STANDARD

ANSI/ASHRAE Standard 199-2016

Method of Testing the Performance of Industrial Pulse Cleaned Dust Collectors

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NOTE

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FOREWORD

ASHRAE Standard 199 provides a method of testing pulse cleaned dust collectors. The approach uses the "black box" concept, by which the dust collector and test system to be evaluated are operated per the instructions of the dust collector manufacturer without modification. This test procedure is not concerned with the internal operation of the dust collector. The performance assessment elements of the test system (inlet challenge hardware, outlet emissions quantification instrumentation, and means to provide regulated airflow through the system) are physically separated and designed so that they can be arranged and independently fastened to the black box to be evaluated.

Other methods of testing fabric and pulse cleaned filter elements (fabric filters) have been used extensively. Although useful, these methods do not adequately address performance. They do not accurately portray the dynamics of pulsed operations of multiple, full-filter arrangements. Moreover, prior to Standard 199, no standardized test was available to test the full system. Standard 199 addresses this need by requiring sequential cleaning consisting of six distinct stages run continuously.

The approach is to introduce a metered dust challenge using a specified test dust and then measure the concentration of the dust by two methods: gravimetric and photometric. Test stages include the following:

a. *Conditioning*
   Stage 1: Initial dust loading
   Stage 2: Initial dust loading with on-demand cleaning
   Stage 3: Dust loading with continuous cleaning
b. *Performance Test*
   Stage 4: Final dust loading with on-demand cleaning
c. *Recovery Test*
   Stage 5: Up-set condition
   Stage 6: Post-up-set condition

The standard describes the collection of total mass emissions and photometric emissions where no more than 25% of the filter elements are pulsed at one time.

a. *Gravimetric Efficiency*
   1. *The standard includes a gravimetric measurement of total mass.*
   2. *Performance is measured by isokinetic sampling at the centerline onto a downstream membrane. The weight change of the membrane is used to calculate mass penetration as a decimal fraction of the upstream mass concentration.*
   3. *The gravimetric efficiency uses a calculated upstream concentration based on measured feed rate.*
b. *Photometric emissions*
   1. *The standard includes downstream airborne concentration of particulate as defined by PM_1, $PM_{2.5}$, and PM_{10}.*

Before beginning the test, the requestor must provide several operating parameters. These include the following:

a. *Specified airflow (the nominal volumetric flow rate for the test)*
b. *Pulse cleaning system high and low tubesheet differential setpoints*
c. *Pulse duration (the time the electronic signal indicates the solenoid valve is open)*
d. *Pulse intervals (the time between initiation of the successive pulses)*
e. *Pulse cleaning pressure*
f. *Pulse cleaning system volume*
g. *Up-set pressure condition limit (minimum of 10 in. of water [2488.4 Pa])*

This method of test does not prescribe performance; rather it provides a way to state the performance of a pulse cleaned dust collector. It characterizes performance of a pulse cleaned dust collector system under specified laboratory conditions and under specified operating parameters using a standard test dust. Test results should not be used to predict absolute performance in actual industrial applications of similar equipment; however, these results will be useful in the comparative performance of different systems.

1. PURPOSE

The purpose of this standard is to provide a quantitative laboratory test method for determining the performance of industrial pulse cleaned dust collectors using a test dust.

2. SCOPE

This method of test applies to bag, cartridge, or envelope industrial dust collectors that recondition the filter media by using a pulse of compressed air to discharge the dust cake from the filter media while the air cleaning device remains online.

3. DEFINITIONS AND ACRONYMS

3.1 Definitions

airflow, specified: airflow rate in acfm (m^3/s) at the lab conditions by which the device is tested. In this standard it is specified by the requestor.

black box: device, system, or object that can be viewed in terms of its input, output, and transfer characteristics without any knowledge of its internal workings.

Informative Note: For the purpose of this test procedure, the industrial pulse cleaned dust collector is treated as a black box. The inputs are airflow, test dust, compressed air, pulsing mode, and electricity. The outputs are cleaned air and dust. The transfer functions are the measurements detailed in Section 11, such as pressure differential, compressed-air consumption, gravimetric efficiency, and photometric emissions. This test procedure is not concerned with the internal operation of the dust collector.

cleaning, continuous: process of cleaning filter elements based on a predetermined time interval as opposed to tubesheet differential pressure initiated cleaning.

cleaning, cycle: period in which all pulse cleaning valves are activated once, in sequential order, until immediately before the sequence starts again.

cleaning, on-demand: process of cleaning filter elements based on tubesheet differential pressure as opposed to predetermined time interval.

coefficient of variation: standard deviation of a group of measurements divided by the mean.

concentration, mass: amount of contamination material in the air expressed as a unit of mass per actual unit volume of air, for example, grains per cubic foot (gr/ft^3) or milligrams per cubic metre (mg/m^3).

efficiency, gravimetric: 100% minus the percentage of mass that passes through the filter from a known upstream concentration.

emissions, photometric: downstream concentration measured by a photometer at the given upstream conditions.

header: component of the pulse cleaning system that stores the compressed air supply for the pulse valves.

penetration, gravimetric: percentage of mass that passes through the filter from a known upstream concentration.

