F^1 elements performance validation

an independent test report validating the performance of the nano F^1 compressed air & gas filter elements to ISO 12500-1:2007 air quality standards

test report:

oil aerosol removal performance of nano F[1] grade M1 & M01 coalescing filter elements

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introduction

This document details the testing methodology and performance characteristics for a series of oil aerosol removal experiments performed on nano grade M01 and M1 nano **F**[1] coalescing filter elements. Target downstream oil aerosol concentrations are 0.01 mg/m³ and 0.1 mg/m³ respectively in order to meet class 1 and 2 of ISO 8573-1:2007 (Compressed Air - Contaminants and Purity Classes).

methods

Filter testing was carried out in accordance with the protocols of ISO 12500-1:2007 (Filters for Compressed Air – Test Methods – Part 1 : Oil Aerosols). The general principle is to generate a known challenge concentration of oil aerosol which is introduced to the filter. The aerosol content is measured downstream thereby quantifying the efficiency and removal performance. The test layout, equipment and measurement points are shown in figure 1 above. In order to simulate worse case, all filter elements selected for testing were determined on the basis of having the highest gas flow velocities (media face velocity) within the range.

Filter testing was carried out using compressed air at the rated inlet flow and pressure (7 barg) of the unit(s) under test. Hydrosafe Grade VG46 (ISO 3448) oil was aerosolized to challenge concentrations of 10 mg/m³ in the case of grade M01 filters and 40 mg/m³ for grade M1 filters.

Aerosol generation was by means of a Laskin nozzle which produced a polydispersed aerosol distribution with an average particle size of between 0.15 microns and 0.4 microns by particle count. Care was taken to ensure that all of the oil challenge concentration was delivered to the filter in aerosol form and within the range detailed above, and not as wall flow.

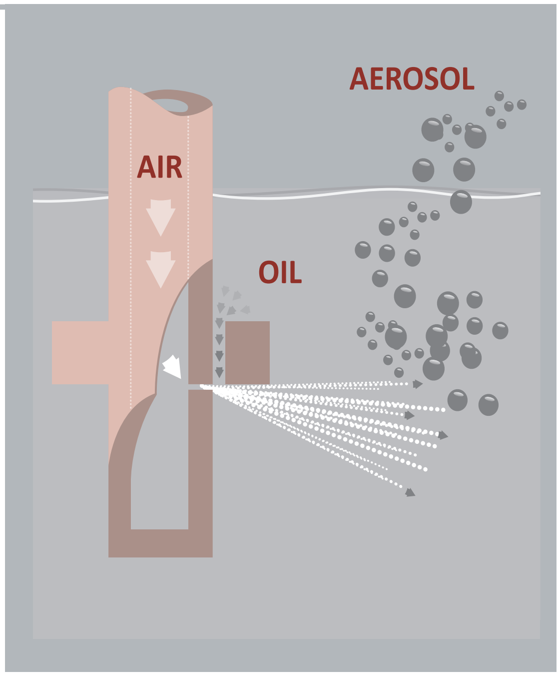
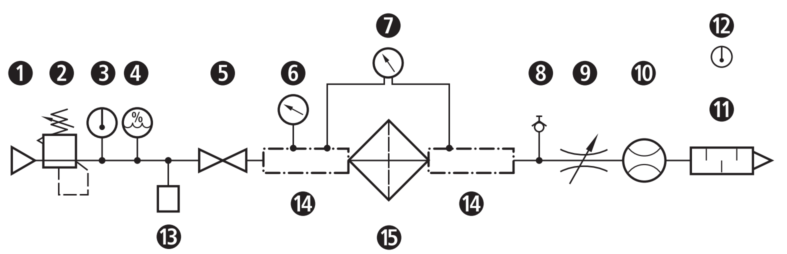


Figure 1: Aerosol generation by Laskin nozzle



1. compressor air supply
2. pressure regulator
3. temperature sensing/measuring
4. dew point sensing/measuring
5. full-flow ball valve
6. pressure sensing/measuring
7. differential pressure gauge
8. sample test point
9. multi-turn flow control valve
10. flow sensing/measuring
11. silencer
12. ambient temperature sensing/measuring
13. aerosol generator
14. pressure measuring tube
15. filter under test

