



REPORT

Contact person



Date

2017-02-13

Reference

7P00438A

Page

1 (3)

Filtech Swiss
Via Pra Mag 9
6862 RANCATE-MENDRISIO
Schweiz

Testing of Air Filter according to ISO 16890:2016

(6 appendices)

A test according to ISO 16890:2016 was carried out by request from Filtech Swiss.

Tested item

Filtech Swiss, R05-50, a 592 mm x 592 mm x 25 mm, Panel filter.

Pictures can be found in appendix 5.

The item was sent to SP by Filtech Swiss and was received by SP on January 13, 2017.

The item was without visible defects.

Test method

The test was carried out according to standard ISO 16890:2016 "Air filters for general ventilation". The standard consists of four parts:

- ISO 16890-1: *Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)*

- ISO 16890-2: *Measurement of fractional efficiency and air flow resistance*

Measurements were performed with dual particle counters according to section 9.3.4 - Testing sequence for dual OPC testing.

- ISO 16890-3: *Determination of the gravimetric efficiency and the airflow resistance versus the mass of test dust captured*

- ISO 16890-4: *Conditioning method to determine the minimum fractional test efficiency*

Eight cabinets with a total surface area of 1.82 m² were placed in the chamber according to ISO 16890-4 section 7. The purity of the 2-propanol was 99.5 %. The test item was conditioned for 24.5 +/- 0.5 hours.

Efficiency at 50% nominal air flow was measured with DEHS in the range 0.3 – 1 µm.

SP Technical Research Institute of Sweden

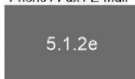
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Deviation from the standard:

Section 9.2.2 and 9.2.8, the evaporated amount of 2-propanol was not determined.
 Section 7.3, the relative humidity (room air) was below 20 %.
 Efficiency at 50% nominal air flow was measured at 700 m³/h. ISO 16890 is applicable for air flow rates between 900 m³/h and 5400 m³/h.

Date and Place

The test was carried out at SP's laboratory of Energy and circular economy in Borås, Sweden on January 30 - February 10, 2017.

Tests according to ISO 16890-2 were carried out on January 30, 2017.
 Tests according to ISO 16890-3 were carried out on February 10, 2017.
 Tests according to ISO 16890-4 were carried out on February 10, 2017, conditioning procedure according to ISO 16890-4 was carried out on February 6-7, 2017.

Results

The results are presented in appendix 1-4 and are valid only for the item tested.

In appendix 1 a summary of the results are reported according ISO 16890-1. It also includes the fractional efficiencies and the calculation of PM-efficiencies.

In appendix 2 fractional efficiency and air flow resistance are reported according to ISO 16890-2.

In appendix 3 determination of the gravimetric efficiency (arrestance) and the air flow resistance versus the mass of test dust capture (test dust capacity) are reported according to ISO 16890-3.

In appendix 4 the minimum fractional efficiency is reported according to ISO 16890-4.

The measured particle concentrations are reported in appendix 2 and appendix 4. Table A6 (upstream count data), A7 (downstream count data) and A9 Uncertainty in ISO 16890-2 Annex A are reported.

Measurement equipment

- Pressure gauge Furness model 318, SP's inventory no. 901 568 (static P Filter)
- Pressure gauge Furness model 318, SP's inventory no. 901 569 (static P Flow)
- Pressure gauge Furness FC012, SP's inventory no. 201 691 (ΔP Filter)
- Pressure gauge Furness FC012, SP's inventory no. 201 690 (ΔP Flow)
- Particle counter TSI, OPS 3330, SP's inventory no. 902240
- Particle counter TSI, OPS 3330, SP's inventory no. 902241
- Barometer, Testo 511, SP's inventory no. 900 078
- Temperature and RH, Testo 635, SP's inventory no. 900 065
- Weighing scale, Mettler PC16, SP's inventory no. 202 741
- Flow meter, MFS-C-250, SP's inventory no. 202 742
- Temperature and RH, Tinytag, DIV 94 S
- Barometer, Druck PACE 1001, SP's inventory no. 902243



Uncertainty of measurement

The uncertainty of the Air flow is better than $\pm 5 \%$
The uncertainty of the Pressure Drop is better than $\pm 3 \%$
The uncertainty of the Temperature is better than $\pm 0.5 \text{ }^\circ\text{C}$
The uncertainty of the Relative Humidity is better than $\pm 2 \%$ RH
The uncertainty of the Atmospheric Pressure is better than $\pm 1 \text{ mbar}$
The uncertainty of the Measured mass is better than $\pm 0.5 \text{ g}$

The uncertainty has been calculated according to EA-4/16 with a coverage factor $k=2$.

