

	SURFACE VEHICLE RECOMMENDED PRACTICE	SAE J2793 FEB2011
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Fuel Dispensing Filter Test Methods		

RATIONALE

To provide guidelines and standard test methodology to assist industry with the development and qualification of filtration products for gasoline and diesel fuel dispensing.

FOREWORD

Fuel dispensing filters are the last line of defense, the final opportunity to control fuel quality, before the contamination burden is transferred to the vehicle on-board fuel filtration system. Contamination is often considered to be in the form of solid particulate, but can also consist of chemical compounds, coarse or emulsified water, or in the case of ethanol blended gasoline, as a phase separated water/ethanol mixture. Particulate contamination can be managed with current technologies common to the filtration industry. As bio-fuel usage increases, the occurrence of water contamination issues escalates in a similar trend. Therefore, it is desirable to understand the contamination involved and to develop industry standard test methods for proper evaluation of dispensing filter performance, which can facilitate protection of vehicle fuel systems.

Heavy duty (HD) equipment and automotive vehicles are fueled frequently, exposing the fuel system to contaminants that are often unknown and in varying quantities. Automotive on-board fuel filters are predominantly in-tank, and comparatively small in size, having limited particulate holding capacity. In-tank filters and fuel pump modules are designed to be durable long-life components and they are correspondingly costly to replace, so it is progressively more important to prevent gross contamination of vehicle fuel tanks. The solid particulate removal function is the most straightforward to address from a dispensing filter design, manufacturing, and testing aspect.

Vehicle on-board fuel systems have limited ability to deal with water-in-fuel. Depending on the fuel chemistry, small amounts of raw, (slug) water can be rejected by a coarse hydrophobic screen at the in-tank fuel pickup (automotive), or by a fuel water separator, (HD) diesel applications. Rejection efficiency is largely dependent on fuel flow demand established by the power-train management system.

HD compression ignition (diesel) on-board fuel filters are more readily accessible, yet they must protect sophisticated ultra-high pressure injection systems from abrasive wear and the damaging effects of water contamination existing in fuel chemistries that are often not conducive for water separation.

Automotive on-board gasoline fuel filter elements will allow gross amounts of raw water, and/or a phase separated water/alcohol mixture, to pass through and be delivered to the engine. Gasoline engines will not operate with high water content, or a phase separated fuel condition, often stranding vehicles in the vicinity of the fueling station.

Heavy duty diesel on-board fuel filters are largely dependent on the fuel chemistry as to their ability to separate water from fuel. Certainly, water complicates cold weather operations and contributes to: icing issues, microbiological growth, generally corrosive conditions, fuel system deterioration and fuel quality degradation.

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Certain types of fuel dispensing filters are tasked to reduce the severity of “water-on-board” situations and alert the station operators to the impending condition in their storage tanks. This alert may be through electronic monitoring of dispensing rates or complaints of “slow-flow” from the person filling a vehicle. The water alert function of these types of dispensing filters is in addition to the particulate control function.

The opportunities for fuel contamination are varied and include; refining operations, pipelines, distribution terminals, truck transportation, real estate at the fueling station, and inattention to detail while setting up fuel drops into the storage tanks at the fuel station.

The following test procedure is relevant to neat gasoline, ethanol blended fuels, diesel, and biodiesel fuel blends. It is applicable to filters installed on fuel dispensing equipment and describes the tests required to evaluate them for reaction to water contaminant in modern fuels. Other SAE and ISO standards are referenced for structural integrity and filtration performance rating.

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1. SCOPE

This SAE Recommended Practice is applicable to gasoline and diesel fuel filters installed on fuel dispensing equipment, mobile or stationary. It describes a set of tests used to characterize the structural integrity, filtration performance, and reaction to water contaminant with fuel dispensing filters.

1.1 Purpose

To provide a standardized method for evaluating performance characteristics on laboratory bench equipment. The laboratory data may be utilized with actual field data to establish dispensing filter performance specifications.