Figure 2: Arrangement of the test rig used in the oil carry-over tests

pressure and flow measurements

The following measurements were taken and recorded for each filter under test:

- flow rate, pressure, temperature and humidity
- differential pressure – empty housing
- differential pressure – complete housing (dry conditions)
- differential pressure – complete housing (saturated conditions)
- oil aerosol challenge
- downstream oil aerosol (filter performance)

Before taking measurements in the saturated condition, the filter element was allowed to reach a state of equilibrium by conditioning the filter under test using the challenge aerosol concentration. Equilibrium was considered to have been achieved when liquid oil is observed in the bottom of the filter housing in which the filter under test is contained and the rate of change in pressure drop was less than 1% per hour of the measured pressure drop.

At this point the pressure drop across the test filter was recorded and the oil aerosol carry-over measured.

determination of oil aerosol concentration

The determination of oil aerosol concentration both upstream (challenge) and downstream was carried out using a calibrated light-scattering aerosol photometer as specified in ISO 12500-1 using compressed-air sampling methods detailed by ISO 8573-2, i.e. iso-kinetic sampling.

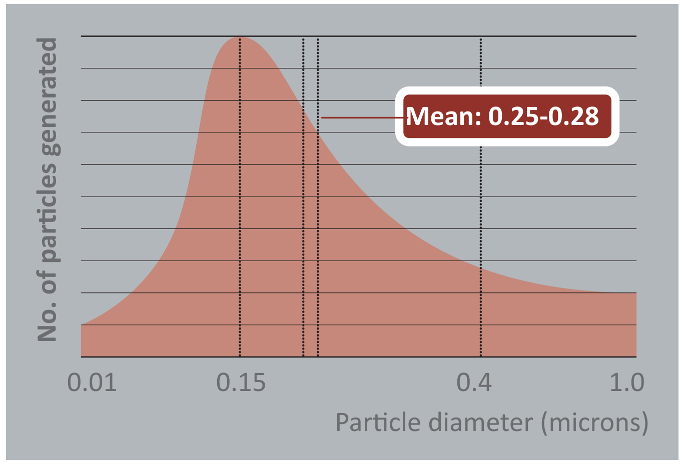


Figure 3: Polydispersed aerosol distribution

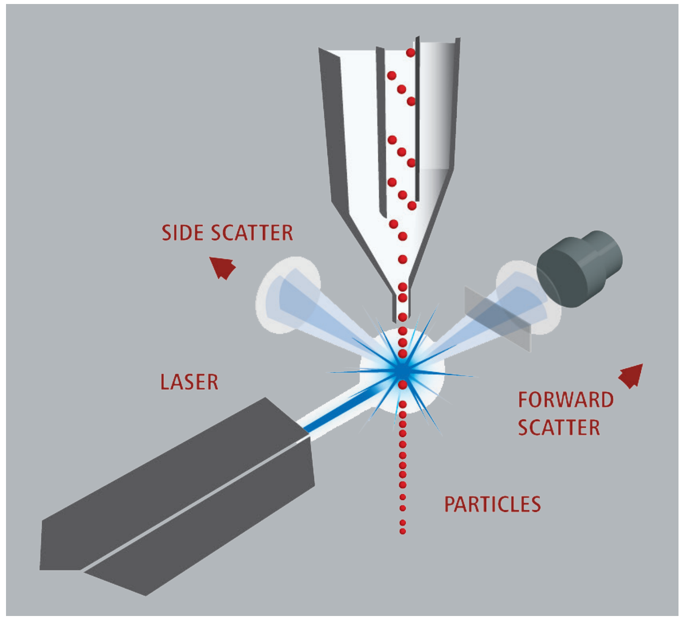


Figure 4: Principles of particle detection

results

oil removal performance

filter grade	ISO 8573-1:2001 quality class	specification	test results
grade M01	1	0.01 mg/m³	0.007 mg/m³
grade M1	2	0.10 mg/m³	0.050 mg/m³

conclusion

In terms of oil aerosol removal performance, nano **F**[1] grade M01 and M1 filter elements, when tested in accordance with ISO 12500-1 challenge conditions at their rated flow, exceed target performance and allow users to meet the relevant compressed air quality classes stated in ISO 8573-1:2001.