The uncertainty of the filtration efficiency according to ISO 16890:2016 is presented in appendices 2 and 4.

SP Technical Research Institute of Sweden Energy and circular economy - Building Services Engineering

Performed by

Examined by

5.1.2e

5.1.2e

Appendices

1. Summary test report according to ISO 16890-1:2016
2. Test report according to ISO 16890-2:2016
3. Test report according to ISO 16890-3:2016
4. Test report according to ISO 16890-4:2016
5. Additional pictures of the test item.
6. The interpretation of test reports



Appendix 1

ISO 16890-1:2016 - Air Filter Test Results				Testing Organization: SP Technical Research Institute of Sweden Brinellgatan 4, 501 15 Borås, Sweden 5.1.2e	
GENERAL					
Report no.: 7P00438A	Date of tests: 2017-01-30 - 2017-02-10		Date of report: 2017-02-13		
Supervisor: 5.1.2e	Device obtained (when and how obtained): The device was sent and obtained on 2017-01-13				
Test(s) requested by: Filtech Swiss					
DEVICE TESTED					
Model: R05-50		Manufacturer: Filtech Swiss		Construction: Panel filter	
Article number: -	Type of medium: Synthetic	Net effective filtering area: 2.2 m ²		Filter dimensions (width x height x depth) 592x592x25 mm	
TEST DATA AND ATTACHED TEST REPORTS					
Test air flow rate: 0.389 m ³ /s	Test aerosol: KCl (1-10 µm) DEHS (0.3-1 µm)	Test report to ISO 16890-2 Test report to ISO 16890-3 (optional) Test report to ISO 16890-4		Report no. 7P00438A Appendix 2 Report no. 7P00438A Appendix 3 Report no. 7P00438A Appendix 4	
RESULTS					
Initial pressure differential: 17 Pa	Initial grav. arstance: 90 %	ePM _{1,min} 6 %	ePM _{2.5,min} 13 %	ISO rating (0.389 m ³ /s)	
Final test pressure differential: 300 Pa	Test dust capacity: 89 g	ePM ₁ 9 %	ePM _{2.5} 18 %	ePM ₁₀ 51 %	ISO ePM₁₀ 50 %
Remarks:					
<p>The top graph plots Fractional efficiency (%) on the y-axis (0.0 to 100.0) against Particle size (µm) on the x-axis (0.1 to 10.0). It shows three data series: Initial fractional efficiency E_i (ISO 16890-2) represented by blue diamonds, Conditioned fractional efficiency E_{D,i} (ISO 16890-4) represented by red squares, and Average fractional efficiency E_{A,i} (ISO 16890-1) represented by green triangles. All series show an increasing trend with particle size, with E_i being the highest and E_{D,i} the lowest.</p> <p>The bottom graph has two y-axes: Pressure differential, 1.2 kg/m³ (Pa) on the left (0 to 400) and Arrestance (%) on the right (0 to 100). The x-axis is Air flow rate (m³/s) from 0.0 to 0.6. It shows three data series: Pressure differential as a function of the air flow rate (clean filter) (ISO 16890-2) represented by blue diamonds, Pressure differential as a function of the test dust captured (ISO 16890-3) represented by red squares, and Grav. arstance as a function of the test dust captured (ISO 16890-3) represented by green triangles. The pressure differential (clean filter) is relatively constant around 17 Pa. The pressure differential with dust increases with air flow rate. Grav. arstance is high, around 90%.</p>					
NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.					



Appendix I

ISO 16890-1:2016 - Fractional efficiency values							
Testing organisation: SP Technical Research Institute of Sweden				Report no: 7P00438A			
Model: R05-50				Manufacturer: Filitech Swiss			
Test air flow rate: 0.389 m ³ /s				Date of report: 2017-02-13			
<i>i</i>	d_i µm	d_{i+1} µm	$d_{a,i}$ µm	$\Delta \ln d_i$ µm	E_i %	$E_{D,i}$ %	$E_{A,i}$ %
1	0.30	0.40	0.35	0.29	7.7	3.4	5.5
2	0.40	0.55	0.47	0.32	10.5	5.1	7.8
3	0.55	0.70	0.62	0.24	13.8	6.0	9.9
4	0.70	1.00	0.84	0.36	17.5	10.3	13.9
5	1.00	1.30	1.14	0.26	35.9	19.4	27.7
6	1.30	1.60	1.44	0.21	36.3	20.8	28.5
7	1.60	2.20	1.88	0.32	43.7	28.2	36.0
8	2.20	3.00	2.57	0.31	58.0	39.0	48.5
9	3.00	4.00	3.46	0.29	69.3	54.1	61.7
10	4.00	5.50	4.69	0.32	77.6	65.2	71.4
11	5.50	7.00	6.20	0.24	82.5	72.7	77.6
12	7.00	10.00	8.37	0.36	85.4	73.7	79.5

