BSR/ASHRAE Standard 63.2.-2017R

Public Review Draft

Method of Testing Liquid-Line Filter Drier Filtration Capability

First Public Review (October 2023)

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## CONTENTS

**BSR ANSI/ASHRAE Standard 63.2-2017**

Method of Testing Liquid-Line Filter Drier Filtration Capability

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>2</td>
</tr>
<tr>
<td>1 Purpose</td>
<td>2</td>
</tr>
<tr>
<td>2 Scope</td>
<td>2</td>
</tr>
<tr>
<td>3 Definitions</td>
<td>2</td>
</tr>
<tr>
<td>4 Materials and Apparatus</td>
<td>2</td>
</tr>
<tr>
<td>5 Test to Determine Accuracy of Test System</td>
<td>4</td>
</tr>
<tr>
<td>6 Procedure</td>
<td>4</td>
</tr>
<tr>
<td>7 Calculation of Results</td>
<td>5</td>
</tr>
<tr>
<td>Informative Annex A: Sample Calculation</td>
<td>6</td>
</tr>
<tr>
<td>Informative Annex B: Bibliography</td>
<td>7</td>
</tr>
</tbody>
</table>

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FOREWORD

ASHRAE Standard 63.2 prescribes a method for measuring the filtration capability of liquid-line filters and filter driers for use in refrigerant systems.

It is recognized that the test contaminant, the test fluid, the test equipment, and the method in the prescribed test do not fully represent the conditions that can exist in the liquid line of a refrigerant system.

The specified test contaminant was chosen as the most nearly representative controlled-particle-size test contaminant commercially available. The wide range of controlled particle sizes used provides a satisfactory degree of repeatability of test results. However, it is recognized that seldom, if ever, will the composition, particle size, and mix of the test contaminant be duplicated in an actual system. Therefore, the filtration capability of a filter determined by this test does not necessarily predict its exact capability in actual service in a refrigerant liquid line.

This test, however, serves as a useful means of comparing filter capabilities and implementing quality control to maintain uniformity of products.

Changes in the 2017 edition of the standard include improvements to the clarity of the test procedure and associated calculations and the addition of test fluid options.

1. PURPOSE

The purpose of this standard is to prescribe a laboratory test method for evaluating the filtration capability of filters and filter driers used in liquid lines of refrigeration systems.

2. SCOPE

2.1 This laboratory test method evaluates the capability of liquid-line filters and filter driers only for removing and retaining solid particles of a standard test contaminant.

2.2 The test method may be applied to all hermetic refrigerant liquid-line filters and filter driers.

2.3 The technique employed in this standard is the one-pass test method. In this test, a clean-up filter is installed downstream of the test sample and is designed to retain and prevent recirculation of the majority of the contaminant particles that are not collected by the test sample in the first pass.

2.4 Filter driers have the added capability of removing and retaining certain dissolved contaminants. This standard does not provide measurement of this capability.

3. DEFINITIONS

- **contaminant capacity** \( M_{c} \): mass in grams of test contaminant that is retained by the filter under test.
- **contaminant loading** \( M_{l} \): total mass in grams of test contaminant that is added to the test apparatus.
- **contaminant loading end point** \( M_{e} \): total mass in grams of test contaminant added that achieved the target end-point pressure drop.
- **end-point pressure drop** \( \Delta P \): the filter pressure drop across the filter under test at the concluding point of the testing.
- **filter efficiency** \( E_{f} \): contaminant capacity divided by contaminant loading, expressed as a percent.
- **filter pressure drop** \( \Delta P \): the difference in pressure between the filter inlet and filter outlet, including fittings, expressed in kilopascals.
- **filter under test** \( \Delta P \): liquid-line filter or liquid-line filter drier that is under evaluation.
- **liquid-line filter** \( L \): a device for removing and retaining solid contaminants from the liquid line of a refrigeration system.
- **liquid-line filter drier** \( L \): a filter containing a desiccant capable of removing moisture and other dissolved contaminants in the refrigerant stream.

