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AEROSPACE RECOMMENDED PRACTICE

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(R) AEROSPACE - DYNAMIC TEST METHOD FOR DETERMINING THE RELATIVE DEGREE OF CLEANLINESS OF THE DOWNSTREAM SIDE OF FILTER ELEMENTS

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1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) describes a procedure for determining the insoluble contamination level of the downstream side of filter elements. Results of this procedure represent the particulate released from the tested filter element under the prevailing conditions of the test. The results may be used for comparative evaluation of the effectiveness of various cleaning methods or the cleanliness of elements after cleaning or as received from manufacturers.

1.1 Outline of Method:

A representative portion of the contamination on the downstream side of the filter element under test is removed by placing the filter element in an ultrasonic bath for a set period of time and then withdrawing a sample through the filter under test into a vacuum flask. The sample is then filtered per ARP598. The insoluble contamination is thus transferred onto the surface of the membrane filter disk where it can be examined microscopically to determine the amount of contamination released from the filter element.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP598 The Determination of Particulate Contamination in Liquids by the Particle Count Method

2.1.2 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-209 Airborne Particulate Cleanliness Classes in Clean Rooms and Clean Zones

2.1.3 ANSI Publications: Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI T2.9.11-1989 Hydraulic fluid power - Method for determining the particulate count of an oil sample from a system using automatic particle counters

3. APPLICABILITY:

This procedure shall only be used on filters that can withstand the ultrasonic cavitational energy of the test equipment to be used. Consideration must be given that the filter may be exposed to many hours of ultrasonic cavitation during its life.

Because the amount of contamination released by this procedure is large in comparison to other cleanliness test methods, it is recommended to be specified for use primarily for filters to be used in applications with strict cleanliness requirements by the system designer or user.

The data obtained from this procedure are comparable only to data previously obtained from the same system under the same conditions. "Same Conditions" is defined as nominally equal in (1) operation of the procedure described herein, (2) results of the foil erosion test of 10.2, and (3) the operating conditions as listed in 10.4. Because of the wide variations in frequency and operating characteristics of various ultrasonic systems and because of the variations in cavitational characteristics of various liquids at different temperatures, it is normal to expect variances in results between different testing agencies. Section 12 suggests one method of correlating the expected variations in results.

This procedure may be used for filters larger than a package volume of 300 ml but as a general rule, it will not produce representative results because of the lowered flow dynamics in the area of the filter media when withdrawing the sample.

4. EQUIPMENT:

4.1 Beaker, glass or stainless steel, to hold the test liquid in the ultrasonic bath.

4.2 Filter with a filtration rating finer than the filter under test to clean test liquid entering the container of 4.1.

4.3 Flask, vacuum, 1000 ml capacity, graduated at 500 ml, to collect the sample from the filter under test.

4.4 Tubing, stainless steel (or equivalent), 300 series, with internal diameter adequate to maintain a minimum liquid velocity of 21 cm/s (0.7 ft/s) during sample withdrawal.

NOTE: This would be approximately 900 ml/min through 10 mm (or 3/8 in) tubing.

4.5 One ultrasonic generator, transducer, and suitable tank. Transducer shall provide at least 0.5 W of power per square centimeter (3 W/in^2) of tank bottom or the same for the transducer surface of an immersible transducer if used.

4.6 Stopper of low sloughing material to fit 4.3 and to accept 4.4.

4.7 Vacuum source, gauge, and regulator capable of maintaining 500 mm of mercury (20 in of mercury or 67 kPa) vacuum minimum during the sample withdrawal period.

4.8 Sampling adapter (see 6.1).

4.9 Forceps with unserrated tips.

4.10 Petri dishes, low profile, plastic or equivalent.

4.11 Sampling equipment as described in ARP598.

4.12 Microscopic equipment as described in ARP598.

4.13 Aluminum foil, annealed, household type (approximately 0.038 mm or 0.0015 in thick).

NOTE: The use of in-line membrane filter in the downstream line for collecting the particles withdrawn in the liquid sample is discouraged because of uneven distribution, retention of particles on the walls of the filter holder, and reduction of flow. If these problems could be circumvented, then an in-line membrane would be preferable.