d_i : Lower limit particle diameter in a size range *i*, µm

d_{i+1} : Upper limit particle diameter in a size range *i*, µm

$d_{a,i}$: Geometric mean diameter of a size range *i*, µm

$\Delta \ln d_i$: Logarithmic width of a particle diameter size in range *i*; ln is the natural logarithm to the base of *e*, where *e* is an irrational and transcendental constant approximately equal to 2.718281828, dimensionless
 $\Delta \ln d_i = \ln (d_{i+1}/d_i)$

E_i : Initial fractional efficiency of particle size range *i* of the untreated and unloaded filter element, %

$E_{D,i}$: Fractional efficiency of particle size range *i* of the filter element after an artificial conditioning step, %

$E_{A,i}$: Average fractional efficiency $(E_i + E_{D,i})/2$ of particle size range *i*, %




Appendix I

ISO 16890-1:2016 - Calculation of PM-efficiencies								
Testing organisation: SP Technical Research Institute of Sweden						Report no.: 7P00438A		
Model: R05-50						Manufacturer: Filtech Swiss		
Test air flow rate: 0.389 m ³ /s						Date of report: 2017-02-13		
<i>i</i>	$d_{a,i}$ µm	$\Delta \ln d_i$ µm	urban distribution $q_{3u}(d_{a,i})$	$q_{3u}(d_{a,i}) \cdot \Delta \ln d_i$	$E_{D,i} \cdot q_{3u}(d_{a,i}) \cdot \Delta \ln d_i$	$E_{A,i} \cdot q_{3u}(d_{a,i}) \cdot \Delta \ln d_i$	$ePM_{x,min}$ %	ePM_x %
1	0.35	0.29	0.226	0.065	0.221	0.36	ePM_{1,min}	ePM₁
2	0.47	0.32	0.199	0.063	0.326	0.50		
3	0.62	0.24	0.158	0.038	0.228	0.38		
4	0.84	0.36	0.115	0.041	0.424	0.57		
∑ line 1-4				0.208	1.199	1.806	6	9
5	1.14	0.26	0.085	0.022	0.433	0.617	ePM_{2.5,min}	ePM_{2.5}
6	1.44	0.21	0.076	0.016	0.328	0.451		
7	1.88	0.32	0.080	0.026	0.721	0.919		
8	2.57	0.31	0.100	0.031	1.206	1.502		
∑ line 1-8				0.302	3.889	5.295	13	18

<i>i</i>	$d_{a,i}$ µm	$\Delta \ln d_i$ µm	rural distribution $q_{3u}(d_{a,i})$	$q_{3u}(d_{a,i}) \cdot \Delta \ln d_i$	$E_{A,i} \cdot q_{3u}(d_{a,i}) \cdot \Delta \ln d_i$	ePM_x %
1	0.35	0.29	0.094	0.027	0.150	ePM₁₀
2	0.47	0.32	0.084	0.027	0.209	
3	0.62	0.24	0.074	0.018	0.177	
4	0.84	0.36	0.070	0.025	0.348	
5	1.14	0.26	0.076	0.020	0.554	
6	1.44	0.21	0.088	0.018	0.523	
7	1.88	0.32	0.108	0.034	1.238	
8	2.57	0.31	0.137	0.043	2.065	
9	3.46	0.29	0.167	0.048	2.967	
10	4.69	0.32	0.195	0.062	4.442	
11	6.20	0.24	0.217	0.052	4.057	
12	8.37	0.36	0.231	0.083	6.564	
∑ line 1-12				0.457	23.294	51