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guide to ISO 8573 & 12500 air quality classes

The ISO 8573 group of international standards are used for the classification of compressed air purity. The standard provides the test methods and analytical techniques for each type of contaminant.

All nano elements are designed to perform above the criteria set out by these industry standard classifications and internal quality management measures have been designed to ensure that all products are monitored for continual improvement against these specific industry measures.

The table below summarizes the maximum contaminant levels specified in ISO 8573 for the various compressed air quality classes. Each compressed air classification can be achieved by installing a specific nano filter grade or a combination of filter grades, depending upon the required performance.

ISO purity class	solid particles				water		oil
	maximum no. of particles per m^3			concentration	vapor	liquid	total oil [1]
	0.1 - 0.5 micron	0.5 - 1 micron	1 - 5 micron	mg/m^3	pressure dew point	g/m^3	mg/m^3
0	as specified by the equipment user or supplier						
1	≤ 20,000	≤ 400	≤ 10	-	≤ -94ºF	-	≤ 0.01
2	≤ 400,000	≤ 6,000	≤ 100	-	≤ -40ºF	-	≤ 0.1
3	-	≤ 90,000	≤ 1,000	-	≤ -4ºF	-	≤ 1
4	-	-	≤ 10,000	-	≤ 37ºF	-	≤ 5
5	-	-	≤ 100,000	-	≤ 45ºF	-	-
6	-	-	-	≤ 5	≤ 50ºF	-	-
7	-	-	-	5 - 10	-	≤ 0.5	-
8	-	-	-	-	-	0.5 - 5	-
9	-	-	-	-	-	5 - 10	-

the ISO 8573 standard

ISO 8573-1 Contaminants and Purity classes
ISO 8573-2 Test Methods for Oil Aerosol Content
ISO 8573-3 Test Methods for the Measurement of Humidity
ISO 8573-4 Test Methods for the Solid Particle Content
ISO 8573-5 Test Methods for Oil Vapor & Organic Solvent Content
ISO 8573-6 Test Methods for Gaseous Contaminant Content
ISO 8573-7 Test Methods for Microbiological Contaminant Content
ISO 8573-8 Test Methods for Particle Content by Mass Concentration
ISO 8573-9 Test Methods for Liquid Water Content

the ISO 12500 standard

ISO 12500 is a new series of standards for compressed air filter testing and has been introduced to complement the existing ISO 8573 series, and consists of four parts:

ISO 12500-1 oil aerosols
ISO 12500-2 oil vapors
ISO 12500-3 particles
ISO 12500-4 water

