

	SURFACE VEHICLE STANDARD	SAE	J905 SEP2009
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		Superseding	J905 JAN1999
Fuel Filter Test Methods			

RATIONALE

Parts of this document have been revised to address changes to fuel systems and fuel chemistries that have taken place in the industry since the previous revision in 1999.

1. SCOPE

The purpose of this fuel filter test method is to provide standardized methods for evaluating the performance characteristics of fuel filters by bench test methods. This, combined with data obtained from application tests, may be used to establish standards of performance for filters when tested by these standard methods. Many variations in requirements of filtration to protect fuel supply equipment on engines and variations in operating conditions make it difficult to specify meaningful "in-service" performance standards by which a filter may be judged. By the use of these standard test methods, test conditions are always the same, and comparisons of the laboratory performance of filters may be made with a high degree of confidence. Once the requirements of a particular application are known, performance standards for suitable filters may be established by these test methods, and adequacy of performance of filters for the job may be determined.

In order to achieve the highest degree of reliability of test results, the procedures and equipment must conform to those specified in this code. No minimum performance requirements for filters have been specified, since these are the responsibility of the user and manufacturer. Only the methods of determining, interpreting, and reporting performance characteristics are the proper province of this SAE Standard.

Separate chapters cover the test methods necessary to evaluate the several functional capabilities and mechanical properties of the filter. Each chapter is complete with recommended materials, apparatus, and procedures for testing and evaluation. The chapters are:

- a. Chapter 1—Resistance to Flow (Section 3)
- b. Chapter 2—Filter Capacity and Contaminant Removal Characteristics (Section 4)
- c. Chapter 3—Media Migration Test (Section 5)
- d. Chapter 4—Collapse Test (Section 6)
- e. Chapter 5—Ability to Meet Environmental Conditions (Section 7)
- f. Chapter 6—Installation and Removal (Section 8)
- g. Chapter 7—Mechanical Tests (Section 9)
- h. Chapter 8—Material Compatibility (Section 10)

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To simplify the chapters covering test methods, information of importance but not directly involved in test methods is covered in appendices as follows:

a. Methods for Sample Analysis (Appendix A)

1.1 Test Condition Accuracy

Set up and maintain equipment accuracy within the limits given in Table 1.

TABLE 1 - TEST CONDITION ACCURACY LIMITS

Test Condition	Units	Measurement Accuracy	Allowed Variability During Test
Flow	L/min	±2%	±5%
Pressure	Kilopascal	±5%	—
Temperature	°C	±1%	±2%
Volume	Liters	±5%	±10%

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version 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 J200	Classification System for Rubber Materials
SAE J1124	Glossary of Terms Related to Fluid Filters and Filter Testing
SAE J1260	Standard Oil Filter Test Oil
SAE J1696	Standard Fuel Filter Test Fluid
SAE HS-806	SAE Oil Filter Test Procedure, 2001 Edition

2.1.2 ISO Publications

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

ISO 1219-1 1991	Fluid power systems and components—Graphic symbols and circuit diagrams—Part 1: Graphic symbols
ISO 12103-1	Road vehicles—Test dust for filter evaluation—Part 1

2.1.3 ANSI Publications

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

ANSI/Y32.10	Graphic Symbols
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2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE Publication

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 J1985 Fuel Filter—Initial Single-Pass Efficiency Test Method

2.2.2 ISO Publications

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

ISO 2941 Hydraulic fluid power—Filter elements—Verification of collapse/burst resistance

ISO 2942 Hydraulic fluid power—Filter elements—Verification of fabrication integrity

ISO 3722 Hydraulic fluid power—Filter elements—Fluid sample containers—Qualifying and cleaning methods

ISO 4021 Hydraulic fluid power—Particulate contaminant analysis—Extraction of fluid samples from lines of an operating system

ISO 19438 Diesel fuel and petrol filters for internal combustion engines—Filtration efficiency using particle counting and contaminant retention capacity

3. CHAPTER 1—RESISTANCE TO FLOW

3.1 Scope

The resistance to flow test determines the pressure loss, which will result when standard test fluid is passed through the filter under standard conditions of flow and fluid viscosity. This procedure may be used to establish flow capacities, and is the method for measuring resistance to flow of sample filters against an established performance standard.

3.2 Test Materials

3.2.1 Test Fluid

SAE J1696 Standard Fuel Filter Test Fluid.