PM_1: particulate mass less than 1 μm as determined by photometric measurement in accordance with USEPA 40 CFR Part 50.

$PM_{2.5}$: particulate mass less than 2.5 μm as determined by photometric measurement in accordance with USEPA 40 CFR Part 50.

PM_{10}: particulate mass less than 10 μm as determined by photometric measurement in accordance with USEPA 40 CFR Part 50.

pressure, differential: difference of static pressure measurements between two points in a system.

Informative Note: Standard 199 includes two differential pressure measurements in this standard: across the tubesheet and inlet piezometer to outlet piezometer.

pulse cleaning system (PCS): term for the components used to momentarily and locally reverse the airflow through a filtration system with the objective of removing collected particulate from the system's filtration elements. These systems include all parts from the compressed air connection to the point of compressed air discharge into the filter element, and any associated equipment.

pulse duration: amount of time that each individual pulse cleaning solenoid is energized, typically expressed in milliseconds (ms).

pulse interval: time between the initiation of two successive pulses when the pulsing algorithm has not been satisfied, typically measured in seconds (s).

Stairmand disk: plate occupying the central half of the area of a duct, oriented so it is perpendicular to the direction of airflow. It is used to induce turbulence and mixing.

3.2 Acronyms and Abbreviations

acfm	quantity airflow in actual cubic feet per minute
CV	coefficient of variation
USEPA	U.S. Environmental Protection Agency
ISO	International Organization for Standardization
NIST	National Institute of Standards and Technology
PCS	pulse cleaning system
in. of water	inches of water

4. TEST METHODOLOGY

4.1 Sequence of Test Events. The objective of Standard 199 is to quantify the performance of a dust collection system as defined Section 2. To achieve this, the black box concept has been employed. The test consists of six distinct stages run continuously without stopping the airflow, as shown in Figure 4-1 and briefly defined in the following subsections. Gravimetric efficiency sampling and photometric emissions measurements are performed throughout the test as required. Refer to Section 9 for a detailed procedure.

4.1.1 Stage 1: Initial Dust Loading. This stage loads dust to the collector to a predetermined differential pressure with no pulse cleaning. Once differential pressure has been reached, the test proceeds to the next stage.

4.1.2 Stage 2: Initial Dust Loading with On-Demand Cleaning. Once the initial dust loading stage is complete, on-demand pulse cleaning is initiated while maintaining airflow and dust feed. Cleaning interval is determined by requestor-specified high and low differential pressure setpoints.

4.1.3 Stage 3: Dust Loading with Continuous Cleaning. This stage follows the initial on-demand cleaning with continuous pulse cleaning while maintaining airflow and dust feed. This stage lasts for 24 hours or until the predetermined maximum differential pressure has been reached, whichever occurs first.

4.1.4 Stage 4: Final Dust Loading with On-Demand Cleaning. This second, longer on-demand stage follows the continuous cleaning stage while maintaining airflow and dust feed. Cleaning is determined by requestor-specified high and low differential pressure setpoints.

4.1.5 Stage 5: Up-Set Condition. Dust feed is maintained and pulse cleaning stopped. This stage continues until differential pressure reaches the predefined maximum. At this point, dust feed is stopped.

4.1.6 Stage 6: Post Up-Set Condition. After up-set condition has been reached, airflow is reduced to 25% of specified value. Continuous pulse cleaning is initiated and continues for 10 complete cycles. The system is then returned to speci-

