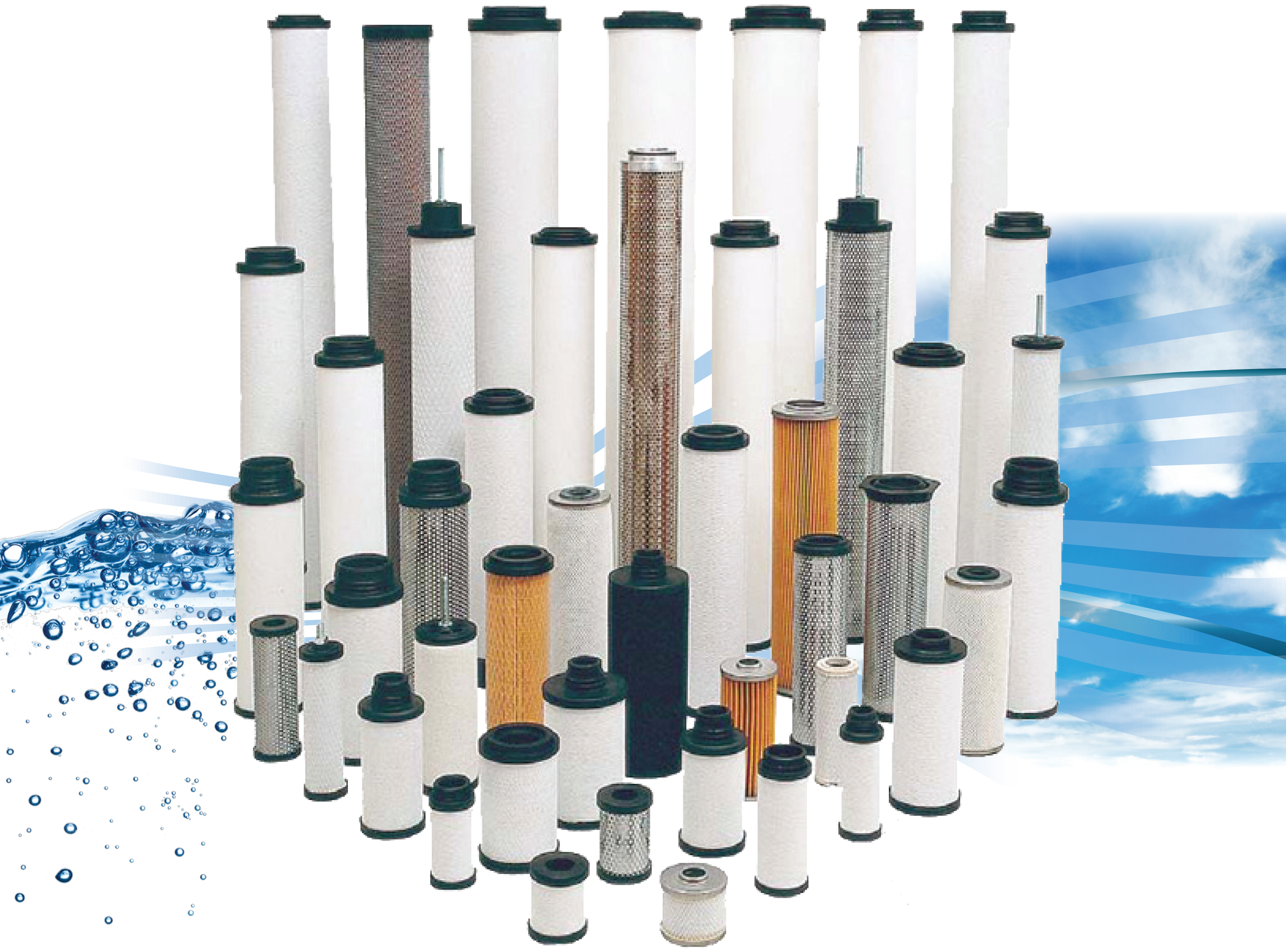
nano

PURIFICATION SOLUTIONS



Alternate Elements Performance Validation

An independent test report validating the performance of the nano A1 Alternate Filter Elements to ISO 8573-2:2001 (E) air quality standards.