3.3 Test Apparatus

3.3.1 Fuel filter flow test stand (or equivalent). A pump, flowmeter, thermometer, and manometers or differential pressure gauge are necessary as shown in Figure 1. It is usually convenient to use the fuel filter test stand as described in 4.4.1.

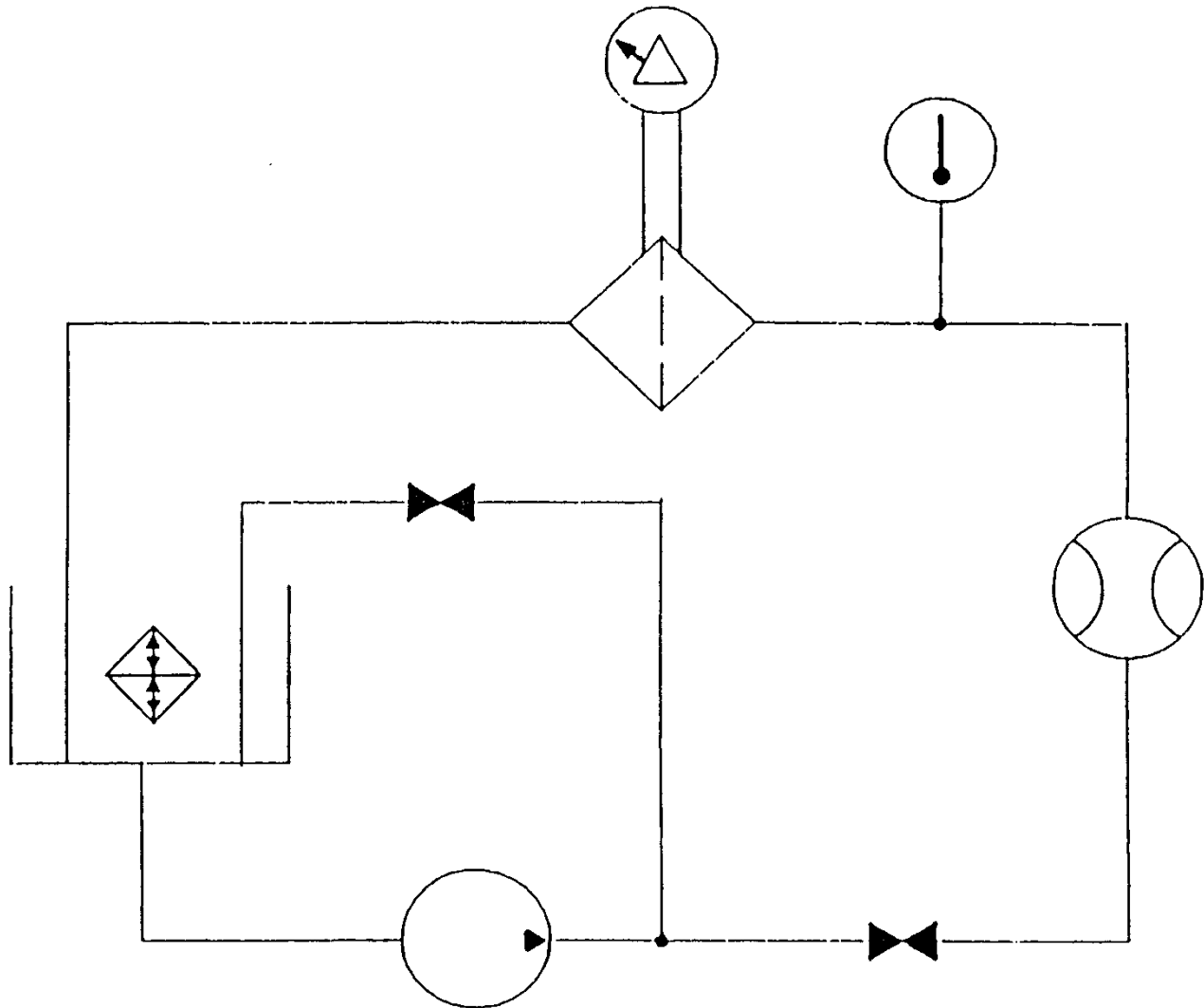


FIGURE 1 - FLOW TEST STAND

- 3.3.2 Filter housing or mounting plate with pressure taps located to give pressure loss across the filter element (or across the entire filter unit, in the case of "spin-on" and "in-line" filters). See Figures 2 and 3 for housing and mounting plate details.
- 3.3.3 If special housings are necessary or desirable, care must be exercised to locate inlet and outlet pressure taps to obtain true pressure values.

