



M98 HEPA Filter System Performance Study: Testing Methods and Criteria

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Agenda

- **Overview of NSWCDD's Filter Performance Evaluation**
- **NSWCDD Particulate Leak Test Method**
- **Issues, Considerations and Actions Taken**
- **HEPA Filtration Overview**
- **Thermal vs. Laskin Nozzle Aerosol Generation**
- **Difference Between Leak and Efficiency Testing**
- **Threat and Filtration Criteria**
- **Recommendations and Continued Work**



M98 Filter Performance Evaluation

- **Task:**

- Beginning in January 2004, NSWCDD examined the remaining filtration capacity of the M98 gas filter after 300, 500, and 700 days of service at a fixed-site location.

- **Objective:**

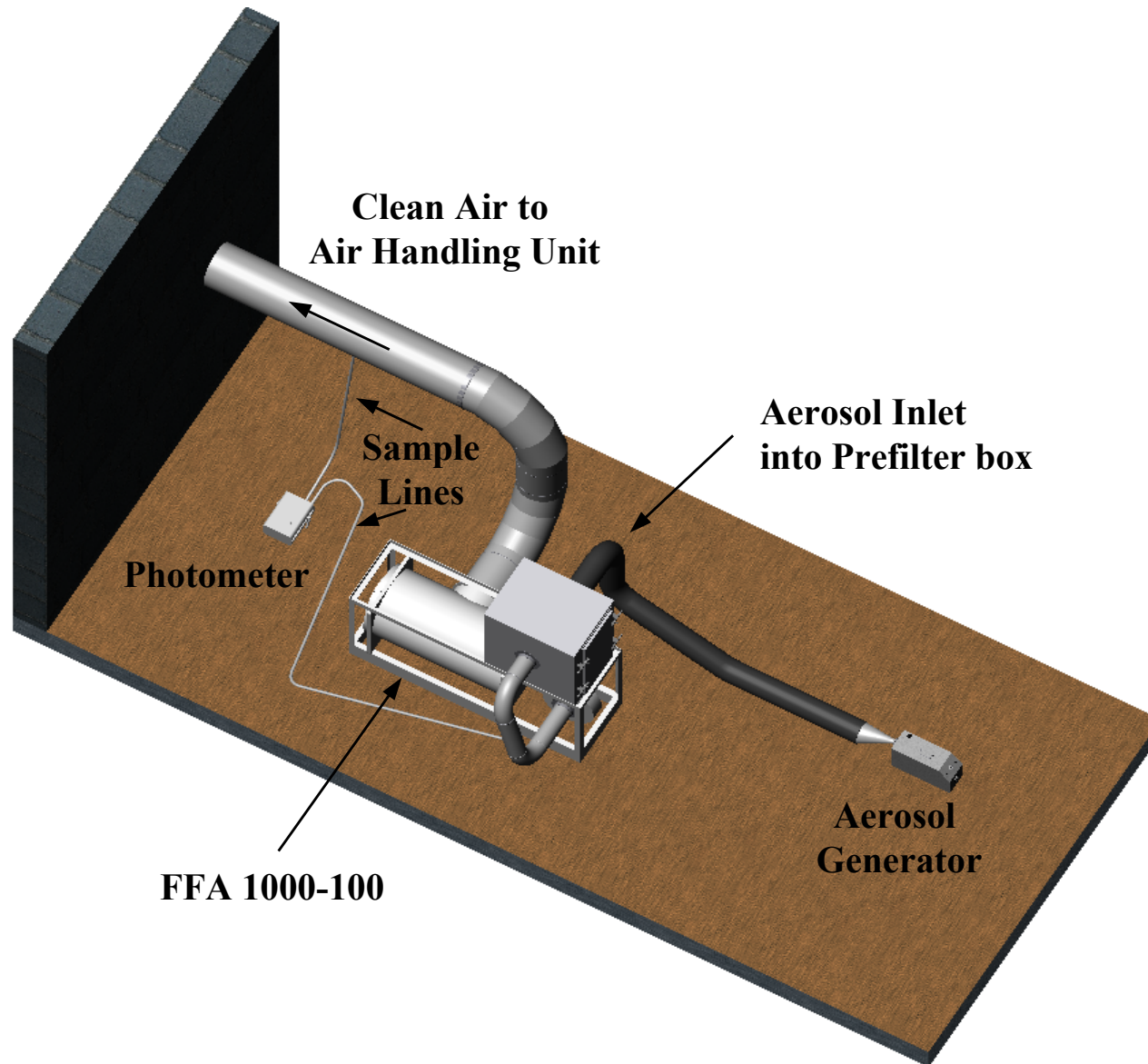
- Provide data and modeling information to accurately assess the performance of new and in-service fixed-site M98 filters.