Appendix 2

ISO 16890-2:2016 - AIR FILTER TEST RESULTS SUMMARY				Testing Organization: SP Technical Research Institute of Sweden Brinellgatan 4, 501 15 Borås, Sweden 5.1.2e			
GENERAL							
Test ID: SP201701301		Date of test: 2017-01-30		Operator: 5.1.2e			
Particle counter information			Air flow measurement:		Device obtained (when and how obtained):		
Manufacturer: TSI GmbH	Model: OPS 3330	Coincidence value (p/cm ³): 300	Annubar, Micatrone Air flow sensor MFS-SS		The device was sent and obtained on 2017-01-13		
DEVICE TESTED							
Model: R05-50		Manufacturer: Filtech Swiss		Construction: Panel filter			
Article number: -	Type of media: Synthetic	Net effective media area (m ²): 2.2 m ²		Filter dimensions (width x height x depth) 592x592x25 mm			
Filter/media electrostatic charge: Yes		Media colour: white		Media adhesive: N/A			
Device Condition: Clean / Initial							
Other descriptive information:							
TEST DATA SUMMARY							
Test air flow rate: 0.389 m ³ /s		Test air temperature: 20.6 - 21.3 °C		Test air RH: 49.1 - 51.8 %		Test aerosol: DEHS (0.3-1 µm) KCl (1-10 µm)	
RESULTS							
Resistance to airflow (Pa)			Fractional Efficiency (%)				
Measured:	17 Pa	Rated initial:	-	Range (µm)	Measured Efficiency	Rated Efficiency	Upstream concentration (particles / dm ³)
		Rated Final:	-				
Test Device Photo				0.30 - 0.40	8		14623
				0.40 - 0.55	11		12755
				0.55 - 0.70	14		8498
				0.70 - 1.00	17		7986
				1.00 - 1.30	36		5341
				1.30 - 1.60	36		2933
				1.60 - 2.20	44		12223
				2.20 - 3.00	58		8091
				3.00 - 4.00	69		3683
				4.00 - 5.50	78		2011
				5.50 - 7.00	83		623
7.00 - 10.00	85		580				
Remarks:							
NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.							



Appendix 2

ISO 16890-2:2016 - AIR FILTER TEST RESULTS DETAILS			Testing Organization: SP Technical Research Institute of Sweden Brinellgatan 4, 501 15 Borås, Sweden																													
Test ID:	SP201701301	Date of test:	2017-01-30	Operator:	5.1.2e																											
TEST DATA DETAILS																																
Resistance to Airflow 1.2 kg/m³																																
% of rated airflow	Airflow (m ³ /s)	Resistance to Airflow (Pa)	<table border="1"> <caption>Data for Resistance to Airflow Graph</caption> <thead> <tr> <th>Airflow (m³/s)</th> <th>Pressure differential (Pa)</th> </tr> </thead> <tbody> <tr><td>0.155</td><td>6</td></tr> <tr><td>0.194</td><td>8</td></tr> <tr><td>0.292</td><td>12</td></tr> <tr><td>0.390</td><td>17</td></tr> <tr><td>0.486</td><td>22</td></tr> </tbody> </table>		Airflow (m ³ /s)	Pressure differential (Pa)	0.155	6	0.194	8	0.292	12	0.390	17	0.486	22																
Airflow (m ³ /s)	Pressure differential (Pa)																															
0.155	6																															
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0.292	12																															
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0.486	22																															
40%	0.155	6																														
50%	0.194	8																														
75%	0.292	12																														
100%	0.390	17																														
125%	0.486	22																														
Fractional Efficiency by Particle Size																																
<table border="1"> <caption>Data for Fractional Efficiency by Particle Size Graph</caption> <thead> <tr> <th>Particle size (µm)</th> <th>Fractional efficiency (%)</th> </tr> </thead> <tbody> <tr><td>0.3</td><td>8</td></tr> <tr><td>0.4</td><td>10</td></tr> <tr><td>0.5</td><td>13</td></tr> <tr><td>0.6</td><td>17</td></tr> <tr><td>0.8</td><td>35</td></tr> <tr><td>1.0</td><td>36</td></tr> <tr><td>1.2</td><td>43</td></tr> <tr><td>1.5</td><td>58</td></tr> <tr><td>2.0</td><td>68</td></tr> <tr><td>2.5</td><td>77</td></tr> <tr><td>3.0</td><td>82</td></tr> <tr><td>4.0</td><td>85</td></tr> <tr><td>5.0</td><td>85</td></tr> </tbody> </table>					Particle size (µm)	Fractional efficiency (%)	0.3	8	0.4	10	0.5	13	0.6	17	0.8	35	1.0	36	1.2	43	1.5	58	2.0	68	2.5	77	3.0	82	4.0	85	5.0	85
Particle size (µm)	Fractional efficiency (%)																															
0.3	8																															
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<p>NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.</p>																																



Appendix 2

Efficiency measurement**Upstream count data**

OPC bin	$d_{g,i}$	Upstream efficiency count data					$U_{e,tot}$
	μm	1	2	3	4	5	
1	0.35	14749	14732	14361	14666	14607	73115
2	0.47	13151	12799	12524	12761	12541	63776
3	0.62	8840	8313	8343	8477	8516	42489
4	0.84	8102	8168	7886	7888	7884	39928
5	1.14	5409	5570	5212	5291	5223	26705
6	1.44	2990	3034	2917	2943	2782	14666
7	1.88	12425	12613	12232	11940	11904	61114
8	2.57	8271	8252	8145	7970	7815	40453
9	3.46	3767	3861	3670	3630	3488	18416
10	4.69	1970	2079	2050	1942	2014	10055
11	6.20	627	611	635	622	622	3117
12	8.37	588	606	589	558	559	2900