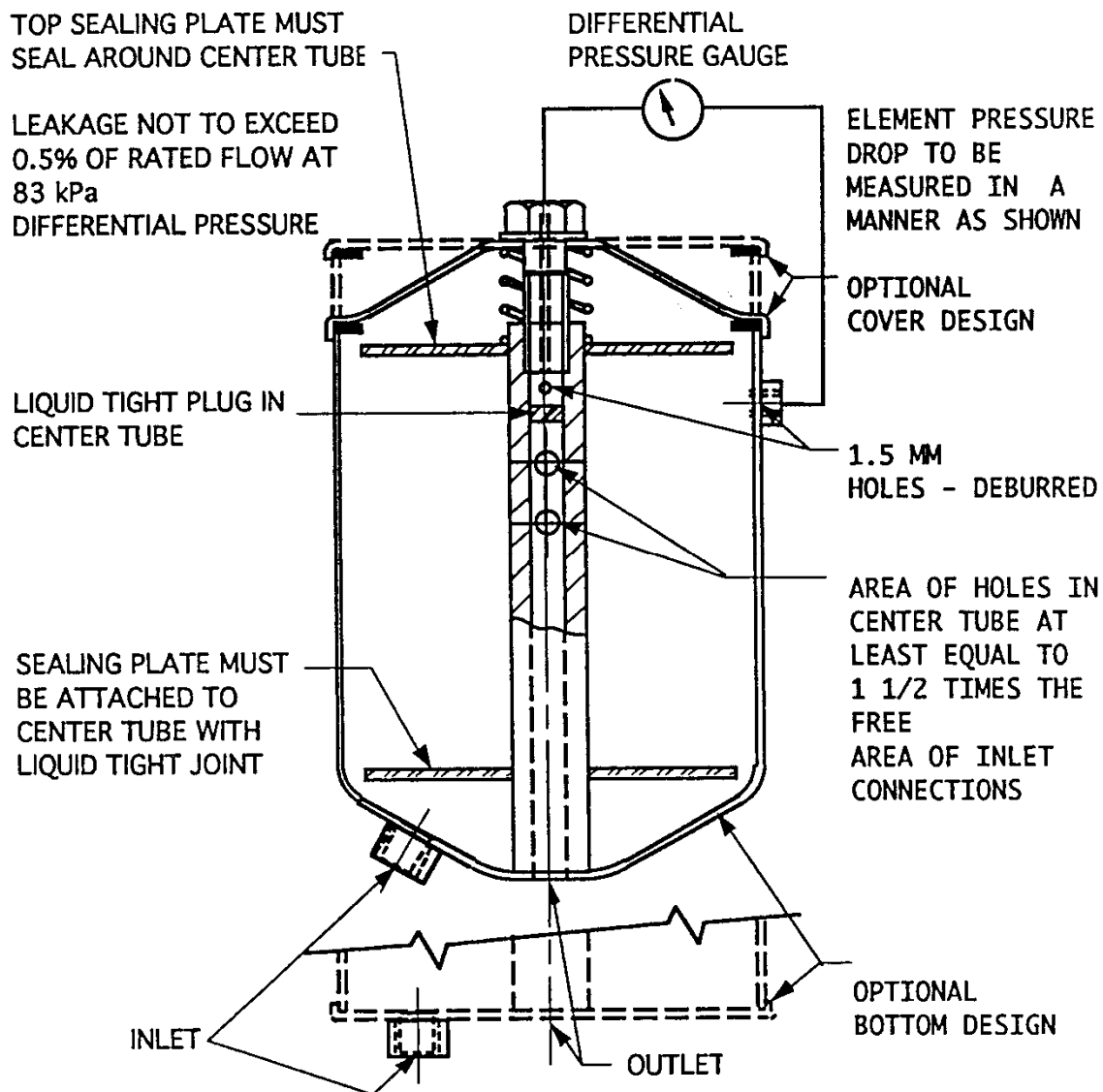


FIGURE 2 - TEST FILTER HOUSING FOR FULL-FLOW ELEMENTS

3.4 Test Preparation

- 3.4.1 Install a cleanup filter on the test stand and add 20 L of prefiltered test fluid.
- 3.4.2 Circulate test fluid through the bypass system until the specified temperature is reached; 40 °C is the recommended test temperature.
- 3.4.3 Circulate the test fluid through a cleanup filter until the test fluid cleanliness is less than 2 mg/L (see Appendix A for methods for sample analysis). Remove the cleanup filter and install the test filter.