2. REFERENCES

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.

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 724-776-4970 (outside USA), www.sae.org.

SAE J905 Fuel Filter Test Method

SAE HS 806 Oil Filter Test Procedure

2.1.2 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 12103-1 Road Vehicles - Test Dust for Filter Evaluation Part 1: Arizona Test Dust

ISO 19438 Diesel Fuel and Petrol Filters for Internal Combustion Engines - Filtration Efficiency using Particle Counting and contamination retention capacity

2.1.2.1 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 D 975 Standard Specification for Diesel Fuel Oils

ASTM D 6751 Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels

ASTM D 7467 Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)

2.2 Related Publications

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

2.2.1 API Publications

Available from American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070, Tel: 202-682-8000, www.api.org

API/IP Specification 1583 Specifications and Qualification Procedures for Aviation Fuel Filter Monitors with Absorbent Type Elements, 3rd Edition 2000

3. DEFINITIONS

3.1 BIODIESEL

A renewable fuel for compression ignition engines, (diesel) which contains modified animal fats and/or vegetable oils blended into petroleum diesel and conforming with ASTM D 6751, ASTM D 7467, and ASTM D 975.

3.2 E-10

Spark ignition motor fuel usually referring to a 10% fuel ethanol (max) and 90% gasoline product.

3.3 GASOHOL

Spark ignition motor fuel usually referring to a 10% fuel ethanol (max) and 90% gasoline product.

3.4 LSD

Low Sulfur Diesel Fuel, ≤ 500 ppm, conforming to ASTM D 975.

3.5 METHYL SOYATE

Biodiesel blending component, soybean base stock, conforming to ASTM D 6751.

3.6 NEAT DIESEL FUEL

Commercial petroleum fuel, straight diesel, no bio-component, conforming to ASTM D 975.

3.7 NEAT GASOLINE

Commercial petroleum fuel, straight gasoline, no bio-component.

3.8 PHASE SEPARATION

Disassociation of a liquid containing multiple solvents into two distinct layers (phases) due to over-saturation of one or more components in the base solvent. Typically characterized by a hydrocarbon based layer over an aqueous layer.

3.9 RAPESEED METHYL ESTER

Biodiesel blending component, Rapeseed base stock, (RME), conforming to ASTM D 6751.

3.10 SUPER ABSORBENT POLYMER (SAP)

A water absorbing material having a high rate of swell volume compared to its free state and capable of retaining water under pressure.

3.11 TEST FLUID

Various motor fuels.

3.12 ULSD

Ultra-low Sulfur Diesel Fuel, ≤ 15 ppm, conforming to ASTM D 975.

3.13 WHITE GREASE

Bio-component made entirely from animal fat, (usually 100% hog fat), conforming to ASTM D 6751.

3.14 YELLOW GREASE

Used fry oil, grease, animal tallow, etc., conforming to ASTM D 6751.

4. TEST CONDITIONS

The measuring instruments shall be capable of measuring to the levels of accuracy required by SAE J905 for flow, pressure, temperature and volume. The test system shall comply with allowable test condition variability.

NOTE: SAE J905 serves as the basis and test methodology for the Part 1: Water Detection Test and Part 2: Slow Flow Reaction Capability Test. Sections for Resistance to Flow, and Collapse Test, also apply to fuel dispensing filters.

5. MULTIPASS FILTRATION RATING OF FUEL DISPENSING FILTERS

ISO 19438 is the normative reference for particle removal efficiency (fractional), and the contaminant holding capacity rating of fuel dispensing filters.

CAUTION: Some fuel dispensing filters have center tubes containing Super Absorbent Polymers (SAP), or a laminant of SAP onto the filter media. It is suggested that surrogate filters using the same filter media may present the safest scenario for the multipass test system.

6. PRESSURE IMPULSE FATIGUE TEST

The mechanical test section of SAE HS 806 specifies the parameters for fatigue testing of the filter assembly via pressure cycling with a prescribed waveform.