Note: All data shown is the number of particle counts for 60 s

Efficiency measurement**Downstream count data**

OPC bin	$d_{g,i}$	Downstream efficiency count data					$D_{e,tot}$
	μm	1	2	3	4	5	
1	0.35	12586	12435	12306	12359	12237	61923
2	0.47	11394	10990	10964	11117	11165	55630
3	0.62	7448	7464	7407	7207	7238	36764
4	0.84	6676	6444	6360	6405	6585	32470
5	1.14	3719	3670	3564	3416	3426	17795
6	1.44	1711	1741	1707	1719	1652	8530
7	1.88	6580	6378	6215	6206	6074	31453
8	2.57	3294	3347	3184	3067	2978	15870
9	3.46	1118	1097	1127	1065	1034	5441
10	4.69	463	437	457	453	457	2267
11	6.20	141	128	109	117	131	626
12	8.37	133	116	122	121	126	618

Note: All data shown is the number of particle counts for 60 s


Efficiency measurement**Final results and uncertainty**

OPC bin	$d_{g,i}$	Penetration data reduction			Uncertainty limits		Uncertainty	Efficiency
	μm	P_a	δ	e	Static	Dynamic	Pass/Fail	%
1	0.35	0.923	0.016	0.020	≤ 0.05	0.065	Pass	7.7
2	0.47	0.895	0.019	0.024	≤ 0.05	0.063	Pass	10.5
3	0.62	0.862	0.033	0.040	≤ 0.05	0.060	Pass	13.8
4	0.84	0.825	0.021	0.026	≤ 0.05	0.058	Pass	17.5
5	1.14	0.641	0.021	0.026	≤ 0.05	0.045	Pass	35.9
6	1.44	0.637	0.018	0.023	≤ 0.05	0.045	Pass	36.3
7	1.88	0.563	0.015	0.019	≤ 0.05	0.039	Pass	43.7
8	2.57	0.420	0.011	0.014	≤ 0.05	0.029	Pass	58.0
9	3.46	0.307	0.010	0.012	≤ 0.05	0.046	Pass	69.3
10	4.69	0.224	0.011	0.013	≤ 0.05	0.034	Pass	77.6
11	6.20	0.175	0.020	0.025	≤ 0.05	0.035	Pass	82.5
12	8.37	0.146	0.011	0.014	≤ 0.05	0.029	Pass	85.4

$d_{g,i}$: Geometric mean diameter of a size range i , μm
 P_a : the final penetration for a given particle size
 δ : the standard deviation of the penetration for a given particle size
 e : the uncertainty of the penetration for a given particle size



Appendix 3

ISO 16890-3:2016 - AIR FILTER TEST RESULTS SUMMARY				Testing Organization SP Technical Research Institute of Sweden Brinellgatan 4, 501 15 Borås, Sweden 5.1.2e	
GENERAL					
Test ID: SP201701301		Date of test: 2017-02-10		Operator: 5.1.2e	
		Air flow measurement: Annubar, Micatrone Air flow sensor MFS-SS		Test sample obtained: The device was sent and obtained on 2017-01-13	
DEVICE TESTED					
Model: R05-50		Manufacturer: Filtech Swiss		Construction: Panel filter	
Article number: -	Type of media: Synthetic	Net effective media area (m ²) 2.2 m ²		Filter dimension (W x H x D) (mm) 592x592x25 mm	
Filter/media electrostatic charge: Yes		Media colour: white		Media adhesive: N/A	
Device Condition: Conditioned per ISO 16890-4					
Other descriptive information:					
TEST DATA SUMMARY					
Test air flow rate: 0.389 m ³ /s		Test air temperature: 20.7 - 21 °C		Test air RH: 40 - 42.3 %	
Loading dust: Particle Technology, ISO 121031 A2-fine					
RESULTS					
Resistance to airflow			Dust loading results		
Measured: 16 Pa	Rated initial:	- Pa	Initial arrestance (%)	Average arrestance(%)	Test dust capacity (g)
Final test pressure: 300 Pa	Rated Final:	- Pa	90 %	93.7 %	89 g
Test Device Photo					
					
Remarks:					
NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.					