NETREC

Conducted by:
Northumbrian Environmental
Training & Research Centre
School of Applied Sciences
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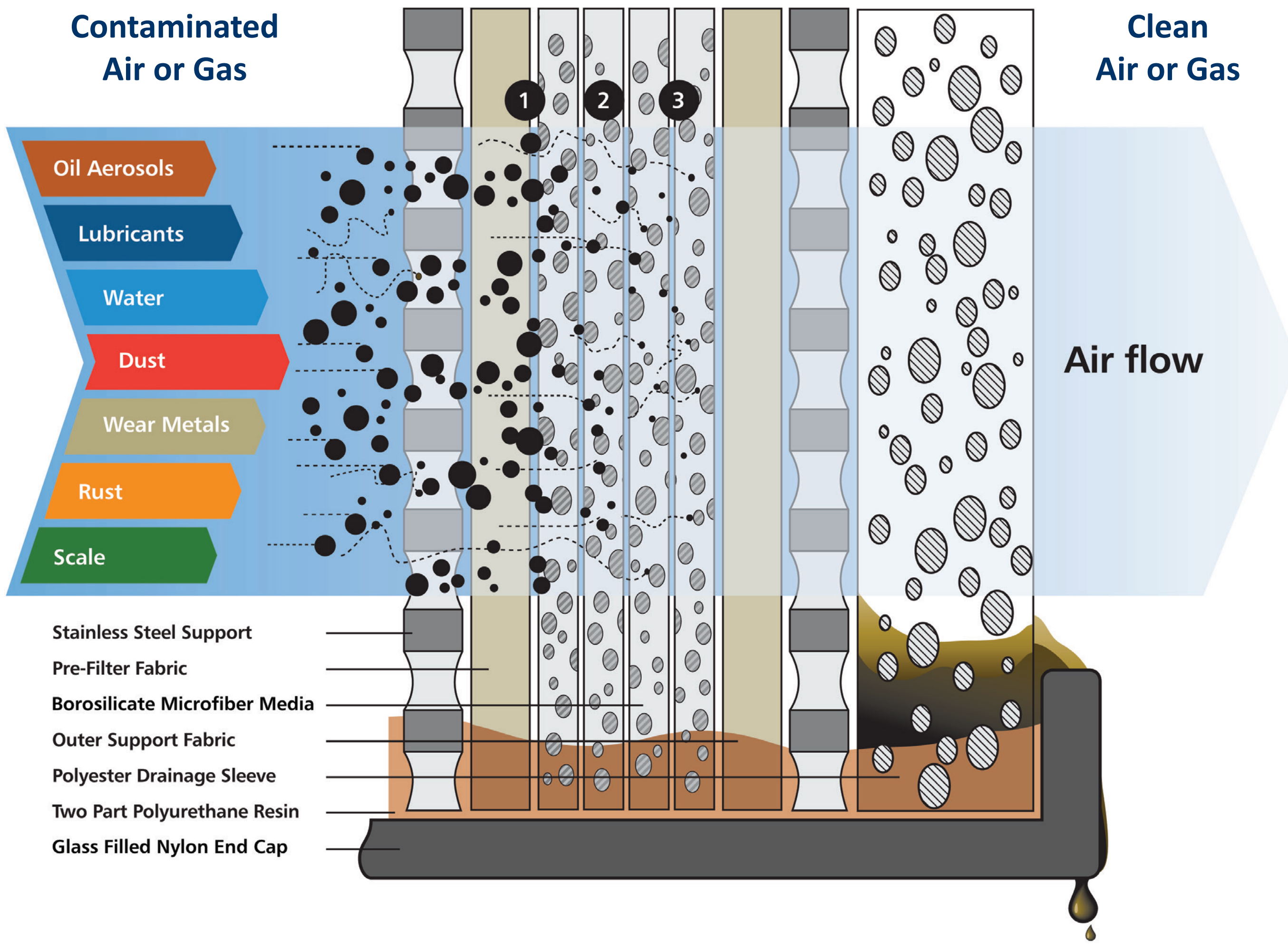
the mechanics of filtration

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 - purification solutions 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.

Extract from:

Report on oil carry over tests for high efficiency oil removal filter elements

June 2004

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Introduction

This report details the methodology and results for a series of oil carry-over experiments performed on the nano-purification solutions M01 and M1 series of coalescing filter elements. The M01 and M1 series have a target downstream oil aerosol concentration of 0.01ppm (0.01 mg/m^3) and 0.1ppm (0.10 mg/m^3) respectively.