7. HYDROSTATIC BURST PRESSURE TEST

The mechanical test section of SAE HS 806 specifies the parameters for determining the ultimate strength of the filter assembly.

8. COLLAPSE TEST

The collapse test section of SAE J905 specifies the parameters for determining the maximum differential pressure the filter element can withstand without bypassing, due to rupture or collapse of the center tube/element assembly.

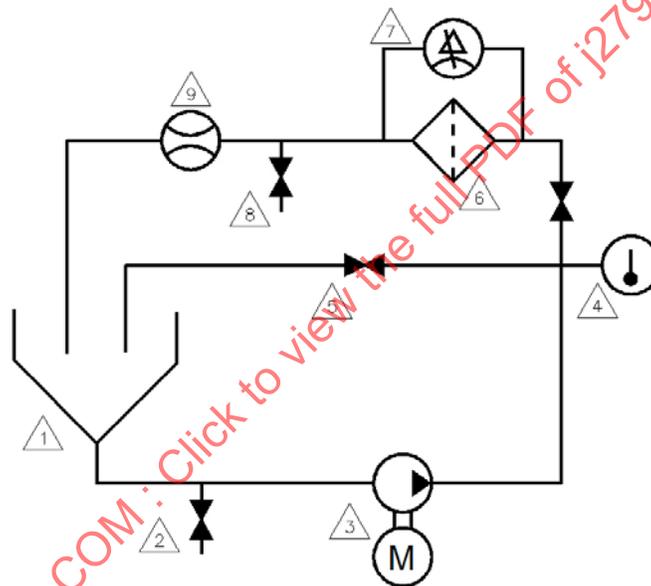
9. PART 1: WATER DETECTION TEST

This test determines the ability of the filter to react to the presence of water-in-fuel and significantly slow the flow of fuel being dispensed to reduce the severity of water-on-board vehicles.

9.1 Test Apparatus

The test system is illustrated in Figure 1. The test stand shall be composed of the following: test sump with (38 L/10 gal) capacity, drain, pump and motor capable of supplying the required test flow and differential pressure, temperature measurement device, by-pass circuit and flow control valve, test filter and mounting base, differential pressure gauge, sample port, and flow meter.

NOTE: Due to the flammability of the test fluids (fuels) used, special care must be taken to insure that no ignition sources are present in the immediate area of the test stand, proper ventilation is provided for, and the test stand must be grounded/bonded at all times. For example; spark proof pumps, wrenches and air motors for pump drives are available as a method of reducing risk.



1. Test Sump
2. Drain
3. Pump & Motor
4. Temperature Measuring Device
5. By-pass circuit Flow Control Valve
6. Test Filter and mounting base
7. Differential Pressure Gauge
8. Sample port
9. Flow meter

FIGURE 1- TEST SYSTEM

9.1.1 Repeating syringe, 10 mL, or as specified.

9.1.2 Timing device reading in minutes and seconds.

9.2 Test Materials

9.2.1 Test Fluids

Neat gasoline, ethanol blended gasoline, diesel, and biodiesel blends, or as specified in report.

NOTE: Gasoline fuel should be verified for ethanol content by using the method described in Appendix A.

9.2.2 Clean-up Fluids

Isopropyl or ethyl alcohol for test stand clean-up of water contaminated fuels.

9.2.3 Water Contaminant

De-ionized water, field water from tanks, and/or as specified in report.

9.2.4 Solid Contaminant

ISO 12103-1 A3 Arizona Test Dust may be batch added to the test sump along with the initial water addition and noted in the test report with the concentration shown as mg/L (optional).

9.3 Initial Test Stand Clean-Up Procedure

9.3.1 Install suitable clean up filter.

9.3.2 Add approximately (3.8 L/1 gal) of isopropyl or ethyl alcohol to test sump and flow through all test stand circuits for a minimum of 5 min at (27 L/min / 7 gal/min) or higher flow.

