



Technical Requirements for GM Aftermarket Diesel Fuel Conditioner Additive

1 Scope

1.1 Material Description. This document provides standard technical requirements for the GM aftermarket Diesel Fuel Conditioner Additive which is a multifunctional middle distillate fuel additive package that provides enhanced lubricity, corrosion protection, keeps engine & fuel injectors clean, enhances stability, and provides cetane boost. It is specifically formulated for low sulfur and ultra-low sulfur applications including biodiesel blends up to B20 (20% biodiesel blends).

Note: The additives shall not contain any metallic content or methanol.

1.2 Symbols. Not applicable.

1.3 Applicability. The additives can be used in all GM diesel engine applications including in-direct fuel injection systems and modern common rail fuel injection systems.

1.3.1 This Diesel Fuel Conditioner is expected to provide following benefits:

- Improves fuel lubricity thereby preventing fuel pump failures.
- Prevents fuel system corrosion due to contamination of water or other corrosive compounds in the fuel.
- Keep injector and engine clean to maintain power, performance and fuel cleanliness.
- Increase cetane number for better engine performance.
- Improves thermal and storage stability, thereby reducing fuel oxidation and sludge formation that can plug fuel filters, cause deposits, and damage to fuel injectors.
- Prevents fuel system corrosion due to contamination of water or other corrosive compounds in the fuel
- Have water separating demulsifier agents to help provide dry fuel.

The diesel fuel conditioner is expected to provide protection against following types of fuel system deposits:

- a. Deposits produced by diesel fuel degradation
- b. Deposits produced by oxidation of biodiesel fuels
- c. Polymeric organic deposits related to specific additive chemistries
- d. Alkali metal carboxylates deposits related to interactions of specific fuel additives with fuel contaminants

As such, the diesel fuel conditioner is envisioned to be used on a regular basis by addition to the fuel tank during fuel fills in order to protect the diesel engines and fuel systems and insure the integrity of their design and performance.

1.3.2 The tests defined in 3.1 through 3.11, must be regarded as minimum requirements for compliance for diesel fuel conditioner additives. Additional requirements may be defined based on the type of additive, its specific chemistry, and cleaning application. This specification applies to diesel and biodiesel blended fuels only.

1.4 Remarks. Program specific technical specifications may include additional requirements that are not referenced in this document and may supercede any requirements included in this document. In case of any conflicts between this document and the program specific technical specifications, the program specific technical specifications shall take precedence.

This specification describes the technical requirements for GM aftermarket diesel fuel detergent packages. The GM Global Propulsion Systems (GPS) Fuels Group will evaluate the technical merits of the additive package prior to being considered by GM Purchasing for the Customer Care and Aftersales Division. These specifications will cover requirements for performance as well as requirements for ensuring compatibility of the additives with fuel system, engine, and the after-treatment catalyst system. The requirements are a combination of

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January 2018

Page 1 of 8



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standardized fuel industry engine dynamometer cleanliness tests, chemical laboratory tests, and supplier specific vehicle performance demonstration tests, as a basis for consistent fuel additives performance evaluation.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM D93	ASTM D975	ASTM D7501	ISO 1817
ASTM D130	ASTM D2274	ASTM D23015	ISO 2160
ASTM D471	ASTM D2500	DIN EN 116	ISO 2719
ASTM D524	ASTM D6079	DIN EN 590	ISO 10370
ASTM D613	ASTM D6217	DIN EN 12662	ISO 12156
ASTM D664	ASTM D6371	DIN EN 14214	SAE J2643
ASTM D971	ASTM D7467	DIN EN 15751	TM0172

2.2 GM Standards/Specifications.

GMW3059	GMW14270	GMW14914
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2.3 Additional References.

- Akron Rubber Development Laboratories - 2887 Gilchrist Rd, Akron, OH 44305 – available at www.ardl.com.
- Coordinating European Council (CEC) DF-79-07.
- Coordinating European Council (CEC) DW-10.
- Coordinating European Council (CEC) F-98-08.
- Coordinating European Council (CEC) F-110-16.
- Coordinating European Council (CEC) RF-06-03.
- dexos® 2 approved brands for diesel engine oil available at www.gmdexos.com.
- GMPT-5-014.
- GMPT-5-019.
- GMPT-5-020.
- GMPT-5-034.
- National Association of Corrosion Engineers (NACE) TM0172 available at www.NACE.org.
- Program Specific Technical Specifications.

3 Requirements

3.1 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to submit a full material composition disclosure to GM via the International Material Data System (IMDS) or via a completed GMW3059 report form.

Note: The additives shall not contain any metallic content or methanol.

3.2 Performance Requirements. The additive formulation should be used in diesel/biodiesel blended fuels which meets relevant country/regional fuel standards (such as ASTM D975 for diesel fuel and ASTM D7467 for biodiesel blends from B6 - B20 in the United States).