Methods

General

The oil carry-over experiments were performed in accordance with method B1 of BS ISO 8573-2:1996 (Compressed air for general use – Part 2: Test methods for aerosol oil content). This method deals with sampling and analysis of airborne aerosols at a constant flow rate. The general layout of the test rig is shown in Figure 1. The method requires that no wall-flow (liquid contamination that can be formed in the bottom of the pipe work) is present and so the rig was modified by connecting an empty filter housing in series, upstream of the test filter housings. Nevertheless, confirmatory tests with and without the empty housing indicated that wall flow is non-existent in the test rig.

The general principle is to generate a known challenge oil aerosol concentration, in this case using a Laskin nozzle, to pass this challenge concentration through a test filter element and then to determine the downstream oil aerosol concentration by sampling through filter membranes. Oil content is determined by solvent extraction of the membranes followed by analysis of the solvent by infra-red spectroscopy.

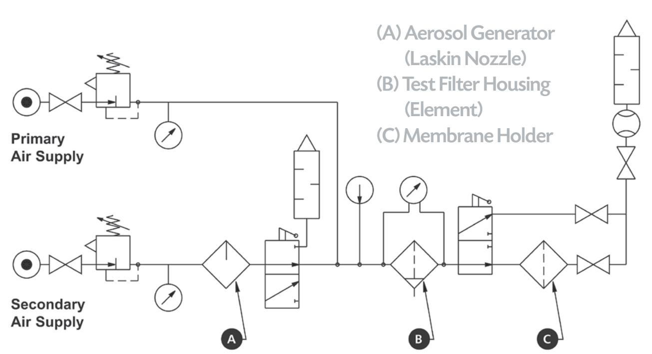


Figure 1: Arrangement of the test rig used in the oil carry-over tests.

Oil aerosol generation

Oil aerosol challenges to the filters were generated using a Laskin nozzle at a typical differential pressure of 4.4 psi (0.3 mbar) to 5.9 psi (0.4 mbar). The actual challenge oil aerosol concentration was determined by weighing the test filter element before and after exposure to the challenge concentration and then dividing the weight difference by the volume of air passing through the filter over the duration of the test.

Pressure and air flow measurements

The following pressure and air flow measurements were made on the test rig:

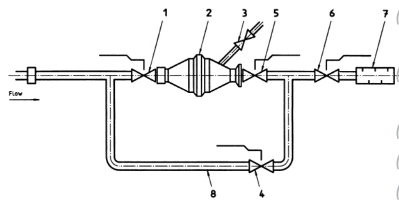
- Differential pressure across housing containing dry filter element
- Differential pressure across empty housing
- Differential pressure across housing containing wet filter element
- Differential pressure across Laskin nozzle
- Flow rate of housing on test

All pressure and flow measuring equipment were within calibration.

Sampling of oil aerosol downstream of the test filters

The sampling apparatus for measuring the downstream oil aerosol concentration is shown in Figure 2. Three Whatman GF/F filters were placed on a membrane support and secured in the membrane holder. Care was taken to ensure that the filter papers were not contaminated during handling, including the use of gloves and solvent washed tweezers. Additionally, because the analysis method depends on the determination of very low levels of oil, particular attention was paid to the cleanliness of the sampling equipment. The sampling equipment, including sample holder was washed with solvent prior to the commencement of sampling.

Test equipment for Method B1



(2) Membrane holder
(3) Valve for evacuating membrane holder
(4) Full flow ball-type shut-off valves
(6) Flow control valve
(7) Silencer
(8) Bypass tube

Figure 2: Sampling Equipment

Oil extraction and analysis

Calibration

The principle of the analysis is to extract oil collected on the filter membranes into a solvent and then to determine the oil concentration using Fourier Transformed Infra Red spectroscopy (FTIR). A series of calibration solutions was prepared using the same 'Tellus 32' oil that was used in the oil challenges to the filter elements. All analysis was performed on a Perkin Elmer Paragon 1000 FTIR spectrometer with a 40mm path length quartz cell transparent to IR radiation down to 2500cm-1.