5. TEST LIQUIDS:

One of the following test liquids (or other suitable solvents with similar degreasing properties) is recommended:

5.1 PF™ Degreaser

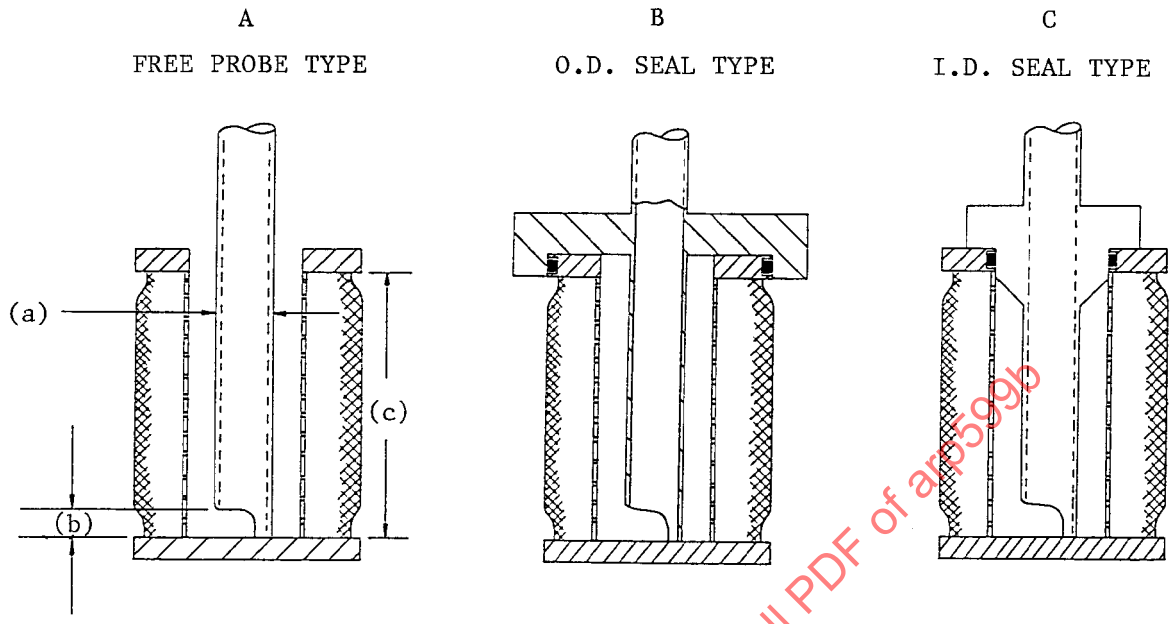
5.2 Distilled or deionized water

5.3 Envirosolv® 655

6. TYPICAL ANALYSIS APPARATUS:

6.1 Sampling Adapters:

Four variations of the sampling adapter may be used. The one selected will depend on the configuration and dimensions of the filter to be tested. The "Probe" refers to the part of the withdrawal tube which enters the filter under test as in types (A), (B), and (C).



a. The probe diameter, (a), shall be no larger than 3/4 or smaller than 1/4 the diameter of the inner support tube of the filter being tested. If the inner support tube is conical, the measurement for inner diameter shall be taken to be an estimation at distance (b).

b. The length of the leg, b, that holds the probe opening away from the bottom of the filter under test shall be between 1/5 and 1/3 the length of c, as shown in Figure 1.

FIGURE 1 - Sampling Adapters

6.1 (Continued):

NOTE: The probe, and therefore requirement (a), may be omitted when the inner support tube is less than 7 mm (1/4 in) in diameter, as in Figure 2.

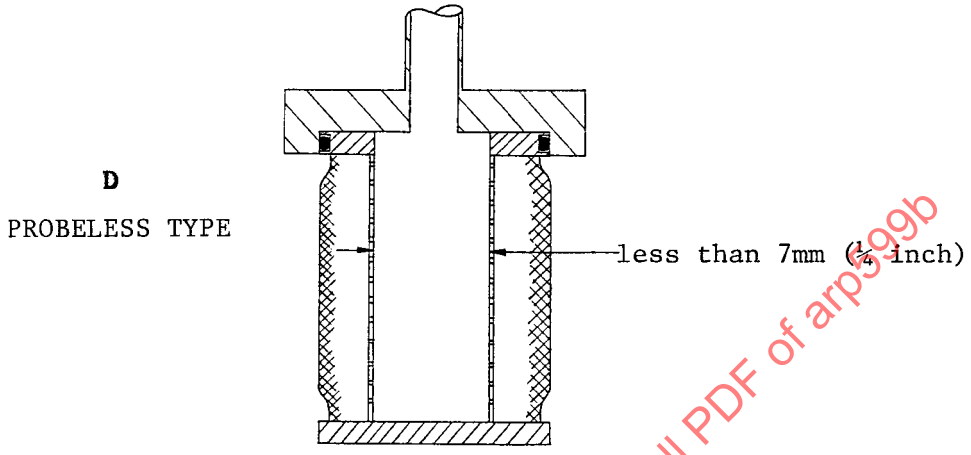


FIGURE 2 - Sampling Adapter With Support Tube Less Than 7 mm

6.2 Filter elements removed from housing with upstream side exposed in a filtered test liquid bath are shown in Figure 3:

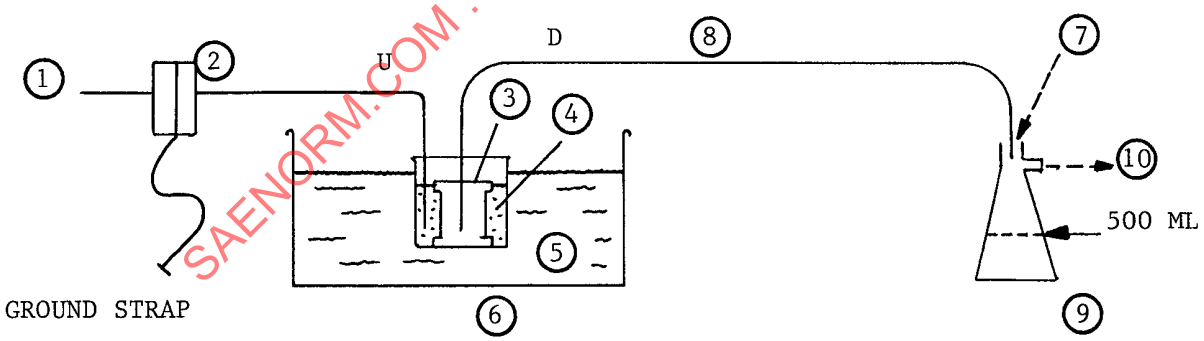


FIGURE 3

6.2 (Continued):

The following apply to the respective parts in Figures 3 and/or 4

1. From test liquid reservoir
2. Filter, membrane type recommended, with electrical ground
3. Filter element under test
4. Test liquid (Section 5) in beaker
5. One of the liquids of Section 5 - Water is recommended.
6. Ultrasonic unit
7. Stopper
8. Stainless steel (or equivalent) tube
9. Vacuum flask graduated at 500 ml
10. To vacuum pump
11. Nonseparable filter case containing filter under test
12. From pressure source
13. Fitting that will remain leak-tight at sampling pressure

U Upstream tubing

D Downstream tubing

6.3 Nonseparable filter assemblies mounted in-line using filtered test liquid are shown in Figure 4:

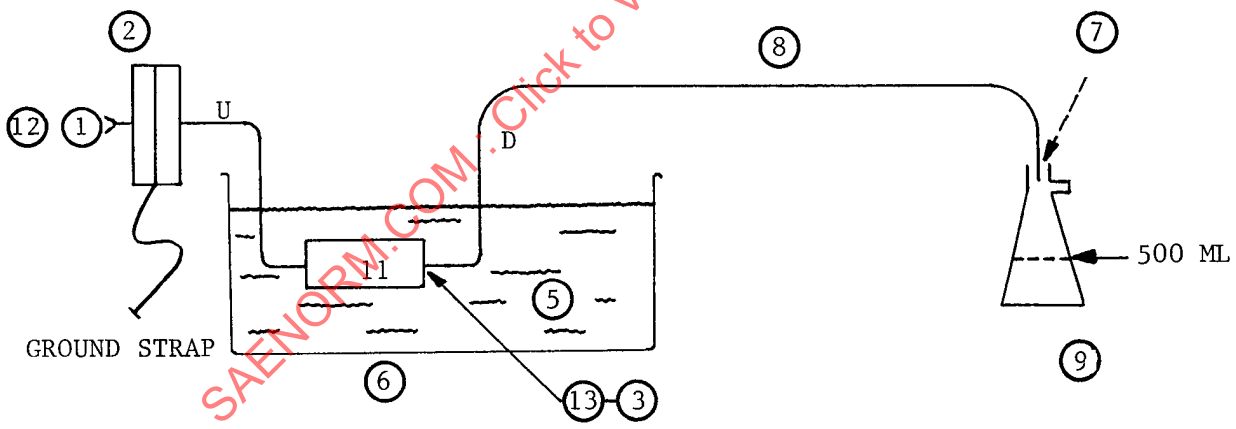


FIGURE 4

7. PROCEDURE FOR BLANK:

NOTE: Because of the probability of extraneous contamination caused by conducting this test in an uncontrolled atmosphere, all operations should be conducted in an environment meeting or exceeding FED-STD-209, Class 100 000.

