SEMI F59-0302 (Reapproved 0613)
TEST METHOD FOR DETERMINATION OF FILTER OR GAS SYSTEM FLOW PRESSURE DROP CURVES

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NOTICE: This Document was completely rewritten in 2002.

1 Purpose

1.1 The purpose of this Document is to define a method for testing filters or gas systems being considered for installation into a high-purity gas distribution system or on semiconductor manufacturing equipment, respectively. Application of this Test Method is expected to yield comparable data among filters or gas systems.

1.2 This Document establishes a test method for preparing a pressure drop versus flow rate curves for filters and gas systems.

2 Scope

2.1 This procedure applies to clean filters including those cartridges of metal, ceramic and membrane construction. The pressure drops for integral housing/cartridge combination units are determined as a single set of values. For housings with removable filter cartridges, the flow curves of the housing and housing/cartridge combination are determined separately.

2.2 This procedure applies to high-purity gas systems. This procedure applies to face-seal, surface mount—modular, and monolithic integrated gas systems.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 For separable filtration units, a single cartridge pressure drop value cannot be combined to give the pressure drop value for an extended length cartridge, because of the limitations imposed by a common outlet port for the assembly.

3.2 This method is written with the assumption that the operator understands the use of the apparatus at a level equivalent to six months of experience.

3.3 This method is written to test a filter under normal operating conditions. It does not prescribe a procedure for reverse flow testing since the manufacturers do not recommend operation of the filter in this manner.

3.4 Components that induce line pressure changes on a system such as pressure regulators, and MFCs are not considered in this test method.

3.5 Proper flow of low vapor pressure gases can be affected by small pressure drops and may need to be evaluated independently.

4 Referenced Standards and Documents

4.1 *ASME Standard*[1]

ASME Performance Test Code PTC 19.5, 1972 — "Applications." Part II of "Fluid Meters, Interim Supplement on Instruments and Apparatus."

[1] American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, USA; Telephone: 973.882.1170, Fax: 973.882.1717, https://www.asme.org

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5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *CDA* — clean, dry air

5.1.2 *°C* — degrees Celsius

5.1.3 *DUT* — device under test

5.1.4 *kg* — kilogram

5.1.5 *kPa* — kilopascals, (kNm^{-2})

5.1.6 *m* — meter

5.1.7 *MFC* — mass flow controller

5.1.8 *N* — Newton (kg m/s^2)

5.1.9 *P* — pressure in kiloPascal (kPa)

5.1.10 *POC* — point of connection

5.1.11 *psi* — pounds per square inch

5.1.12 *psia* — pounds per square inch absolute

5.1.13 *psid* — pounds per square inch differential

5.1.14 *psig* — pounds per square inch gauge

5.1.15 *s* — second

5.1.16 *scfm* — standard cubic feet per minute

5.1.17 *slpm* — standard liters per minute

5.1.18 *T* — (K) temperature in Kelvin

5.1.19 *ΔP* — differential pressure in kPa

5.1.20 *ΔP(Housing)* — (kPa, differential) differential pressure of housing in kiloPascal, differential

5.1.21 *ΔP(Unit)* — (kPa, differential) differential pressure of filtration unit in kiloPascal, differential

5.1.22 *ΔP(cartridge)* — (kPa, differential) differential pressure of cartridge element in kiloPascal, differential

5.2 *Definitions*

5.2.1 *filter cartridge* — the filtration element.

5.2.2 *filter housing* — the shell that contains the filter cartridge.

5.2.3 *filtration unit* — the assembly consisting of a filter cartridge and housing.

5.2.4 *gas box* —a gas distribution subsystem which generally contains the final shut-off valve(s) prior to the POC.

5.2.5 *gas pallet* — individual gas distribution subsystems within a gas box that control flow of gas to individual process chambers.

5.2.6 *gas stick* — a series of components for an individual gas within a gas box. It may contain valves, a regulator, a pressure transducer, a purge line, an MFC, and a filter.

5.2.7 *integral unit* — the filter cartridge and housing are not separable.

5.2.8 *normal conditions* — 101.3 kPa (14.7 psia) and ambient temperature conditions 293.15 K (20°C).

5.2.9 *separable unit* — the filter cartridge and housing can be disassembled.

5.2.10 *spool flow through component* — a null component consisting of an electropolished flow passage and appropriate fittings used in place of the test component.

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5.2.11 *standard conditions* — 101.3 kPa, 273.15 K (14.7 psia, 0°C).

6 Summary of Method

6.1 This Test Method describes the test equipment and procedures for determining the flow pressure drop of filters or gas systems. The differential pressure is measured across a device under test (DUT) at various inlet pressures and flows. If the filtration unit is separable the individual contributions from the housing and cartridge are determined.

7 Interferences

7.1 Test stand must be of adequate dimensions so that it does not limit the flow through the test DUT. The pressure drop for the test stand must be insignificant compared to the pressure drop for a DUT at the test flow rate.