4. MATERIALS AND APPARATUS

4.1 Test Contaminant

4.1.1 Composition. The test contaminant will be a blend of 50% coarse test dust as received and 50% retained in a 200-mesh screen. Prepare this blend from Society of Automotive Engineers (SAE) coarse test dust, described in ISO 5011.

4.1.2 Preparation of Test Contaminant. To prepare the blend of contaminant, first wet-screen a quantity of coarse test dust on a U.S. (ASTM) or Tyler 200-mesh screen with particle retention equal to 74 \( \mu \)m (0.0029 in.). This is done by placing a portion of the coarse test dust on a 200-mesh screen and running water through the screen while stirring the coarse test dust with the fingers. Discard the fine particles passing through the screen.

The +200-mesh particles collected on the screen are removed and dried for one hour at 110°C (230°F). The test contaminant is prepared by mixing 50% by mass of the coarse test dust as received (after drying for one hour at 110°C) with 50% by mass of the +200-mesh-screened dust.

4.1.2.1 Particle Size Analysis. The coarse test dust as received and the blend used as the test contaminant have the particle sizes listed in Table 1.

4.2 Test Fluid. Permissible test fluids are shown in Table 2. Take appropriate steps to minimize evaporation or loss of test fluid during the test procedure.

4.3 Clean-Up Filter. The clean-up filter shall be a filter membrane of 0.8 \( \mu \)m (3.15 \( \times \) 10\(^{-5}\) in.) pore size. The filter is used to determine the amount of contaminant that passed through the filter under test.
(This foreword is not a part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process.)

This is a revision of Standard 63.2-2017. This standard was prepared under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). It may be used, in whole or in part, by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interests of obtaining uniform standards throughout the industry.

The changes made for the 2023 revision were:

- References were updated in informative Annex B- Bibliography
4.4 Balance. A weighing method with less than or equal to 0.1% resolution of the masses being weighed shall be used during the test procedure.

4.5 Test Loop Specification (see Figure 1)

4.5.1 Pump. The pump shall be capable of producing a steady-state, nonpulsating flow able to maintain the standard flow rate through the filter being tested at pressure drops up to 69 kPa (10 lb/in.²).

4.5.2 Heat Exchanger. A heat exchanger shall be provided (if necessary) to maintain the test fluid at 30°C ± 6°C (86°F ± 11°F).

4.5.3 Three-Way Flow Regulating Bypass Valve. A flow regulating bypass valve shall be provided in the test apparatus in order to vary and control the flow rate through the filter under test. The three-way regulating bypass valve allows constant fluid flow to the filter under test with varying pressure drop. This is accomplished by regulating the amount of fluid being directed back to the reservoir without passing through the filter under test. Controlling the flow rate by regulating the pump speed is an alternate method to bypass regulation.

4.5.4 Reservoir. The reservoir shall be sized to maintain a suitable liquid level at the pump while the test apparatus is operating. To avoid potential problems with contaminant
settling out in the reservoir, the reservoir shall be provided with a conical bottom outlet. The volume will be such that the flow rate of the test fluid returning to the reservoir will create enough turbulence to prevent settling of the test contaminant. The reservoir shall be designed to prevent the test contaminant from settling out of the test fluid.

4.5.5 Flowmeter. Methods of flow measurement are described in ANSI/ASHRAE Standard 41.7-2015, Method of Test for Measurement of Flow of Gas. The meter shall be of such construction, and installed in such a way, that undue turbulence or disturbances of the steady-state flow in the test apparatus are not created. The meter shall be calibrated so that any error in indicated flow is less than 5% of the nominal flow rate.

4.5.6 Contaminant Loading Device. A contaminant loading device shall be installed with bypass valves upstream of the filter under test to permit the introduction of the test contaminant into the test apparatus while in operation.