The calibration graph for Tellus oil in 1,1,2,trichlorotrifluoroethane (TCTFE) in the range 0 to 100ppm is shown in Figure 3. The total absorbance is obtained from the sum of the individual absorbances at 2960cm-1, 2925cm-1 and 2860cm-1 after correction for the solvent blank. The graph shows linearity over the full range and has a correlation coefficient (r) of 0.9998.

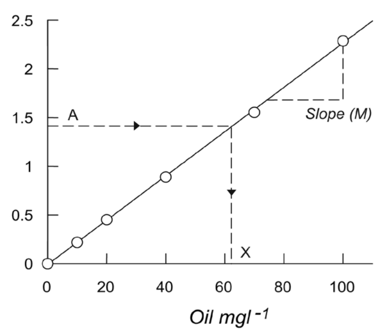


Figure 3: Calibration graph for 'Tellus 32' oil used in filter challenges

Extraction and analysis

The three filter membranes were removed from the membrane support using solvent washed tweezers and placed in a solvent washed glass container. 50ml of 1,1,2- trichlorotriflouroethane was poured onto the filters and the container was agitated for 5 minutes to extract all of the absorbed oil aerosol.

Approximately 12 ml of solvent was then transferred to a 40mm path-length quartz cell using a Pasteur pipette. As with the calibration solutions, the total absorbance of the sample was determined from the sum of the individual absorbances at 2960cm-1, 2925cm-1 and 2860cm-1 after correction for the solvent blank which was run prior to the sample. The oil concentrations in the samples were determined from the slope of the calibration graph, and were in the range 2.54 to 9.09 mgl-1.

$$\text{Oil carry over (mg/m3)} = \frac{\text{oil collected (mg)}}{\text{volume of air (m3)}} = \frac{X}{Y}$$

Results

Pressure and flow data for tests

Table 1 details the results for differential pressure measurements across the filter housing with a wet element.

Filter grade	Specification		Test Results	
	mbar	psi	mbar	psi
Grade M1	150	2.2	150	2.2
Grade M01	300	4.4	223	3.2

Table 1: Pressure loss data at maximum rated flow (average)

Oil concentrations downstream of test filters

Table 2 details the results of the oil carry-over experiments. The specified maximum concentrations downstream of the filters under test are 0.01 ppm and 0.1 ppm for the MO1 and the M1 filter elements respectively. All elements under test exceeded these performance requirements.

Filter grade	ISO 8573	Specification		Test Results	
	class	mg/m3	ppm	mg/m3	ppm
Grade M1	2	0.1	0.08	0.06	0.048
Grade M01	1	0.01	0.008	0.005	0.004

Table 2: Results of oil carry-over tests at maximum rated flow (average)

Oil Concentration

Explanation:

$$X = \frac{(A-C) \times S \times F \text{ (mg)}}{M \times 1000}$$

where

X = Oil collected

A = FTIR absorbance (see graph below)

$$= \log_{10}\left(\frac{I_0^3}{I_1 I_2 I_3}\right)$$

C = intercept from calibration graph

M = slope

S = solvent sample (ml)

F = dilution factor

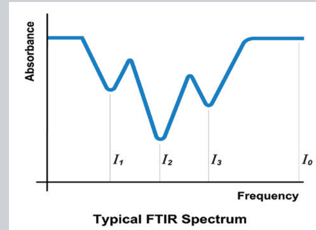
$$Y = \frac{R \times D}{60}$$

where

Y = volume of air passed (m3)

R = test flow rate (m3/hr)

D = test duration (mins)



Conclusions

In terms of oil removal the M01 and M1 units tested in both sizes, exceeded their rated performance when tested in accordance with ISO 8573-2.

Signed for and on behalf of NETREC

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guide to ISO 8573 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 - purification solutions 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.

Filter grade	ISO 8573 Air Quality Class	Solid Particles (maximum number of particles per m³)			Water Vapor & Liquid	Oil Vapor & Liquid
		0.1 - 0.5 micron	0.5 - 1.0 micron	1.0 -5.0 micron	(pressure dewpoint)	(mg/m³)
Grade M01	1	100	1	0	-70°F	0.01
Grade M1	2	100,000	1000	10	-40°F	0.1
Grade M5	3	-	10,000	500	-20°F	1
Grade M25	4	-	-	1000	+3°F	5

ISO 9001:2000 quality management systems

All nano - purification solutions 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.