Appendix 3

ISO 16890-3:2016 - AIR FILTER TEST RESULTS DETAILS			Testing Organization: SP Technical Research Institute of Sweden Brinellgatan 4, 501 15 Borås, Sweden																											
Test ID: SP201701301	Date of test: 2017-02-10	Operator: 5.1.2e	5.1.2e																											
TEST DATA DETAILS																														
Resistance to Airflow 1.2 kg/m³																														
% of rated airflow	Airflow (m ³ /s)	Resistance to Airflow (Pa)	<table border="1"> <caption>Data for Resistance to Airflow 1.2 kg/m³ Graph</caption> <thead> <tr> <th>Airflow (m³/s)</th> <th>Resistance to Airflow (Pa)</th> </tr> </thead> <tbody> <tr><td>0.157</td><td>5</td></tr> <tr><td>0.195</td><td>7</td></tr> <tr><td>0.292</td><td>11</td></tr> <tr><td>0.389</td><td>16</td></tr> <tr><td>0.487</td><td>22</td></tr> </tbody> </table>		Airflow (m ³ /s)	Resistance to Airflow (Pa)	0.157	5	0.195	7	0.292	11	0.389	16	0.487	22														
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<table border="1"> <caption>Data for Resistance to Airflow vs Dust fed 1.2 kg/m³ Graph</caption> <thead> <tr> <th>Dust fed (g)</th> <th>Resistance to Airflow (Pa)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>20</td><td>40</td></tr> <tr><td>50</td><td>80</td></tr> <tr><td>70</td><td>140</td></tr> <tr><td>85</td><td>230</td></tr> <tr><td>95</td><td>300</td></tr> </tbody> </table>			Dust fed (g)	Resistance to Airflow (Pa)	0	0	20	40	50	80	70	140	85	230	95	300	<table border="1"> <caption>Data for Arrestance vs Dust fed 1.2 kg/m³ Graph</caption> <thead> <tr> <th>Dust fed (g)</th> <th>Arrestance (%)</th> </tr> </thead> <tbody> <tr><td>10</td><td>90</td></tr> <tr><td>35</td><td>95</td></tr> <tr><td>60</td><td>92</td></tr> <tr><td>78</td><td>98</td></tr> <tr><td>90</td><td>95</td></tr> </tbody> </table>		Dust fed (g)	Arrestance (%)	10	90	35	95	60	92	78	98	90	95
Dust fed (g)	Resistance to Airflow (Pa)																													
0	0																													
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<p>NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.</p>																														



Appendix 3

**ISO 16890-3:2016 -
Resistance to air flow and arrestance after different dust loading phases**

Test device:		R05-50									
Test no.:		SP201701301									
Test dust:		Particle Technology, ISO 121031 A2-fine, Batch nr: 9173									
Air flow rate:		0.389 m ³ /s									
Date	Δp_1 Pa	Δm g	m_{ot} g	Δp_2 Pa	m_1 g	m_2 g	Δm_f g	m_d g	A_j %	A_m %	
2017-02-10	16	20	20	28	2131.3	2133.3	2.0	0.1	89.5	89.5	
2017-02-10	28	30	50	77	2133.3	2134.9	1.6	0.1	94.3	92.4	
2017-02-10	77	20	70	143	2134.9	2136.1	1.2	0.1	93.5	92.7	
2017-02-10	143	15	85	231	2136.1	2136.4	0.3	0.1	97.3	93.5	
2017-02-10	231	10	95	301	2136.4	2136.8	0.4	0.1	95.0	93.7	

Mass of tested device

Initial mass of tested device: 309.1 g

Final mass of tested device: 387 g

Test dust: Particle Technology, ISO 121031 A2-fine, Batch nr: 9173

Symbols and units


A_j	arrestance, %
A_m	average arrestance, %
Δm	dust increment, g
Δp_1	resistance to air flow before dust increment (air density 1.20 kg/m ³), Pa
Δp_2	resistance to air flow after dust increment (air density 1.20 kg/m ³), Pa
m_d	dust in duct after device, g
m_1	mass of final filter before dust increment, g
m_2	mass of final filter after dust increment, g
m_{ot}	cumulative mass of dust fed to filter, g
Δm_f	mass gain of final filter, g



REPORT

Date
2017-02-13Reference
7P00438APage
1 (4)