4.5.7 Vent Valve. A vent valve (solenoid valve optional) shall be located at the top of the test loop immediately ahead of the filter under test to permit the test fluid to drain freely from the filter under test and the clean-up filter. Take appropriate steps to recover the test fluid discharged from the vent valve.

4.5.8 Sight Glasses. Sight glasses shall be installed in the test apparatus allowing visual verification of single-phase liquid flow at the inlet and outlet of the filter under test.

4.5.9 Differential Pressure Measuring Device. A manometer or other pressure measuring device with a maximum error of 0.3 kPa (0.04 lbf/in.²) shall be used to measure the pressure drop across the filter under test. If a U-tube manometer is used, the reading shall be corrected for the effect of the test fluid column on top of the measuring fluid. The pressure taps shall be located 2 tube diameters upstream of the filter and 10 tube diameters downstream of the filter. Burr-free holes measuring 1.6 mm (0.063 in.) in diameter shall be used for pressure taps; however, in line sizes 6 mm or smaller, 0.8 mm (0.031 in.) diameter holes shall be used.

4.6 Equipment Layout. The layout of the test apparatus is shown in Figure 1. The line size used throughout the test apparatus shall be any convenient size to cover a range of flow rates that will permit the testing of filters of various size and prevent settling or trapping of the contaminant. The line lengths shall be minimized so that all contaminant reaches the filter under test within the three-minute run cycle. The line entering and exiting the filter under test shall have the same size as the fittings of the filter under test for a minimum straight distance of at least 15 tube diameters upstream and downstream of the filter under test.

5. TEST TO DETERMINE ACCURACY OF TEST SYSTEM

5.1 Scope. The test for accuracy consists of adding a specified amount of contaminant to the test apparatus without filter under test and determining the amount of contaminant retained on the clean-up filter.

5.2 Procedure for Test Apparatus Accuracy

5.2.1 With only a fresh, preweighed clean-up filter element installed and the test apparatus filled with clean test fluid, start the pump and close the three-way flow regulating bypass valve slowly until the flow rate through the test loop equals the predetermined test flow rate agreed on between the supplier and the customer. The test apparatus shall be clean before starting the test.

5.2.2 Use of the same amount of contaminant as that added during the filter test is not required because only a part of that contaminant was recirculated during the filter test. A total of one gram of contaminant shall be added in at three or more equal increments during three four-minute operating cycles, as specified in Section 6.4.3. Allow the test apparatus to run one additional operating cycle after the last addition of contaminant.

5.3 Required Accuracy. The test apparatus is accurate if the clean-up filter retains at least 95% of the contaminant added.

6. PROCEDURE

6.1 Operating Cycle. The majority of refrigeration systems operate on an on-off basis according to the demand for cooling. Therefore, the intention of this method for testing the filtration ability of a filter is to operate the test apparatus with interrupted flow such as occurs in an actual refrigeration system.

After the pump is started and the flow rate adjusted, the contaminant is added at the beginning of the three-minute flowing cycle. This length of time is enough to carry the contaminant to the filter under test. At the end of the three-minute period, record the pressure drop, stop the pump, and immediately open the vent valve. This permits air to enter the test apparatus and the lines to drain for one minute. At the end of this time, close the vent valve and restart the pump. The velocity head from the liquid starting up impinges on the filter under test in the same manner as occurs in an actual system. Conduct the cycle described in Section 6.4.4.

6.2 Filter Under Test Position. The filter under test shall be vertical with the flow downward.

6.3 Test Parameters. The filter under test, line size, test flow rate, and end-point pressure drop shall be reported.

6.4 Test Procedure

6.4.1 Install the filter under test and a new preweighed element in the clean-up filter. Open the three-way flow regulating bypass valve. Fill the test apparatus with enough clean test fluid so that, with the pump running, the reservoir is about half full. This will permit the returning test fluid to create turbulence in the reservoir.

6.4.2 With the pump running, operate the three-way flow regulating bypass valve (or regulate the pump speed) slowly until the test flow rate is obtained. Allow the test apparatus to run until a steady flow rate is maintained. Record the pressure drop across the filter under test produced by the test flow rate that is to be maintained throughout the test.