- **Testing:**

- Aerosol leak tests were performed on each system before the old filters were removed and after the new filters were installed.



NSWCDD Leak Test Method





Issues and Considerations

- **Test Results:**
 - Lower than expected leak test results
- **Possible Explanation of Results:**
 - Individual filter performance vs. overall system performance
 - Environmental effects
 - Gaskets
 - Filter media
 - Test equipment and procedures

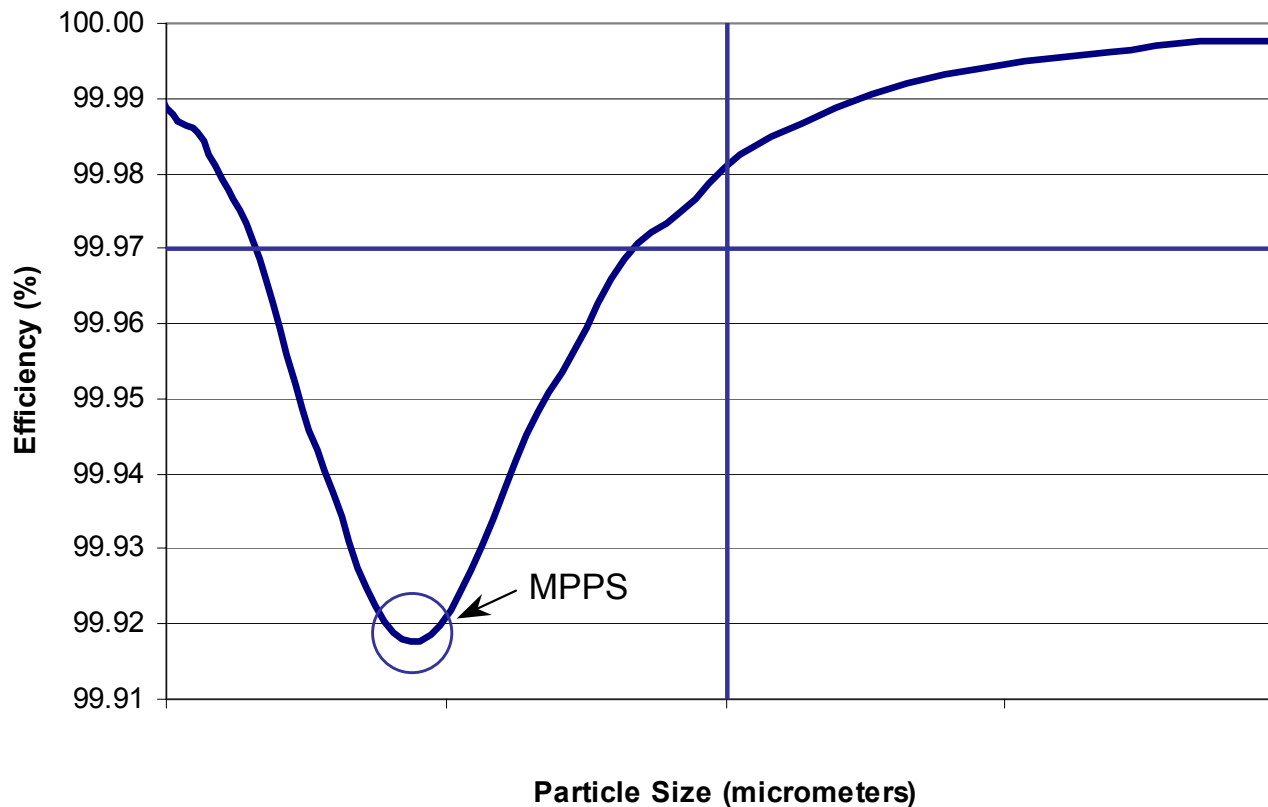


Actions Taken

- **Environmental Effects:**
 - Testing performed across a diverse range of environmental conditions, ruling out the possibility of humidity and temperature having an effect on the testing process.
- **Gaskets:**
 - Gaskets were tested by two methods:
 - Caulking to eliminate any error caused by gaskets.
 - Metal to gasket seal to eliminate gasket to gasket error.
 - Neither method had a noticeable effect on photometer reading.
- **Test Method:**
 - Standardized test methods through research and following IEST and ASME standards.
- **Test Equipment:**
 - Researched and determined the equipment needed for testing.