3.5 Test Procedure

- 3.5.1 Circulate the test fluid through the test filter and adjust flow rate to 20% of the flow rate specified for the Capacity and Contaminant Removal test, at the specified test temperature. When the temperature and flow rate have stabilized, record the pressure differential. Adjust the flow rate in increments of 20% of the specified test flow rate, to a maximum of 120%, and record pressure differential after stabilization at each increment.
- 3.5.2 If the filter housing does not have pressure taps located to read element pressure only, an empty housing pressure differential must be obtained. The difference between the pressure loss for the empty housing and for the housing with elements is the pressure loss for the element only. For "spin-on" and "in-line" filters, pressure loss for the complete unit may be the only value of interest, in which case pressure loss for the element only will not be required.

3.6 Presentation of Data

- 3.6.1 Tabulate pressure differential at each required flow and temperature.
- 3.6.2 Plot a curve of flow rate versus pressure differential using the ordinate for pressure differential and the abscissa for flow rate.

4. CHAPTER 2—FILTER CAPACITY AND CONTAMINANT REMOVAL CHARACTERISTICS

4.1 General Information

This procedure has been developed to provide a standard method for evaluating filter performance in terms of contaminant holding capacity and ability to maintain effluent cleanliness within specified contamination limits. These characteristics are defined as follows:

4.1.1 Contaminant Holding Capacity

The amount of abrasive contaminant removed from a recirculating flow of test fluid and held by the filter before a specified pressure drop across the filter is reached. The limiting pressure drop is specified by the user and is related to the limitations of the fuel system served by the filter.

4.1.2 Fluid Cleanliness

The measure of the level of contaminant remaining in the filter effluent fluid samples at specified time intervals during the test with abrasive contaminant.

Cleanliness is specified in terms of mass of contaminant per unit volume of fluid, or mass of contaminant per unit mass of fluid.

Test fluids and contaminants have been selected because their characteristics are closely controlled so that, used in accordance with standard procedures contained in this document, test results will be repeatable and comparable among laboratories using these test procedures. Producers of the test materials will not alter any characteristics unless they have first ascertained that the proposed change will have negligible effect on all tests in which they are used. No changes are made without consultation with the SAE Filter Test Methods Committee.

4.1.3 Cautionary Notes

Prior standard tests incorporated in SAE J905 used a nondispersant fluid for the tests of filtration efficiency and dirt capacity. The test fluid specified for the tests in this chapter has significant dispersancy. For this reason, apparent filtration efficiency and capacity by this revision will be significantly lower than if the same filter was evaluated by the older method. These results are more realistic than earlier test results and are more repeatable and reliable.

This test is an evolution of the previously used test, which was derived from years of experience in the testing of fuel filters. However, the procedure is limited strictly to the laboratory comparison of filters. Test results are not directly relatable to the field performance of the filter.

The differences between laboratory results and field experience are attributable to the types of contaminant used in the test procedure and that found in the field. General experience is that fuel filters in the field become restricted rapidly due to asphaltenic type materials in the fuel. Asphaltenic materials are micron or submicron particles of carbon with a resinous coating. The abrasive contaminant used in this test procedure provides a poor approximation of this type of clogging action. This is supported by the experience that plugged field filters have only a small fraction of the contaminant weight gain as one would expect from this test procedure.

The SAE Filter Test Methods Committee has ongoing programs to evaluate new test methods for the investigation of fuel filter capacity and efficiency. These programs address the contaminant problem and the relation of test results to field performance. In addition, testing avenues such as particle counting are being used for fuel filtration evaluation. Consideration will be given to new technology and testing methods, as they become known to the FTMC.

This test procedure has been included in the interim because there are years of background and data, which have been generated through its use. Most users have significant experience with the procedure and have developed special in-house methods to extend the test results to field applications. Although this is not the optimal situation, the FTMC feels that this procedure will be useful in the interim, as long as users continue to exercise care in the interpretation of the test results.