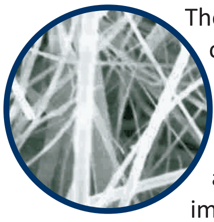
Accreditation to ISO 9001:2008 is under constant review and certification is granted based on a customer focused policy of continual improvement to deliver the ongoing progression of quality throughout the organization.

built for industry

Corrosion Resistant End Caps

Injection molded from glass filled nylon then bonded to the filter core with a quick setting two part polyurethane resin for maximum strength.

Borosilicate Microfiber Media



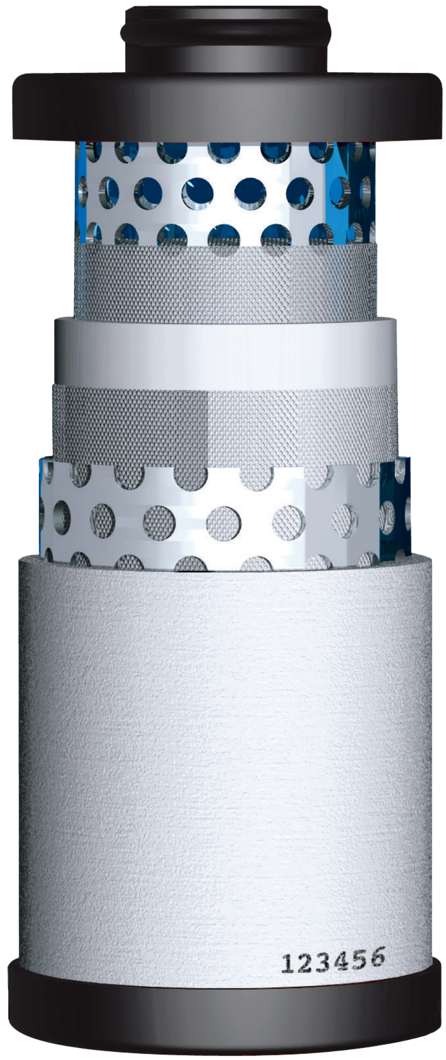
The bonded structure of these high quality fibers can withstand high temperatures and are completely immune to degradation. The sub micron fiber diameters and extremely high voids volumes are available in different grades for varying efficiency.

Deep Bed Multi Wrap Technology

Offers low differential pressure while maintaining extremely high oil removal efficiencies and a long service life.

Stainless Steel Coil Support

On larger reverse flow elements the addition of a coil spring spot welded to the inner cylinder provides the rigidity needed for the high demands of "outside in" flow. This avoids collapse and downstream contamination.



High Nitrile O-Rings

Ensures a perfect seal between the element and the filter housing eliminating contaminant bypass. Withstands temperatures up to 250°F.

Stainless Steel Support Cylinders

Twice as strong as galvanized steel, these perforated screens can withstand 100 psig differential pressure in either direction.

Pre-Filtration Layers

Offers media protection with air flow in either direction. This non-woven fabric also enhances the strength of the element and increases service life.

Polyester Fiber Drainage Sleeve

Now an industry standard, this polyester material collects coalesced oil from the media and drains it into the filter bowl preventing oil carryover. Unlike reticulated foams which degrade causing downstream contamination, this material has a high tensile strength and withstands temperature and chemical degradation

Quality Control

Traceability is provided by ink jet marking specific manufacturing codes on every filter element complying with ISO 9001 manufacturing procedures.

built to fit most major brands

nano A1 alternate filter elements are made to fit most major brands of filter housings around the world. This list is continually expanding - contact support @n-psi for a complete cross reference list.

Ace	Curtis-Toledo	Hiross	Sullair
Air Filter Engineering	Dollinger	Hydrovane	Sullivan Palatek
Air/Tak	Domnick Hunter	Ingersoll Rand	Technolab
Aitek	Edwards	Kaeser	Ultrafilter
Atlas Copco	Finite	Lacy Hulbert	Van Air
Balston	Flair/Technolab	Leybold Hereaus	Watts
Becker	Gardner Denver	Mattei	Wilkerson
Champion	Gemoc	Mils	Zander
Compair	Great Lakes	MTA	
Comp Air Leroi	Grimmer Schmidt	Norgren	
CTA	Hankison	Pioneer	

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