HEPA Filtration Curve

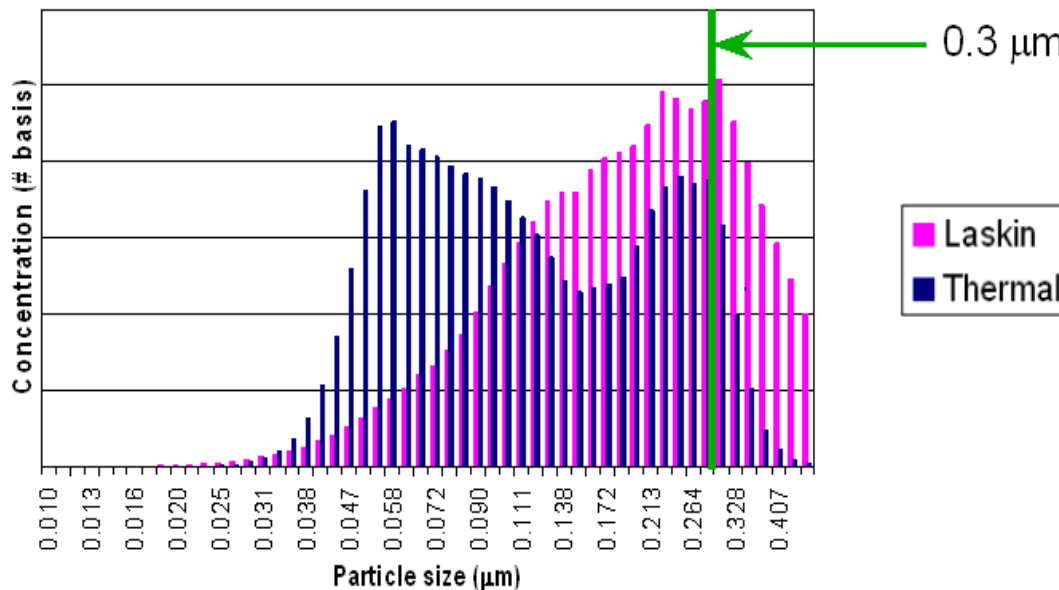


Widely Known Facts:

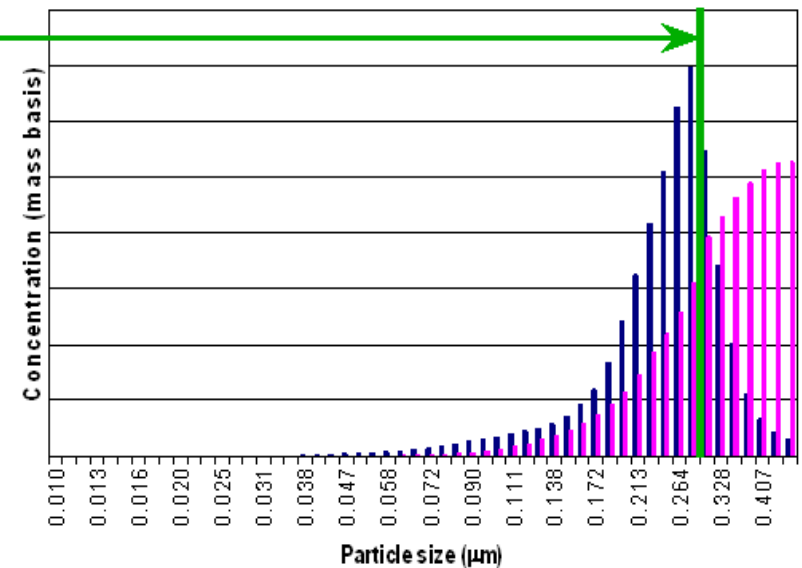
1. Efficiency testing is conducted at 0.3 μm because it was thought to be the most penetrating particle size (MPPS). The actual MPPS is between 0.1 and 0.2 μm depending on the media.
2. Efficiencies at larger particle sizes (1.0-10 μm) are significantly higher.