Appendix 4

ISO 16890-4:2016 - AIR FILTER TEST RESULTS SUMMARY				Testing Organization: SP Technical Research Institute of Sweden Brinellgatan 4, 50115 Borås, Sweden 5.1.2e			
GENERAL							
Test ID: SP201701301		Date of test: 2017-02-06 - 2017-02-07		Operator: 5.1.2e			
Particle counter information			Air flow measurement:		Device obtained (when and how obtained):		
Manufacturer: TSI GmbH	Model: OPS 3330	Coincidence value (p/cm ³): 300	Annubar, Micatrone Air flow sensor MFS-SS		The device was sent and obtained on 2017-01-13		
DEVICE TESTED							
Model: R05-50		Manufacturer: Filtech Swiss		Construction: Panel filter			
Article number: -	Type of media: Synthetic	Net effective media area (m ²): 2.2 m ²		Filter dimensions (width x height x depth): 592x592x25 mm			
Filter/media electrostatic charge: Yes		Media colour: white		Media adhesive: N/A			
Device Condition: Conditioned per ISO 16890-4							
Other descriptive information:							
TEST DATA SUMMARY							
Test air flow rate: 0.389 m ³ /s		Test air temperature: 20 - 20.9 °C		Test air RH: 42.3 - 45.9 %		Test aerosol: DEHS (0.3-1 µm) KCl (1-10 µm)	
RESULTS							
Resistance to airflow (Pa)			Fractional Efficiency (%)				
Measured:	16 Pa	Rated initial:	-	Range (µm)	Measured Efficiency	Rated Efficiency	Upstream concentration (particles / dm ³)
		Rated final:	-				
Test item photo				0.30 - 0.40	3		15913
				0.40 - 0.55	5		13969
				0.55 - 0.70	6		9303
				0.70 - 1.00	10		8847
				1.00 - 1.30	19		5778
				1.30 - 1.60	21		3162
				1.60 - 2.20	28		12705
				2.20 - 3.00	39		7943
				3.00 - 4.00	54		3624
				4.00 - 5.50	65		2143
				5.50 - 7.00	73		680
7.00 - 10.00	74		656				
Remarks:							
NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.							



Appendix 4

ISO 16890-4:2016 - AIR FILTER TEST RESULTS DETAILS				Testing Organization:		
				SP		
				Technical Research Institute of Sweden		
				Brinellgatan 4, 501 15 Borås, Sweden		
				5.1.2e		5.1.2e
Test ID: SP201701301		Date of test: 2017-02-06 - 2017-02-07		Operator: 5.1.2e		
TEST DATA DETAILS						
Resistance to Airflow, 1.2 kg/m ³			Fractional efficiency			
Initial			Range (µm)	E _i , 100% nominal air flow	E _d , 100% nominal air flow	E _d , 50% nominal air flow
Airflow (m ³ /s)	Resistance to Airflow (Pa)					
0.155	6		0.30 - 0.40	7.7	3.4	4.5
0.194	8		0.40 - 0.55	10.5	5.1	6.6
0.292	12		0.55 - 0.70	13.8	6.0	8.4
0.390	17		0.70 - 1.00	17.5	10.3	10.8
0.486	22		1.00 - 1.30	35.9	19.4	
Conditioned			1.30 - 1.60	36.3	20.8	
Airflow (m ³ /s)	Resistance to Airflow (Pa)		1.60 - 2.20	43.7	28.2	
0.157	5		2.20 - 3.00	58.0	39.0	
0.195	7		3.00 - 4.00	69.3	54.1	
0.292	11		4.00 - 5.50	77.6	65.2	
0.389	16		5.50 - 7.00	82.5	72.7	
0.487	22		7.00 - 10.00	85.4	73.7	
TEST CONDITIONS						
Temperature in the chamber: 20.9 - 21.6 °C		Relative humidity in the chamber: 15.3 - 21.1 %		Atmospheric pressure: 1003.1 - 1010.7 mbar		
NOTE: The results of this test relate only to the test device in the condition stated herein. The performance results cannot by themselves be quantitatively applied to predict filtration performance in all "real life" environments.						



Appendix 4

Efficiency measurement**Upstream count data**

OPC bin	$d_{a,i}$	Upstream efficiency count data					$U_{e, tot}$
	μm	1	2	3	4	5	
1	0.35	15852	15931	15957	15961	15865	79566
2	0.47	13864	14212	13996	13859	13914	69845
3	0.62	9211	9369	9395	9278	9263	46516
4	0.84	8800	8936	8867	8823	8808	44234
5	1.14	5943	5849	5418	5770	5908	28888
6	1.44	3325	3289	2974	3031	3189	15808
7	1.88	12999	12943	12001	12670	12913	63526
8	2.57	8075	8153	7468	7958	8059	39713
9	3.46	3623	3632	3481	3616	3770	18122
10	4.69	2141	2176	2007	2172	2218	10714
11	6.20	674	685	648	676	717	3400
12	8.37	679	669	621	640	671	3280