ISO 9001:2000 quality management systems

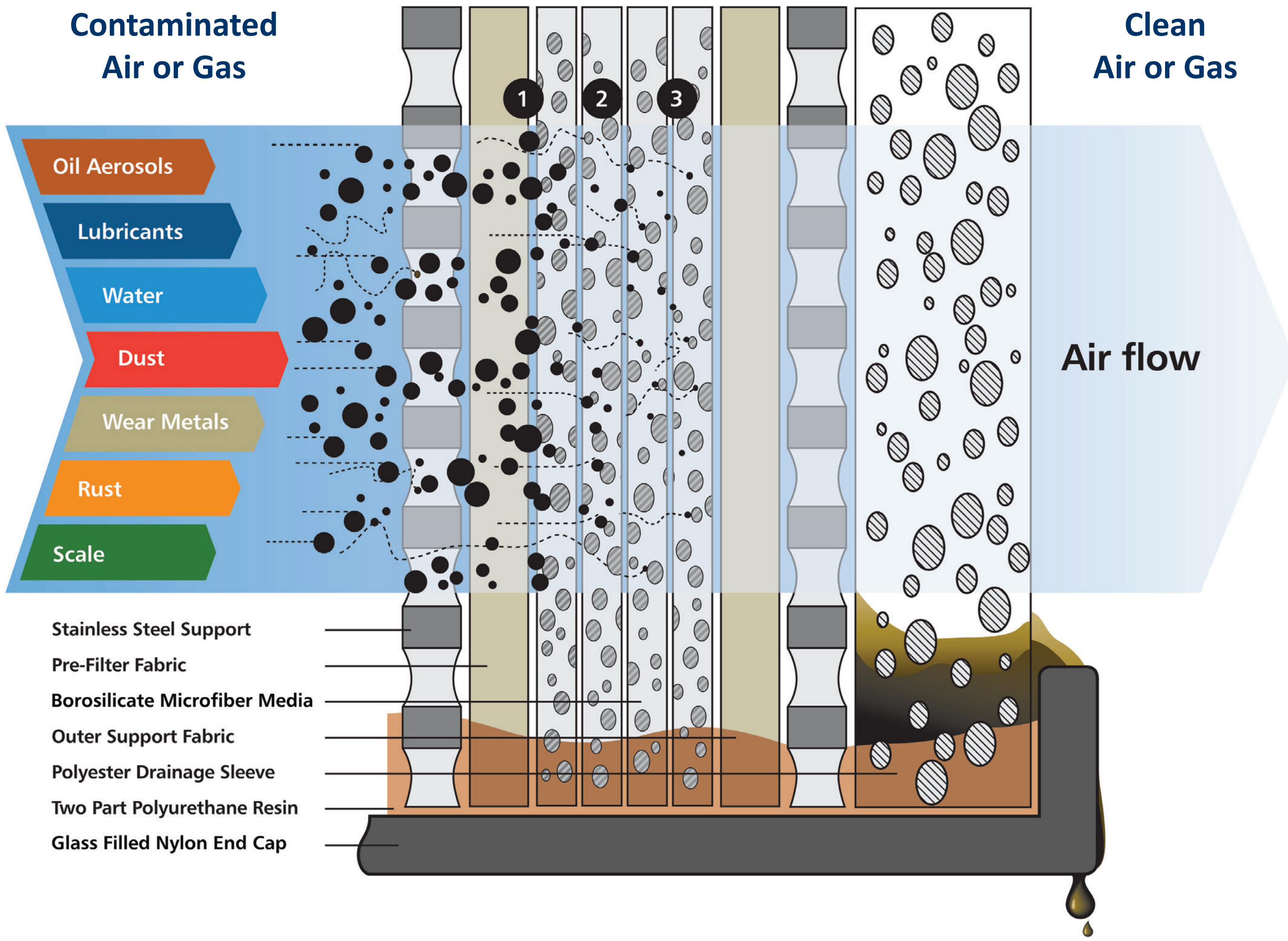
All nano elements are manufactured in an ISO 9001:2008 facility.

This certification is focused on providing a framework for consistent manufacturing quality with performance objectives set at executive level and arrived at through adherence to predefined business procedures. Quality and production teams measure and review quality on a daily basis from goods inwards, through a vendor rating system evaluating core suppliers, to detailed inspection of all manufactured products produced for despatch to customers.

Accreditation to ISO 9001:2008 is under constant review and certification is granted based on a customer focused policy of continual improvement to deliver the ongoing progression of quality throughout the organization.

the mechanics of filtration

Effective filtration takes place in three stages facilitated by the single fiber collection mechanisms explained below. Each mechanism is effective in eliminating certain contaminants at varying particle sizes that are collected on individual fibers in the filter media. Solid particles are trapped within the media. Liquids and aerosols coalesce into larger droplets, migrating through the media to be drained away.



1: direct interception

Particles larger than the mean pore size of the filter media will simply impact directly onto the surface of the fiber matrix. nano utilizes a borosilicate microfiber filter media with a mean fiber diameter of 0.5 micron.

2: inertial impaction

Inertial impaction occurs when particles smaller than the pore size penetrate beyond the surface of the filter media but cannot negotiate the torturous path between the fibers and are therefore eventually captured by them.