Thermal vs. Laskin Nozzle Aerosol Generation

Count Basis



Mass Basis



Count Basis Measurement Method

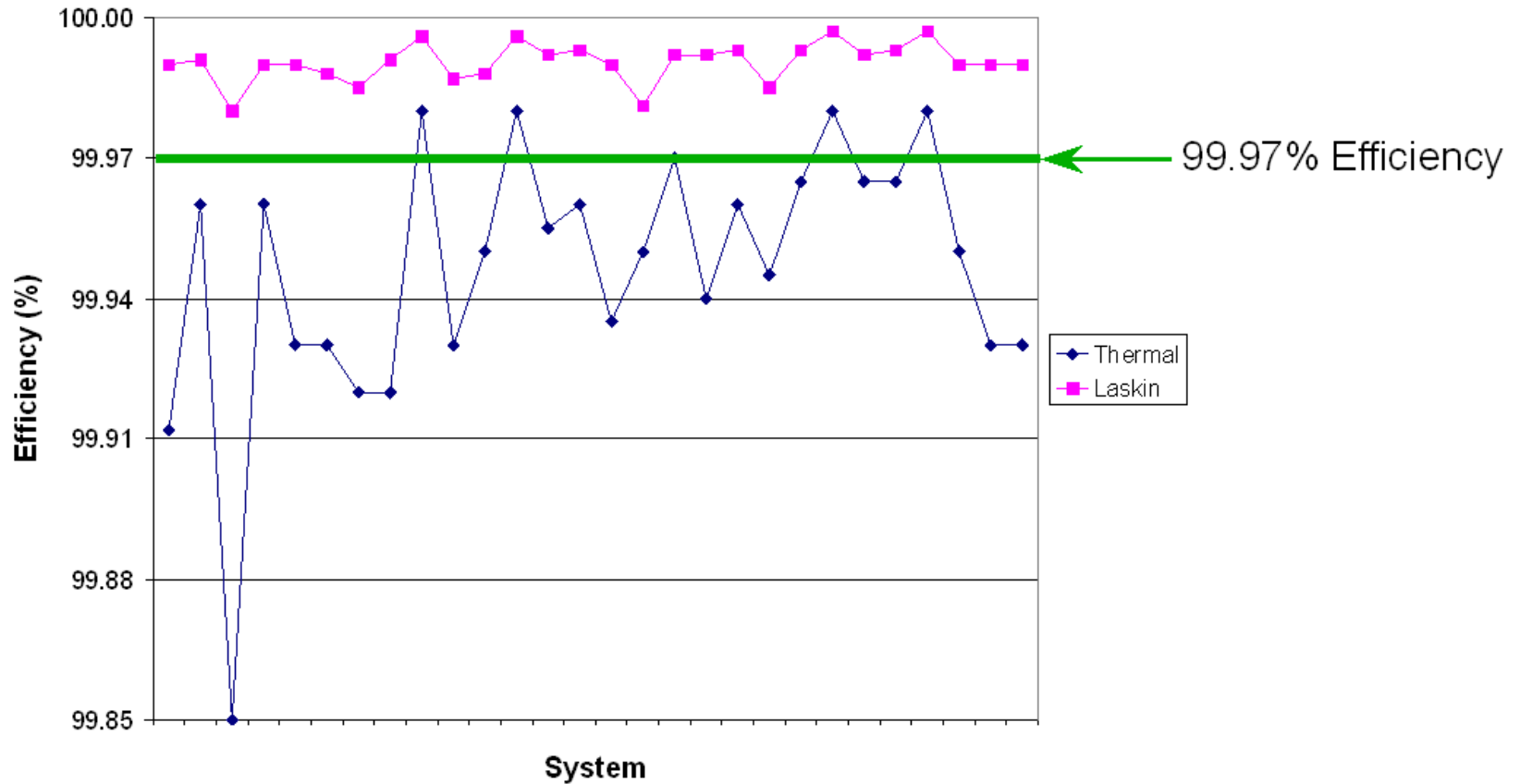
- Laser Particle Counter
- Scanning Mobility Particle Sizer

Mass Basis Measurement Method

- Photometer



Thermal vs. Laskin Nozzle Generator Leak Test Results



Note:

1. Systems were tested on the same day with the same calibrated photometer.



COLPRO System: Leak Test vs. Efficiency Test

- **Leak Test:**

- Measure of the bypass leakage of a polydispersed aerosol through a filtration system at its rated airflow.
- Verifies that both the particulate filter gaskets and o-ring seals within a COLPRO system are free from leaks, as well as identifying any significant damage to the filters.

- **Efficiency Test:**

- Measure of the penetration of a specific size aerosol through a filtration system at its rated airflow.
- A quantifiable examination of not only the gaskets and o-rings, but also the installed filter's media.
- Characterizes the system performance against specific threat particle sizes.



Equipment Required for a System Efficiency Test

- **Monodispersed aerosol:**
 - Challenging a filtration system with only particles of the desired challenge size.
 - Insufficient output of aerosol will result in statistical uncertainty for larger systems (i.e. above 5,000 CFM).

OR

- **Specific particle size measurement:**
 - Measuring only the desired particle size of a polydispersed aerosol challenge.
 - Equipment is costly (> \$100K), non-ruggedized and contains a radiation source.



Topics Considered for Particulate Performance

- **Threat:**
 - What is the threat particle size?
 - What is the expected upstream concentration of particles?
 - What is an allowable downstream concentration of particles?
- **Type of testing required:**
 - Leak
 - Efficiency
- **M98 particulate filters media selection:**
 - HEPA
 - ULPA



Recommendations and Continued Work

- **Perform leak tests on all systems.**
- **Design one set of equipment capable of performing leak tests on all systems regardless of airflow.**
- **Develop the equipment needed to characterize a system's efficiency across a range of sizes.**
- **Standardizing test ports for all COLPRO applications.**
- **Study the threat as compared to current HEPA media efficiency to determine desired filtration criteria.**



Questions?

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