Test results using ultrasonically dispersed test dust show slightly lower efficiency and dirt capacity than when the Waring blender is used. The differences in results between these two methods are within the normal expected variation among laboratories. The Waring blender is specified because it will reliably disperse the test dust adequately. Other blenders have been tried, and results show that the dust was not well dispersed. Blenders, which can be demonstrated to disperse contaminant as well as the Waring, verified by test results, which correlate well with test results using a Waring blender, may be used. The Committee has no evidence to recommend other blenders, but some may be available.

4.2 Scope

This test determines the abrasive contaminant holding capacity and abrasive contaminant removal characteristics of fuel filters. While the test is generally applied to filters intended to handle fuel oils for diesel engines, it is equally applicable to filters for other classes of liquid fuel. The specified test fluid has viscosity characteristics similar to No. 2 diesel fuel.

In the construction of the test stand, care must be taken to insure that any contaminant added to the test sump is properly dispersed and fully presented to the test filter. To insure validation, the system must not have any traps or settling zones where contaminant could be lost, nor should the pumping system alter the contaminant in any way. The test apparatus recommendations are made with these points in mind.

4.3 Test Materials

4.3.1 Test Fluid

SAE J1696 Standard Fuel Filter Test Fluid.

4.3.2 Test Contaminant

ISO 12103-1, A2 Fine Grade.