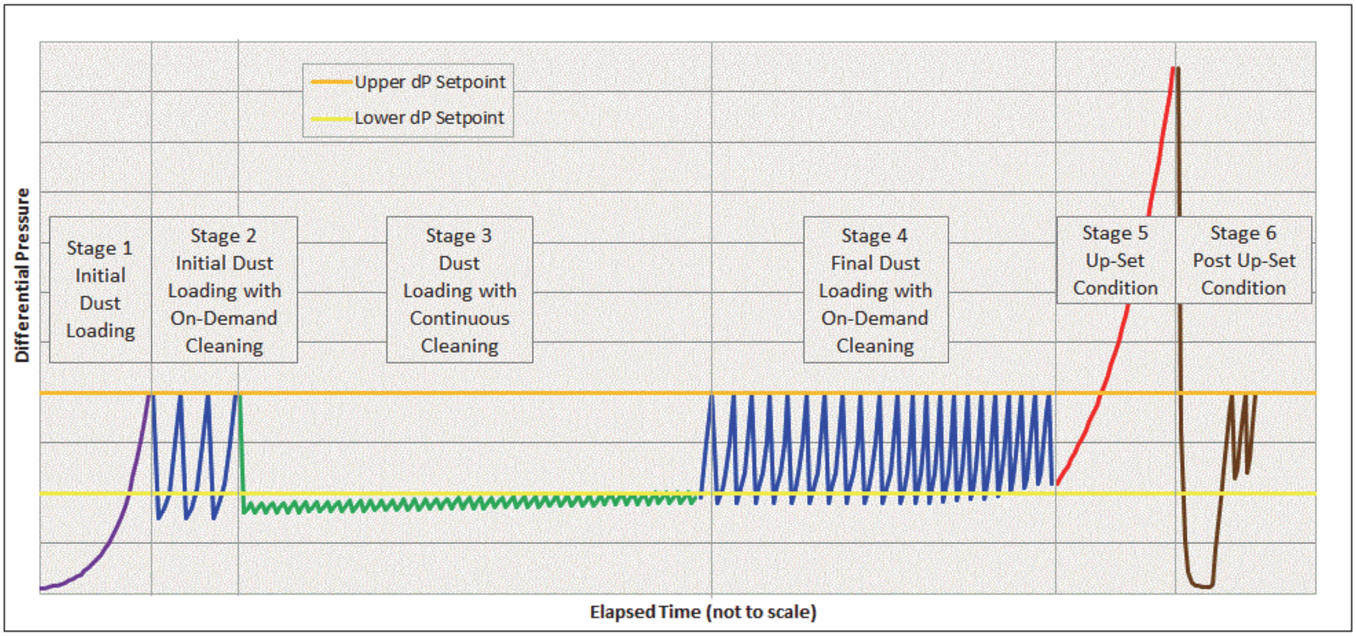

FIGURE 4-1 Schematic showing sequence of test stages.

fied airflow, and differential pressure is measured. Dust feed is then restarted and final measurements are performed.

5. TEST APPARATUS

5.1 Dust Feeder/Dispersion System. The dust feeder shall be capable of continuously feeding the test dust at 1 gr/ft^3 (2.28 g/m^3) at the specified airflow. The dust feeder shall incorporate a scale with active feedback control, such that the dust feed rate is automatically controlled within the stated tolerance. Aspiration of the fed dust shall be accomplished by an ISO 5011 [2] heavy-duty dust injector at a pressure between 20 and 50 psig (1.38 and 3.45 bar). Ensure that all items that come into contact with the dust feed system are grounded.

5.2 Test Duct. The test duct shall consist of round duct sections sufficient to maintain an inlet carrying velocity between 3500 to 5000 ft/min (17.78 to 25.4 m/s). The upstream and downstream duct diameters shall be the same from the inlet to 1 duct diameter downstream of the gravimetric sampling port. The duct material shall be electrically conductive and electrically grounded, have a smooth interior finish, and be sufficiently rigid to maintain its shape at the operating pressure. A Stairmand disk shall be used upstream of the downstream sampling devices to ensure aerosol uniformity.

Flow measurement shall be made by standardized flow measuring device in accordance with ASHRAE Standard 41.2 [1].

The test duct and the necessary hardware are schematically shown in Figure 5-1, and locations are specified in Table 5-1. Required details are specified in Figures 5-2 and 5-3. Performance requirements are detailed in the qualification of test setup (Section 8).

5.3 Pulse Cleaned Dust Collector. The requestor shall supply all items, including pulse cleaning system with control, filter housing, filters, and continuous dust removal system. The system shall be set up to clean a maximum of 25% of the filter media at any one time. The system shall not contain an integral blower. See Section 7 for requestor-defined parameters.

5.4 Blower and Associated Control System. The blower and associated control system shall have sufficient capacity to consistently maintain specified airflow throughout the test.

5.5 Instrumentation

5.5.1 Aerosol Photometer. Downstream concentration shall be measured by a 90 degree light scattering aerosol photometer. The instrument shall be calibrated to the test dust and capable of the mass and flow requirements of the specified test parameters. It shall be capable of detecting 0.001% of the upstream concentration in the size range of 0.1 to 10 µm. The instrument shall be set to a time constant of 60 s and capable of simultaneously measuring and recording size-segregated mass fraction concentrations corresponding to PM_1, $PM_{2.5}$, and PM_{10}.