9.3.3 Drain clean-up fluid from test system drain(s) and remove clean-up filter.

9.4 Test Conditions

9.4.1 Test Flow Rate

Unless otherwise specified this test is conducted at (38 L/min / 10 gal/min)

9.4.2 Test Sump Volume

Standard test sump volume is (27 L/7 gal), unless otherwise specified.

9.4.3 Test Temperature

Test temperature is to be reported and monitored throughout the test. Room temperature and temperatures of other extremes may also be desired. Due to the nature of fuel dispensing systems many temperature ranges are encountered and the SAP function must work regardless.

9.4.4 Contaminant Add Rate

9.4.4.1 Water contaminant addition rate for gasoline filters is 10 mL/min. For larger diesel type dispensing filters 20 mL/min is allowed.

9.4.4.2 ISO 12103-1 A3 contaminant is optional, a 10 mg/L concentration based on sump volume is recommended, and should be batch added at the start of the test (see 9.5.4).

9.5 Test Procedure

9.5.1 Install test filter.

9.5.2 Add test fluid to sump and flow at (38 L/min / 10 gal/min) for 3 min through the test filter.

9.5.3 Record initial differential pressure, ambient temperature, and fluid temperature.

9.5.4 Add initial water contaminant at the 3 min point, which is defined as time zero, and record differential pressure and flow rate.

NOTE: A3 test dust contaminant may be added to the sump, if desired, at this same point in time.

9.5.5 Add water contaminant at 1 min intervals recording differential pressure and flow rate.

9.5.6 Maintain flow rate throughout the test without exceeding (345 kPa/50 PSID).

NOTE: Regulations limit dispensing pump differential pressure to (345 kPa/50 PSID).

9.5.7 Termination

Flow rate drops to (1.8 L/min / 0.5 gal/min), flow rate reduction trend stabilizes, or reverses, or 30 min time has elapsed.

NOTE: If the flow rate reduction does not occur, stabilizes or reverses, the filter failed to react or withstand the differential pressure, and/or the SAP did not control the fluid flow as designed, reference Appendix B.

9.6 Report

9.6.1 Report test data graphically per Appendix B. The report should also include the following information: Test laboratory, test date, test filter p/n, test fluid (fuel), fuel brand and octane, ethanol content, biodiesel content, contaminant(s), addition rate, differential pressure, test time, temperature and flow rate information. No determination of efficiency, capacity, or other values are made from the ISO 12103-1 A3 dust addition option.

10. PART 2: SLOW FLOW REACTION CAPABILITY TEST

10.1 Test Apparatus

The test system is illustrated in Figure 1. The test stand shall be composed of the following: test sump with (38 L/10 gal) capacity, drain, pump and motor capable of supplying the required test flow and differential pressure, temperature measurement device, by-pass circuit and flow control valve, test filter and mounting base, differential pressure gauge, sample port, and flow meter.

NOTE: Due to the flammability of the test fluids (fuels) used, special care must be taken to insure that no ignition sources are present in the immediate area of the test stand, proper ventilation is provided for, and the test stand must be grounded/bonded at all times. For example; spark proof pumps, wrenches and air motors for pump drives are available as a method of reducing risk.

10.1.1 Graduated cylinder, 100 mL or as specified.

10.1.2 Timing device reading in minutes and seconds.

10.2 Test Materials

10.2.1 Test Fluid

Ethanol blended gasoline.

NOTE: Fuel must be verified for ethanol content by using the method described in Appendix A.

10.2.2 Clean-up Fluids

Isopropyl or ethyl alcohol for test stand clean-up of water contaminated fuels.

10.2.3 Water Contaminant

De-ionized water, field water from tanks, and/or as specified in report.

10.2.4 Solid Contaminant

ISO 12103-1 A3 Arizona Test Dust may be batch added to the test sump along with the initial water addition and noted in the test report with the concentration shown as mg/L, (optional).