4.4 Test Apparatus

4.4.1 Fuel Filter Test Stand, as shown in Figure 4, with or without optional continuous contaminant feeder.

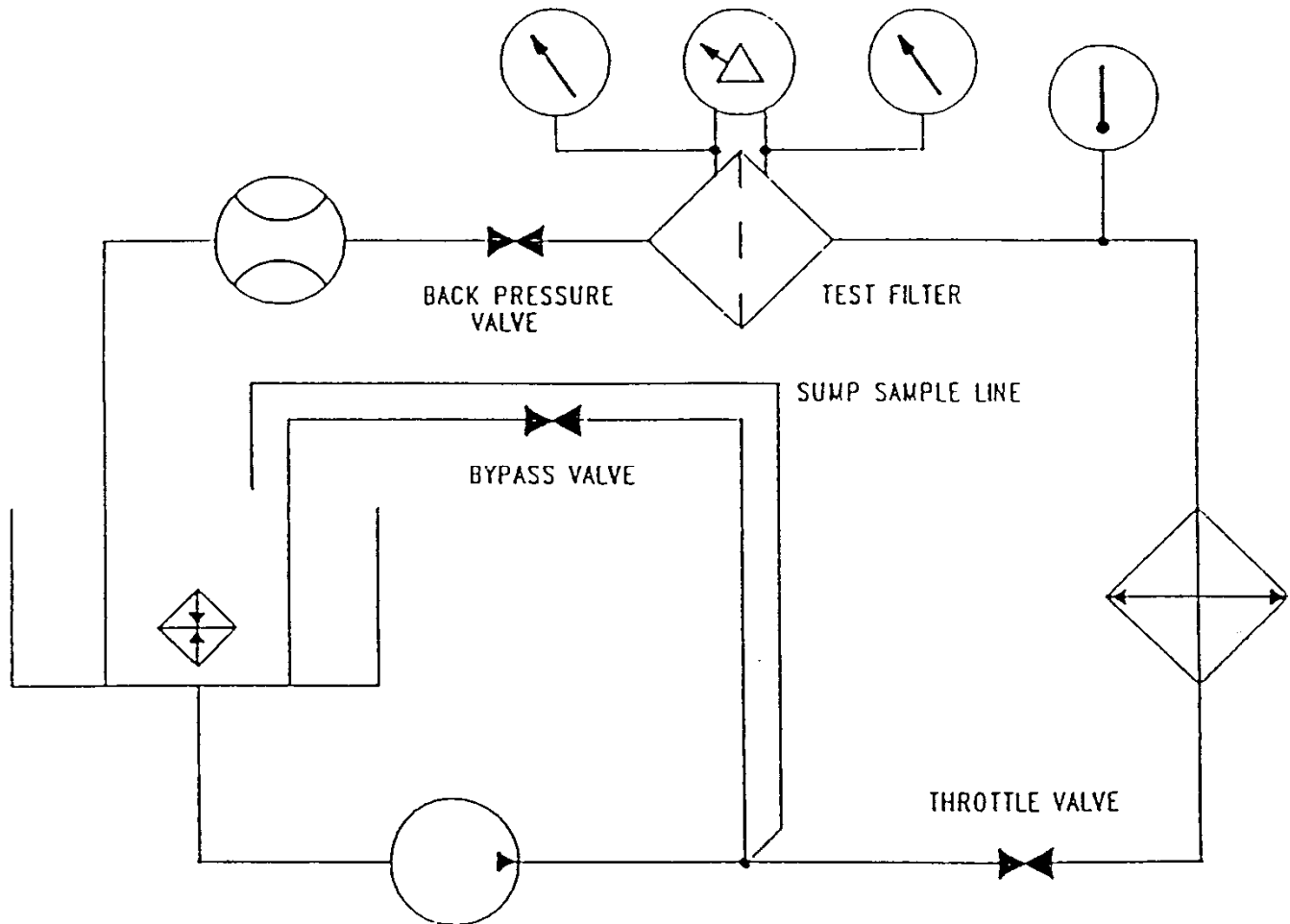


FIGURE 4 - FUEL FILTER TEST STAND

4.4.1.1 Pump

Progressive cavity type (Moyno pump or equivalent).

4.4.1.2 Heat Exchanger

Water-jacketed length of system tubing.

4.4.1.3 Sump Sample Line

Positioned to deliver a constant flow from the pump outlet, returning to the sump.

4.4.1.4 System Tubing and Fittings

16 mm I.D tubing recommended; all fittings should be of such construction that they do not create any contaminant traps.

4.4.2 Appropriate housing or standard mounting base for spin-on filters (Figures 2 and 3).

- 4.4.3 Ultrasonic Bath (0.78 w/cm^2) with slurry beaker suspended 13 mm above the tank bottom (see Figure 5). Use the following or proven equivalent: Branson Model S8340-12 120 V Generator 500 W and Branson C1012-40-12 transducerized tank having inside dimensions of 25 cm x 25 cm x 25 cm.