7.1 Set up equipment to be used for testing filter per 6.2 or 6.3, but do not as yet install filter to be tested. Attach line U to line D for set up per 6.3. Take precautions to assure cleanliness of sampling apparatus and the test liquid. Degas the ultrasonic bath by running for 3 min minimum.

7.2 Ready ARP598 apparatus for testing the cleanliness of liquid samples.

7.3 Withdraw (6.2) or expel (6.3) 500 ml of test liquid from the bath into the graduated vacuum flask with the ultrasonic bath turned on.

7.4 Filter the sample per ARP598 except test the full 500 ml. Alternatively, contamination may be determined with automatic particle counters based on the light blockage principle, per ANSI T2.9.11.

7.4.1 Empty approximately 250 ml into the filtration funnel. Turn on the vacuum.

7.4.2 Agitate the remaining 250 ml in the flask and add to the liquid in the filtration funnel as the level drops. The level must not be allowed to drop below 100 ml until all the sample has been added.

7.4.3 Add approximately 50 ml of filtered test liquid into the sample flask, agitate with a rapid back and forth motion and add to the funnel before the level has dropped to 50 ml. The filtration rate may have to be slowed by backing off the vacuum in order to complete this step without the liquid level dropping below 50 ml.

7.5 Continue per ARP598 except count the particles to the size ranges specified in the filter requirement.

8. DETERMINATION OF LEVEL OF CLEANLINESS:

8.1 The ultrasonic bath shall have been degassed (7.1) prior to test.

8.2 The filter element should be handled with appropriate technique to prevent contamination when the filter is installed in the test set up. The filter shall be dry or dried prior to installing in the test set up. Tests run in succession without intermediate drying will show reduced particle release. At the discretion of responsible engineering, the requirement for cleanliness may be set based on a wet filter rather than a dry one.

8.3 Install filter in the test set up. Do not allow the level of liquid to go below the top of the filter media, nor allow liquid to enter the filter elsewhere than through the filter media. If a seal is used on the element or the adapter, it must be compatible with the test liquid.

With nonseparable filters, assure the exclusion of air traps in the filter case while under test.

8.4 Ready sample analysis apparatus as in 7.2.

8.5 Turn on ultrasonic field within 1 min after immersing the element in the test liquid. The ultrasonic field should be tuned to maximum intensity.

8.6 Expose element to ultrasonic cavitation without liquid flow for a period of 5 min ± 5 s. At the end of this period, apply vacuum and withdraw (or apply pressure and expel, for nonseparable filters) 500 ml of test liquid into the collection flask with the ultrasonic bath still on.

8.7 Repeat 7.4.

8.8 Repeat 7.5. Record results.

8.9 Rigorous drying is recommended for filters due to their ability to hold liquid. The most effective way is vacuum drying where the filter is heated to 90 °C (approximately 200 °F) for 15 min prior to pulling a vacuum down to 10 kPa (1.5 psi) absolute for 30 min. Backfill with dry nitrogen. Purge filter with dry nitrogen when cool enough to touch.

9. REPORTING OF RESULTS:

9.1 The following information should be reported with each analysis:

a. The total analysis count as obtained from 8.8. (Do not subtract the blank of 7.5.)
b. The total blank count as obtained from 7.5.
c. The test liquid used.
d. The bath liquid used and the temperature of this liquid.
e. The frequency, model, and power (watts per square centimeter or square inch of tank bottom) of the ultrasonic system.

10. DISCUSSION OF METHOD:

10.1 Because of the current lack of satisfactory method for accurate measurement of cavitational energy in the wide variety of ultrasonic cleaning equipment now in use, specific minimum intensity values cannot be specified. It is recommended, however, that all possible steps be taken to increase the effectiveness of ultrasonic equipment on the filter element.

10.2 Foil Erosion Control Test:

Whenever a test or series of tests are begun employing this procedure, the activity of the ultrasonic unit should be qualitatively checked by observation of the effect of the bath. A strip of aluminum foil (see 4.13) at least 25 mm (1 in) wide extending into the bath to within 25 mm (1 in) of the tank bottom should be placed during testing. The liquid in the bath (transfer liquid) should be between 37 and 44 °C (100 to 110 °F). Activate the ultrasonic energy for 60 s. The foil is then removed and examined. A definite erosion of the foil should be in evidence. If this is the first time an aluminum foil erosion test for this procedure has been run, save the foil for future reference in a transparent container. Subsequent aluminum foil erosion tests per this paragraph should be compared to the original reference. This is advised since ultrasonic units can degrade and lower particle yields thereby possibly showing filters to be acceptable that wouldn't have met the requirements as originally established under the original ultrasonic conditions.