10.3 Initial Test Stand Clean-up Procedure

10.3.1 Install suitable clean-up filter.

10.3.2 Add approximately (3.8 L/1 gal) of isopropyl or ethyl alcohol to test sump and flow through all test stand circuits for a minimum of 5 min at (27 L/min / 7 gal/min) or higher flow.

10.3.3 Drain clean-up fluid from test system drain(s) and remove clean-up filter.

10.4 Test Conditions

10.4.1 Test Flow Rate

Unless otherwise specified this test is to be conducted at (38 L/min / 10 gal/min).

10.4.2 Test Sump Volume

Standard test sump volume is (27 L/7 gal), unless otherwise specified.

10.4.3 Test Temperature

Test temperature is to be reported and monitored throughout the test. Room temperature and temperatures of other extremes may also be desired.

NOTE: Due to the nature of fuel dispensing systems many temperature ranges are encountered and the SAP function must work regardless.

10.4.4 Contaminant Add Rate

10.4.4.1 Water Contaminant

Test sump is put into a state of phase separation (see 10.5.5).

10.4.4.2 ISO 12103-1 A3 contaminant is optional, a 10 mg/L concentration based on sump volume is recommended, and should be added at the same point in time as the initial water contaminant (see 10.5.6).

10.5 Test Procedure

10.5.1 Install test filter.

10.5.2 Verify test fluid (fuel) contains ethanol per Appendix A.

NOTE: Fuel is expected to be a 10% maximum ethanol blend, report the percentage found in the test report.

10.5.3 Add test fluid to sump and flow test filter for approximately 3 min at (38 L/min / 10 gal/min).

10.5.4 Isolate test filter from the circulation flow while maintaining flow rate through the sump for mixing.

10.5.5 Calculate the volume of water required for phase separation, at the test temperature of the fuel, per Appendix C. Report this value in the test report.

NOTE: A default saturation rate is 50 mL per (3.785 L/1 gal) of fluid.

10.5.6 Add the calculated volume of water contaminant and circulate fluid in sump while the test filter is isolated for 1 min to allow mixing of water and test fluid.

NOTE: A3 test dust contaminant may be added to the sump, if desired, at this same point in time.

10.5.7 Record ambient air and fluid temperature.

10.5.8 Initiate flow to test filter, this is time zero.

10.5.9 Record differential pressure and flow rate at the 30 s point and then at 1 min intervals.

10.5.10 Maintain flow rate throughout the test without exceeding (345 kPa/50 psi).

10.5.11 Unless otherwise specified, terminate the test when 5 min have elapsed. This verifies the flow rate reduction does not reverse, indicating the element reacted and withstood the maximum differential pressure for the charted time period.

NOTE: The flow rate would be expected to be in the range of (1.8 L/min / 0.5 gal/min) at termination and the flow rate may be reduced as early as 30 s after flow to the filter has been initiated, as shown in Appendix D.

10.5.12 Report test data graphically per Appendix D. The report should also include the following information. Test laboratory, test date, test filter p/n, test fluid (fuel), fuel brand and octane, ethanol content, contaminant(s), water volume used to achieve phase separation, differential pressure, test time, temperature and flow rate information. No determination of efficiency, capacity, or other values are made from the ISO 12103-1 A3 dust addition option.

11. NOTES

11.1 Marginal Indicia

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

APPENDIX A

Method to check for alcohol in gasoline:

Place 95 mL of the subject fluid in a 100 mL graduated cylinder. Add 5 mL of water to the cylinder, cap and shake. Allow to stand 3 min for full separation of fluids. If ethanol is present, the water phase (bottom) will extract the ethanol and its volume will increase from 5 mL. An approximate ethanol percentage can be calculated by the following relationship:

$$\frac{\text{Volume of water phase} - 5 \text{ mL}}{95 \text{ mL}} \times 100\%$$

(Eq. A1)

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