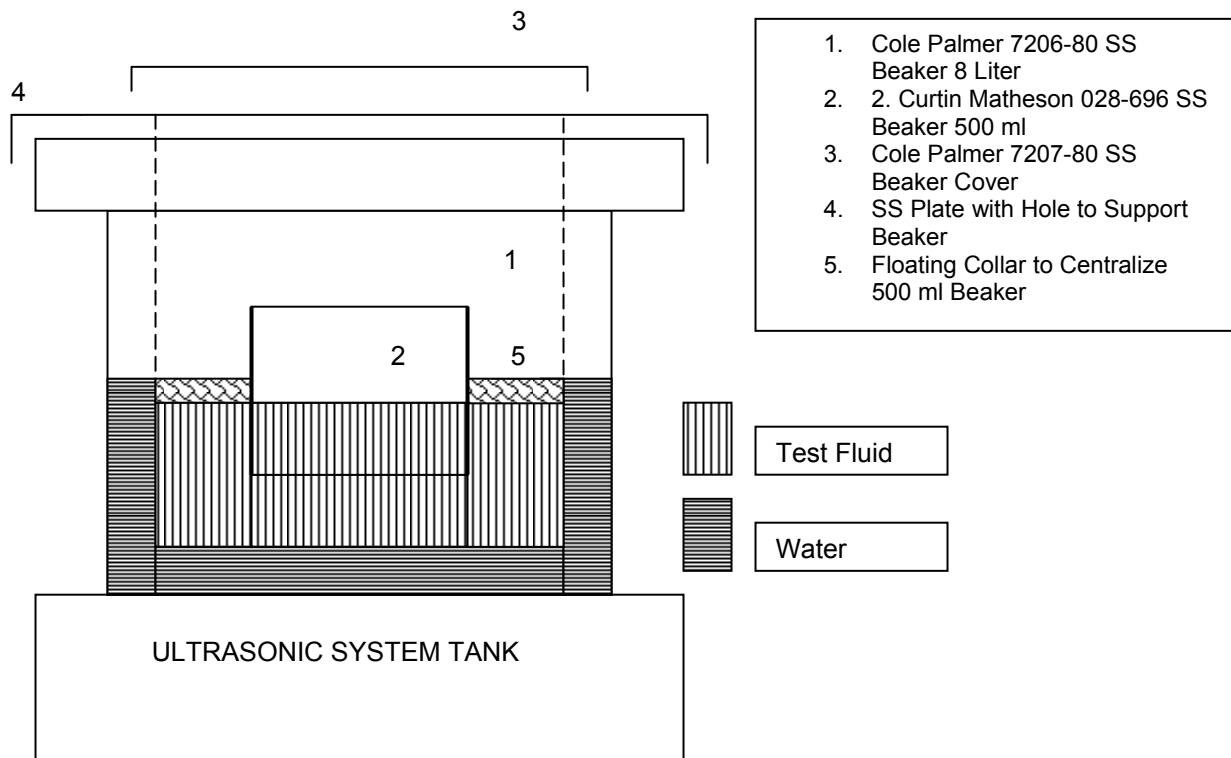


FIGURE 5 - ULTRASONIC SLURRY PREPARATION BATH

Alternately, a heavy-duty laboratory Waring Blender may be used. Use the following or proven equivalent: Waring Blender Model 7011S, 2 speed, with Blender Container SS610, 1-L Bakelite bottom with drawn one-piece shell. Blender speed 21 000 rpm, no load.

NOTE: Blade wear may cause inconsistent dispersion; based on use, blades should be replaced at periodic intervals.

Report the specific type and model of the contaminant dispersing device when reporting test results. Test results may not be consistent between the two recommended methods. The use of devices other than those recommended may compound the problem.

- 4.4.4 Analytical apparatus for effluent sample analysis (see Appendix A).

4.5 Validation of Test Circuit

- 4.5.1 Validate at the minimum flow that the filter test system will be operated.
- 4.5.2 Adjust the total test system volume to 20 L. Insure that turbulence will not add air to the fluid.
- 4.5.3 Start the main system flow and circulate to clean the fluid to the appropriate cleanliness level (see 4.7.1)
- 4.5.4 Contaminate the test system fluid to the highest gravimetric level expected during testing using ISO 12 103/1 Part 1 A-2 (Fine) contaminant. Follow contaminant preparation method 4.6.2 or 4.6.3.

- 4.5.5 Circulate the contaminated fluid in the test system for 1 h and extract fluid samples from the upstream sample line at 15, 30, 45, and 60 min.
- 4.5.6 Analyze the fluid samples gravimetrically (see Appendix A).
- 4.5.7 Accept the validation test only if:
 - 4.5.7.1 The gravimetric level of each sample is within $\pm 10\%$ of the average of the four samples and $\pm 10\%$ of the known gravimetric level.

4.6 Preparation of Contaminant Slurry

- 4.6.1 Prepare the contaminant slurry using either the ultrasonic or the alternate blender dispersion method. Equipment is as described in 4.4.

NOTE: Dry the test contaminant in an open container in a convection oven at a temperature of 110 to 150 °C for 2 h. The depth of the test dust in the drying container should be less than 25 mm. Store the dried dust in a desiccator prior to use.

4.6.2 Ultrasonic Dispersion Method

- 4.6.2.1 Place the specified mass of dried contaminant required for a 5 min incremental addition in the 500 mL beaker shown in Figure 5.
- 4.6.2.2 Mix test contaminant with 50 mL of test fluid using a rubber policeman for 15 s.
- 4.6.2.3 Dilute the mixture to 350 to 400 mL, total volume with test fluid. Test fluid used should be taken from the test stand in use for the test.
- 4.6.2.4 Place beaker with contaminant/fluid mixture in the ultrasonic bath and disperse for 2.5 min $\pm$ 0.5 min. The preparation of the slurry should be performed in the 5 min interval between slurry additions to the test system.

4.6.3 Blender Dispersion Method

Place the specified mass of dried contaminant required for a 5 min incremental addition in the blender container.

- 4.6.3.1 Add approximately 700 mL of test fluid to the contaminant and blend at high speed (21 000 rpm, no load) for 2.5 min $\pm$ 0.5 min. The preparation of the slurry should be performed in the 5 min interval between slurry additions to the test system.

4.7 Test Procedure

- 4.7.1 Fill the test stand sump with 20 L of test fluid. Install a cleanup filter in the test filter location and circulate the test fluid until a 100 mL sample has an insoluble concentration of less than 2 mg/L.
- 4.7.2 Remove the cleanup filter and install the test filter.
- 4.7.3 Adjust the test sump fluid volume to 20 L using test fluid prefiltered to a level of less than 2 mg/L insolubles.
- 4.7.4 Start the pump and adjust the flow rate to 200 LPH or to a flow rate as agreed upon by the supplier and user. Adjust the fluid temperature to 40 °C and maintain throughout the test.
- 4.7.5 Close the throttling valve to stop flow to the test filter. Adjustment of the back pressure or bypass valves should not be necessary.