5.5.2 Gravimetric Sampling. A sample train capable of conducting isokinetic sampling and recording total gas flow shall be used.

5.5.3 Sensors. Sensors shall meet the minimum requirements as listed in Table 5-2. A calibration system shall be employed to track accuracy and traceability to appropriate NIST primary standards.

5.6 Lab Conditions. Temperature shall be kept between 60°F and 100°F (16°C and 38°C). Relative humidity shall be kept between 45% ±10% rh. These conditions apply to the lab and the inlet airstream.

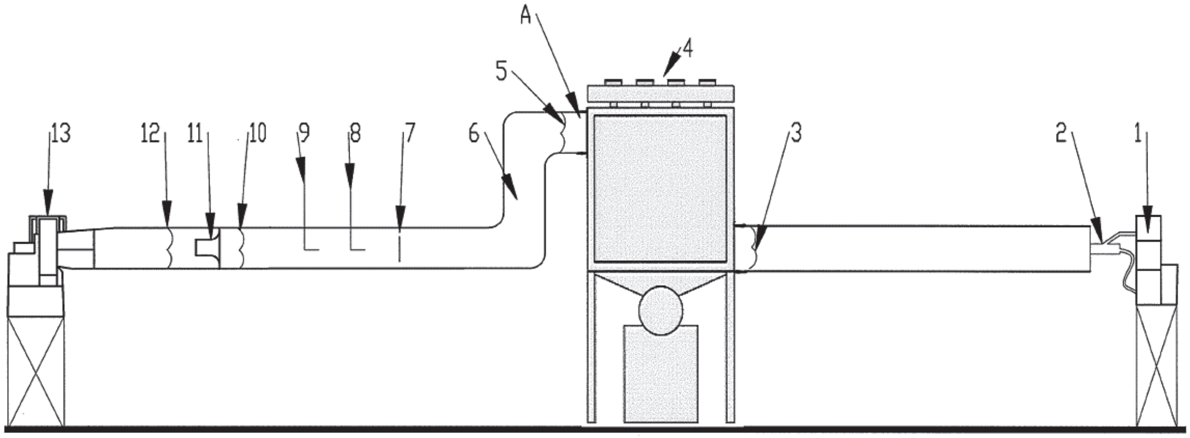

FIGURE 5-1 Schematic showing test setup.

1. Dust feed system
2. Heavy-duty dust injector
3. Collector inlet fitting and inlet piezometer ring
4. Pulse cleaned dust collector (including pulse controls, airlock, and dust bin)
5. Outlet piezometer ring
6. Collector outlet fitting
A. Leak checkpoint (See Section 8.4)
7. Stairmand disk
8. Photometer sampling port
9. Gravimetric sampling port
10. Upstream airflow nozzle piezometer pressure tap (including upstream static pressure)
11. Airflow nozzle
12. Downstream airflow nozzle piezometer pressure tap
13. Blower and associated control system (with optional exit filter)

TABLE 5-1 Required Device Placement Minimums, Stated in Straight Duct Diameters (*D*) [a] where Necessary

Device	Location	Comment
Inlet duct	6*D* upstream of inlet fitting	
Inlet and outlet fittings	Immediately connected to pulse cleaned dust collector	Fittings from duct to device are allowed.
Inlet and outlet piezometer rings	Immediately connected to pulse cleaned dust collector	Constructed per Figure 5-2
Stairmand disk	2*D* downstream of the outlet fitting and 6*D* upstream of the photometric sampling port	If airflow uniformity at the photometric sampling port can be demonstrated without this device, it may be omitted.
Photometric sampling port ***Informative Note:*** No part of the photometric sampling system shall have a cross-stream dimension perpendicular to the photometer sample flow greater than 1% of the square root of the duct cross-sectional area. The inlet area of the isokinetic sampling probe shall be less than 1% of the duct cross-sectional area.	6*D* downstream of the exit of the Stairmand disk and 3*D* upstream of any change in duct cross-section or direction	
Gravimetric sampling port ***Informative Note:*** The gravimetric sampling system shall not block more than 10% of the cross-sectional area of the duct.	2*D* downstream of the photometric sampling port and 1*D* upstream of any change in duct cross-section or direction	
Airflow nozzle	The duct upstream and downstream of the flowmeter shall conform to the requirements in Section 8.1.	Change in duct diameters are allowed to accommodate airflow nozzle.

a. There shall be a minimum of one diameter (1*D*) between any two sampling or measurement devices.