8 Apparatus

8.1 Pressure regulator.

8.2 Downstream flow regulating valve.

8.3 Flow meter capable of measuring flow rates to better than 5% full scale and of appropriate range.

8.4 Several pressure transducers or gauges.

8.5 Differential pressure transducer (0.67 kPa, (0.1 psi) sensitivity).

8.6 Test stand.

8.7 Temperature measuring device (°C).

9 Reagents and Materials

9.1 Test Gas nitrogen or clean, dry air (CDA) filtered to <0.02 micrometer with a dew point of less than or equal to −40°C.

10 Safety Precautions

10.1 *Safety Precautions* — This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.

10.2 The user must have a working knowledge of the respective instrumentation, must practice proper handling of test components, and must understand good laboratory practices. The user should not operate the components in such a manner as to exceed the ratings (i.e., pressure, temperature, flow and voltage).

11 Test Specimen

11.1 A gas box may consist of several gas pallets that uniquely control flow of gases to a specific process chamber. More than one gas stick layout is possible on the pallet. The user shall test only one stick at a time for pressure drop measurement. The gas stick may be removed from the pallet to attach to the test fixture.

11.2 Pressure regulators and mass flow controllers (MFCs) shall be maintained in their fully open position during testing.

11.3 When comparing different gas system designs, it is useful to use components of similar design.

11.4 If the stick design contains a filter that dominates the pressure drop on the system, such filters shall be replaced by spool flow through components.

12 Preparation of Apparatus

12.1 Construct a test stand for the measurement of gas flow rates and pressure drop across a DUT. Examples of such a test stand are shown in Figures 1a or 1b as schematic drawings.

12.2 The gas supply is filtered by an electronics grade high purity point-of-use gas filter before it is delivered to the DUT through a pressure regulator.

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12.3 A flow meter can be installed either upstream or downstream of the DUT. See Figures 1a or 1b. The test filter is upstream of a throttle valve to allow for control of the flow through the DUT.

12.4 Inlet pressure is measured immediately upstream of the DUT by a pressure gauge or pressure transducer.

12.5 Pressure drop across the test specimen is measured by an electronic differential pressure transducer capable of reading 0.67 kPa (0.1 psid) across the test device.

12.6 Flow measurements are carried out through a flow meter installed upstream or downstream of the test filter. See Figures 1a or 1b.

NOTE 1: The flow measurement can be influenced by both upstream and downstream pressure fluctuations. It is necessary to verify the accuracy of any flow measurement under the test conditions used to complete this testing.

12.7 A temperature measurement device can be installed in the test stand to measure the gas stream temperature.

12.8 Figure 2 gives the piping requirements for the test stand configuration.

12.9 Figure 3 gives the recommended pressure connection to be followed in constructing the test apparatus.

13 Calibration and Standardization

13.1 For each test, verify that calibration of test equipment is up-to-date.

13.2 A series of flow meters should be used to cover the full range of flows that will be tested.

14 Procedure

14.1 *Integral Filtration Unit*

14.1.1 Assemble the filtration unit into the test apparatus. (See Figure 1.)

14.1.2 Set the inlet pressure using the pressure regulator to 10% of the filter's maximum rated inlet pressure or to 205 kPa (29.7 psia) whichever is less. Pressure is read on the inlet pressure gauge.

14.1.3 Adjust the flow rate using the regulating valve to give 10% of the maximum rated flow. Adjustments to the inlet pressure regulator may be required to maintain a constant inlet pressure of 205 kPa (29.7 psia). The flow and pressure adjustments can be an iterative process requiring several iterations to achieve the desired flow rate and inlet pressure. The flow rate is read on the flow meter and recorded.

14.1.4 Read and record the ambient temperature, inlet pressure, pressure drop across the test filter, ambient pressure, and flow rate corrected for upstream pressure based on manufacturer's recommendation.

14.1.5 Repeat steps in ¶¶ 14.1.3 and 14.1.4 at 25%, 50%, 75% and 100% of the maximum rated flow.

14.1.6 Repeat steps in ¶¶ 14.1.2 through 14.1.5 at several inlet pressures: 309 kPa (44.7 psia), 516 kPa (74.7 psia), and 723 kPa (104.7 psia).

14.1.7 Additional testing of the filter at higher pressures can be completed up to the maximum rated pressure.

14.1.8 When the filter has a lower maximum pressure rating than 90 psig, it is recommended that the filter be tested at pressures of 33%, 67% and 100% of the filter's maximum pressure rating, with tests being limited by the sensitivity of the differential pressure device.

14.2 *Separable Filtration Unit — Filter Housing*

14.2.1 Assemble the empty filter housing into the test apparatus.

14.2.2 Set the inlet pressure using the pressure regulator to 10% of the housing's maximum rated inlet pressure or to 205 kPa (29.7 psia) whichever is less. The inlet pressure is read on the inlet pressure gauge and recorded.

14.2.3 Adjust the flow rate using the regulating valve to give 10% of the maximum rated flow. Adjustments to the inlet pressure regulator may be required to maintain a constant inlet pressure of 205 kPa (29.7 psia). The flow and pressure adjustments can be an iterative process requiring several iterations to achieve the desired flow rate and inlet pressure. The flow rate is read on the flow meter and recorded.

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