Jeff Klopfenstein started his career at Cummins in 2006, working for Cummins Fuel Systems within in the Materials Engineering group. During this time, he helped to support various engineering groups within the BU with any chemistry related issues. After several years, Jeff transitioned for a short time to the Corporate Chemical Technology group as the chemistry lab manager. After this role, he transitioned back to PSBU, working again in the Materials Engineering group until fall of 2022. At present Jeff works in the Corporate Chemical Technology group as the liquid fuels subject matter expert. In this role Jeff works on any fuel related issues affecting Cummins products, helps assist Cummins personnel with any fuel related questions, and acts as Cummins voice to the industry with respect to various fuels topics. Jeff earned his bachelor's degree in chemistry from Purdue University – Fort Wayne.



Justin L. Hohn

Fuel Systems and Integration Technical
Advisor, PSBU Diesel Fuel Systems

Justin Hohn started his career at Cummins in 2008 after 14 years of service in the US Air Force, joining the Heavy Duty Engineering group as a fuel system validation specialist. After an additional role in fuel system and air handling validation, he transitioned to leading market support activities for all Power Generation products. Later returning to fuel system validation for the High Horsepower business, he now serves as Technical Advisor for PSBU fuel filtration and delivery. He holds a Bachelor's degree from the US Air Force Academy and Master's degree from Indiana University.



Cummins Inc.
Box 3005
Columbus, IN 47202-3005
U.S.A.

cummins.com

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