Note: All data shown is the number of particle counts for 60 s

Efficiency measurement**Downstream count data**

OPC bin	$d_{a,i}$	Downstream efficiency count data					$D_{e, tot}$
	μm	1	2	3	4	5	
1	0.35	14348	14661	14295	14073	14101	71478
2	0.47	12844	13162	13015	13036	12987	65044
3	0.62	8663	8945	8818	8689	8918	44033
4	0.84	8014	7820	8116	8049	7890	39889
5	1.14	4964	4832	4594	4577	4866	23833
6	1.44	2431	2307	2068	2306	2375	11487
7	1.88	8738	8684	7774	8345	8629	42170
8	2.57	4366	4486	4072	4388	4442	21754
9	3.46	1633	1600	1512	1583	1633	7961
10	4.69	793	758	717	757	690	3715
11	6.20	224	231	206	188	237	1086
12	8.37	240	271	244	242	221	1218

Note: All data shown is the number of particle counts for 60 s

Efficiency measurement**Final results and uncertainty**

OPC bin	$d_{a,i}$	Penetration data reduction			Uncertainty limits		Uncertainty	Efficiency
	μm	P	δ	e	Static	Dynamic	Pass/Fail	%
1	0.35	0.966	0.022	0.027	≤ 0.05	0.068	Pass	3.4
2	0.47	0.949	0.017	0.021	≤ 0.05	0.066	Pass	5.1
3	0.62	0.940	0.015	0.019	≤ 0.05	0.066	Pass	6.0
4	0.84	0.897	0.018	0.022	≤ 0.05	0.063	Pass	10.3
5	1.14	0.806	0.024	0.030	≤ 0.05	0.056	Pass	19.4
6	1.44	0.792	0.041	0.051	≤ 0.05	0.055	Pass	20.8
7	1.88	0.718	0.016	0.020	≤ 0.05	0.050	Pass	28.2
8	2.57	0.610	0.017	0.021	≤ 0.05	0.043	Pass	39.0
9	3.46	0.459	0.013	0.016	≤ 0.05	0.069	Pass	54.1
10	4.69	0.348	0.033	0.041	≤ 0.05	0.052	Pass	65.2
11	6.20	0.273	0.025	0.031	≤ 0.05	0.055	Pass	72.7
12	8.37	0.263	0.025	0.032	≤ 0.05	0.053	Pass	73.7

$d_{a,i}$: Geometric mean diameter of a size range i , μm
 P_a : the final penetration for a given particle size
 δ : the standard deviation of the penetration for a given particle size
 e : the uncertainty of the penetration for a given particle size

Appendix 5



Fig 1. Overview of the test item.

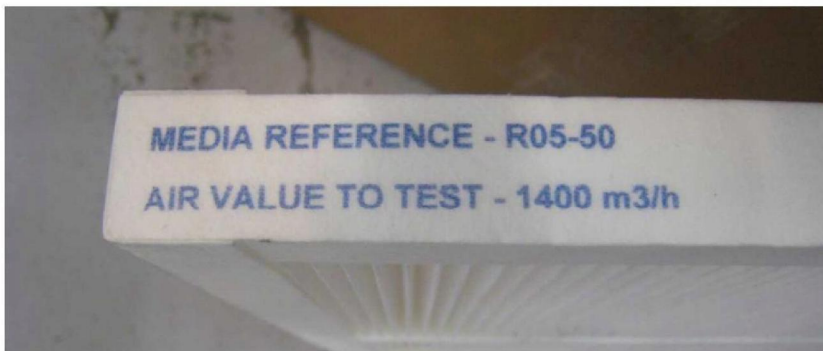


Fig 2. Label on the test item.



Appendix 6

The interpretation of test reports according to ISO 16890:2016

This brief review of the test procedures, including those for addressing the testing of electrostatic charged filters, is provided for those unfamiliar with the procedures of this series of ISO standards. It is intended to assist in understanding and interpreting the results in the test report/summary. (For further details of procedures the full ISO 16890 document series shall be consulted).

Air filters may rely on the effects of passive static electric charges on the fibres to achieve high efficiencies, particularly in the initial stages of their working life. Environmental factors encountered in service may affect the action of these electric charges so that the initial efficiency may drop substantially after an initial period of service. This could be offset or countered by an increase in efficiency (“mechanical efficiency”) as dust deposits build up. The reported, untreated and conditioned (discharged) efficiency shows the extent of the electrical charge effect on initial performance and indicates the potential loss of particle removal efficiency when the charge effect is completely removed and when at the same time there is no compensating increase of the mechanical efficiency. These test results should not be assumed to represent the filter performance in all possible environmental conditions or to represent all possible “real life” behavior.