3: diffusion (brownian motion)

It has been established that very small particles (less than 0.1 to 0.2 microns) move in a very random and erratic manner within the airstream. These particles are so small their motion is often violent causing them to impact the media fibers.

element design & materials

A dynamic approach to design, material selection and construction means that nano is at the forefront of filtration technology. Our Research and Development team constantly identify, evaluate and implement enhancements to improve the ease of use and performance of their market leading product range.

stainless steel support cylinders

corrosion resistant and twice as strong as expanded galvanized steel. Can withstand pressure in both directions

ultrasonic seam welded elements

ensures element strength & integrity

outer drainage layer

compatible with synthetic lubricants & prevents oil carry over

spiral wound inner coil

spot welded to the inner cylinder on larger elements. Provides extra strength preventing rupture - especially with out-to-in flow

hydrophobic & oleophobic

borosilicate glass microfiber media repels oil & water for improved coalescing performance

support media

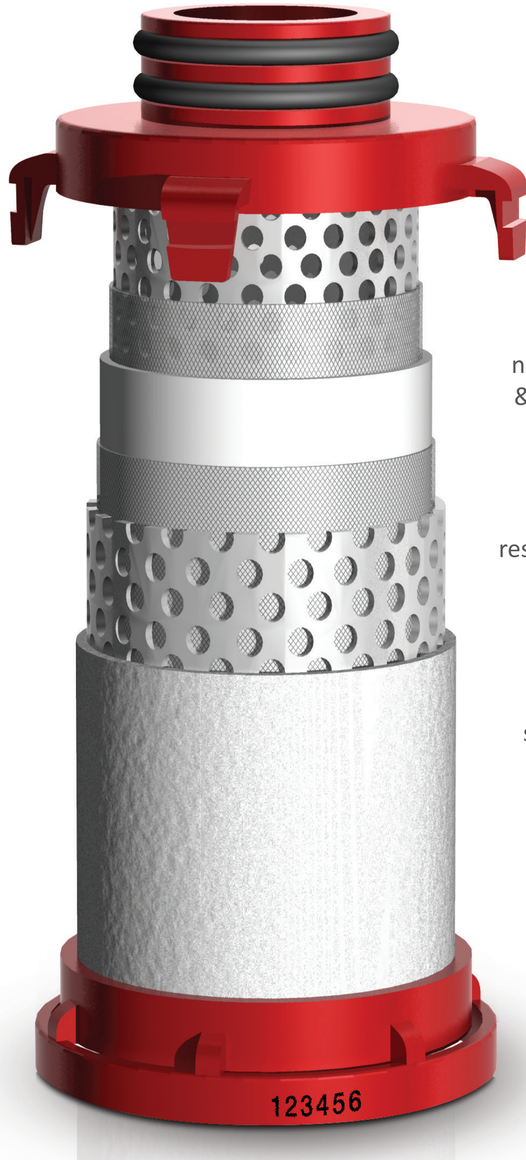
offers protection with air flow in either direction. This non-woven glass fiber also enhances the strength of the filter pack and increases filter life

air distribution duct

provides uniform air flow, resulting in lower differential pressure & improved filtration & flow dynamics

element end cap label

facilitates identification and reordering



double element o-ring

prevents contaminant by-pass by ensuring a perfect seal within the filter housing. Withstands temperatures up to 248°F. This feature is a standard requirement for pharmaceutical environments where o-ring bypass has been identified as a significant risk for contamination for many years

drop-fit, self locating elements

no tie rod simplifies element change out & reduces access requirements for bowl removal simplifying installation as well

deep bed filter media

provides low differential pressure resulting in improved energy efficiency & long element life

corrosion resistant endcaps

injection molded from nylon then bonded to the filter core with a high strength two part polyurethane potting resin for maximum strength

color coded endcaps

color coded to provide easy & accurate filtration grade identification

lower annular location ring

prevents element vibration, improves stability in reverse flow (dust removal) applications & improves drainage

anti re-entrainment layer

Optimizes liquid drainage & minimizes differential pressure. Chemically treated and custom engineered. It collects coalesced oil from the media pack allowing swift drainage to the quiet zone of the filter bowl, preventing oil carry-over. Unlike reticulated foams which degrade causing downstream contamination, this polyester material has a high tensile strength and withstands temperatures up to 248°F (120°C). All elements are suitable for use with mineral and synthetic oils as well as oil free applications.

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