6.4.3 With the test apparatus operating, arrange the contaminant loading device bypass and shutoff valves to bypass
the contaminant loading chamber, remove the chamber cap, and add a measured amount of test contaminant. Replace the cap and regulate the contaminant loading device shutoff and bypass valves to slowly introduce the contaminant. Allow the test apparatus to operate, maintaining the test flow rate per Section 6.4.2. Record the pressure drop at the end of a three-minute running cycle. Shut off the pump and open the vent valve to allow the test fluid to drain from the filter under test for one minute.

6.4.4 Close the vent valve and restart the pump, adjust to the test flow rate per Section 6.4.2 if necessary, and repeat the cycle in Section 6.4.3 until the pressure drop after start-up reaches a stable condition greater than the end-point pressure drop specified for the filter under test. As the pressure drop approaches the limiting value, fluctuations above or below the end-point pressure drop during the running cycle have been known to occur due to rearrangement of contaminant on the filter. When the pressure drop remains above the end-point pressure drop, then the addition of contaminant test is complete.

6.4.5 Adjust the increment of contaminant addition so that the end-point pressure drop is reached within 6 to 12 additions. Slightly different results will be obtained if a higher number of cycles are used. Replace the clean-up filter if the test flow rate cannot be maintained. Retain all clean-up filters for use in the contaminant loading calculation.

6.4.6 After the end-point pressure drop is reached or exceeded, repeat five four-minute cycles per Section 6.4.3 at the test flow rate without contaminant addition.

6.5 Mass of Contaminant. Remove the filter element from the clean-up filter. Thoroughly dry the filter element in a 110°C (230°F) oven before reweighing to determine the mass of contaminant that passed through the filter under test.

7. CALCULATION OF RESULTS

7.1 Determine the Filter Efficiency in % (E_f)

Calculation

\[ E_f = \frac{M_t - M_{cf}}{M_t} \times 100\% \]

7.2 Plot a graph of cumulative contaminant loading as the abscissa versus pressure drop (\(\Delta P\)) as the ordinate. From the graph, or through trendline or interpolation calculations, read the contaminant loading at the end-point pressure drop (\(M_p\)). An exponential fit trendline will fit the majority of data sets generated; however, a linear interpolation (graphical or calculational) using the 2 data points bracketing the end-point pressure drop will sometimes provide a better fit.

7.3 Compute the contaminant capacity (\(M_c\)) by applying the filter efficiency (\(E_f\)) to the end-point contaminant loading (\(M_p\)) determined from the graph:

\[ M_c = M_p \times E_f \]
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INFORMATIVE ANNEX A
SAMPLE CALCULATION

Test flow rate of 4.5 kg/min (0.075 kg/s) R-113. End-point pressure drop of 30 kPa. Contaminant added in ten 1.2 g increments for a total of 12 g to produce a final pressure drop in excess of the end-point pressure drop.

The contaminant remaining in the test apparatus after the filter under test was removed was found to be

\[ M_f = \text{total mass added to the test apparatus} = 12 \text{ g} \]

\[ M_{cf} = \text{mass of contaminant on clean-up filter} = 3.23 \text{ g} \]

Filter Efficiency

\[ \frac{12 - 3.23}{12} \times 100\% = 73\% \]

As shown in Figure A-1, plot a graph of cumulative contaminant loading versus filter under test pressure drop. From the graph, read the contaminant loading at 30 kPa.

\[ M_e = \text{Mass of contaminant at end-point pressure drop} = 11.2 \text{ g} \]

Compute the contaminant capacity by applying the filter efficiency to the contaminant loading value read from the curve.

\[ M_c = \text{Contaminant capacity of the filter-drier under test} = (11.2 \text{ g} \times 73\%) = 8.2 \text{ g} \]

Figure A-1 Pressure drop vs. contaminant added.
INFORMATIVE ANNEX B

BIBLIOGRAPHY


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