3.3 Lubricity. Good lubricity of diesel fuel is important to minimize friction and damage in diesel fuel system components, especially in the fuel pumps. A position statement by the Diesel Fuel Injection Manufacturers suggests that the lubricity of the fuel as measured by the HFRR according to ASTM D6079 must have a lubricity value of 460 microns maximum. Fuel with lubricity exceeding 460 microns can adversely affect the lifetime of some of the fuel lubricated injection system components.

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January 2018

Page 2 of 8

3.3.1 Test Method. The lubricity of the diesel fuel should be measured by the High Frequency Reciprocating Rig (HFRR) method which measures the wear scar on the test specimen ball as per the procedure described in ASTM D6079.

3.3.2 Demonstration of Performance. The additive must demonstrate improvement in lubricity performance as measured by HFRR at +60 °C wear scar diameter in a base diesel fuel which has lubricity of > 600 µm to < 460 µm with the use of additive.

It is recommended to use GM test fuel, GMPT-5-034, Ultra Low Sulfur Diesel Fuel – Low Lubricity, as a reference test fuel for demonstration of the performance. Details on fuel suppliers for the test fuels can be found in 3.5.

3.4 Fuel Stability. Biofuels such as fatty acid esters, commonly called “biodiesel,” are increasingly being used in the marketplace. In the United States, the quality of common fatty acid alkyl esters is defined in the ASTM D6751 standard for biodiesel fuel blend stock (B100) intended for use in blends at concentrations of up to 20 volume percent. There are two (2) additional standards that define the quality of the blended fuels, ASTM D975 which applies to blended fuels up to B5 and ASTM D7467 which applies to blended fuels from B6 to B20.

Field warranty and validation tests have shown significant concerns with stability of biodiesel fuels including fuel system deposits, engine oil deterioration, and efficiency loss of the after-treatment system. Maintaining high stability of biodiesel blended fuels is critical for its optimal performance as a vehicle fuel.

In the United States, the ASTM D6751 standard for FAME has a stability requirement as measured by an induction period of 3 h minimum for B100 fuel, which is significantly lower than the induction period of a minimum of 8 h that is required by the European DIN EN 14214 standard for B100 fuel. There are no stability requirements in ASTM D975 for biodiesel blends up to B5, while the stability requirements for B6 to B20 blends as per ASTM D7467 is a minimum of 6 h. In comparison, the DIN EN 590 standard which allows biodiesel content up to 7 volume percent has a limit for stability of a minimum 20 h.

Fuel injection equipment and after-treatment systems could be significantly damaged from the use of oxidized fuel. Fuel must have sufficient stability to prevent damage due to oxidation under all normal scenarios in which the fuel is stored and used.

3.4.1 Test Method. Fuel stability of biodiesel and biodiesel blended fuels ($\geq$ B2) is best described by the parameter ‘ageing reserve’ determined as Rancimat induction period (IP) according to the DIN EN 15751 test method.

Fuel stability of diesel fuels without any biodiesel (B0) or up to B2 blend must be determined by Rapid Small Scale Oxidation Test (RSSOT) - PetroOxy test as per ASTM D7545 method which measures the induction period under specified conditions and can be used as an indication of the oxidation and storage stability of diesel fuels.

3.4.2 Acceptable Performance. The additive should demonstrate following performance:

The additive must demonstrate improvement in fuel stability as measured by Rancimat IP DIN EN 15751 test method in a soy based FAME biodiesel B20 blend meeting requirements of ASTM D7467. The base biodiesel blend, B20, must not have any stability additive and must have a Rancimat IP of about 7 h to 12 h which is typical for B20 blends in US marketplace. Use of fuel stability additive must improve the Rancimat IP of the base B20 blend to > 20 h. It is recommended to use GM test fuel, GMPT-5-020 (Ultra Low Sulfur B20) as base fuel for demonstration of the performance. Details on fuel suppliers for the test fuels can be found in 3.5.

- For petroleum diesel without any biodiesel the performance must be demonstrated in base diesel fuel which meets ASTM D975 standard requirements. The base diesel fuel must have a stability as measured by PetroOxy test (ASTM D7545) of around 50 minutes ($\pm$ 10 minutes). Use of stability additive must improve PetroOxy IP be > 80 minutes on the base fuel.

3.5 Detergent Performance Standard. All performance testing and fuel composition analysis shall be conducted by an Independent Laboratory. Initial deposit control performance shall be demonstrated using the following test.

3.5.1 Diesel Injector Nozzle Deposit Test.

3.5.1.1 Test Method. Diesel Injector nozzle keep clean performance shall be demonstrated using CEC F-98-08 (DW10B) Diesel injector nozzle fouling. In the test, the base reference fuel minimum deposit level and additive performance shall be conducted using the same engine block and cylinder head. For the CEC-F-98-08 (DW10B), performance data shall be reported in terms of torque loss for each cycle of the test. The final result shall be

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January 2018

Page 3 of 8

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