Testing of Filters according to EN1822-5:2009

(4 appendices)

Three tests according to EN1822-5:2009 was carried out by request from Expansion-Electronic S.r.l.

Tested items

Expansion-Electronic S.r.l. FE600, 592 x 592 x 218 mm, Electrostatic

filter, 3filters The items were handed to SP by Expansion-Electronic S.r.l.

on March 24, 2015.

The items were without visible defects.

Date and Place

The tests were carried out at SP's laboratory of Energy Technology in Borås, Sweden.

The tests were carried out on April 17-23, 2015.

Test method

The tests were carried out according to standard EN 1822-5:2009 (Determining the efficiency of filter elements).

One, two and three filters in series were tested.

The test with one filter was carried out at 850 and 1700 m^3/h.
The test with two filters in series was carried out at 850, 1700 and 2550, m^3/h.
The test with three filters in series was carried out at 850, 1700, 2550, 3400 and 4250 m^3/h.

The filters were mounted in a duct section manufactured by Expansion-Electronic S.r.l.

The efficiency of the filters and was determined by measuring the average particle concentration on the upstream and downstream sides with stationary sampling probes. An optical particle counter was used to measure the particle concentration; the same particle counter was used for both upstream and downstream samples. A polydisperse aerosol of DEHS was generated by a laskin nozzle. Upstream the filter element and flat sheet filter media the aerosol was diluted 10-100 times with an ejector dilution system. A fan followed by a HEPA filter was mounted upstream the filters. The static pressure was measured upstream and downstream the filters to get the pressure drop.

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Test results

The results are presented in Appendix 1. The results are valid only for the tested items.

Deviation from the standard:

- It was not established that the measuring range of the instrumentation included the minimum of the fractional efficiency curve and the position of the most penetrating particle size (MPPS). The reported results are based on measurements of particle sizes 0.1 - 1.5µm.
- The reported results are based on the overall efficiency. EN1822-4 was not performed.

Measurement equipment

Barometer, Testo 511	SP's inventory number 900 078
Temperature and RH, Testo 635	SP's inventory number 900 065
Flow meter, MFS-C-250	SP's inventory number 202 742
Pressure gauge, Furness FC012	SP's inventory number 201 691
Pressure gauge, Furness FC012	SP's inventory number 201 690
Pressure gauge, Furness Model 318	SP's inventory number 901 568
Pressure gauge, Furness Model 318	SP's inventory number 901 569
Aerosol Neutralizer Kr-85, TSI	SP's inventory number 202 635
Diluter, PALAS VKL-10	SP's inventory number 201 713
Diluter, PALAS VKL-10	SP's inventory number 201 714
Particle counter, Las-X II	SP's inventory number 701 378

Uncertainty of measurement

The uncertainty of the air flow is better than ± 3 %
The uncertainty of the pressure drop is better than ± 3 %
The uncertainty of the temperature is better than ± 0.5 ºC
The uncertainty of the relative humidity is better than ± 3 % RH
The uncertainty of the atmospheric pressure is better than ± 1 mbar
The uncertainty of the dilution factor is better than ± 3 %

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

The method error in determination of the filtration efficiency is:
η = 0-90 %: ± 0.1 • penetration value [%]
η = 90-99 %: ± 0.2 • penetration value [%]
η = 99-99.99 %: ± 0.5 • penetration value [%]
η > 99.99 %: ± 1 • penetration value [%]

SP Technical Research Institute of Sweden
Energy Technology - Combustion and Aerosol Technology

Appendices

1. Test results according to EN1822-5:2009, three filters in series
2. Test results according to EN1822-5:2009, two filters in series
3. Test results according to EN1822-5:2009, one filter
4. Pictures of tested items

Appendix 1

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

GENERAL

Test no.: SP201504171	Date of test: 17/04/2015 - 23/04/2015	Supervisor: CM
Test requested by: Expansion-Electronic S.r.l.		Device receiving date: 24/03/2015
Device delivered by: Expansion-Electronic S.r.l.		

DEVICE TESTED

Model/Type: FE600, 3 filters in series	Manufacturer: -	Construction: Electrostatic filters
Article number: -	Serial number: -	Filter dimensions (width x height x depth): 592 x 592 x 218 mm
Type of media: -	Net effective filtering area: - m^2	

TEST DATA, RESULTS

Test air flow rate: 4250 m^3/h	Atmospheric pressure 994.6 - 995 mbar	Test air temperature: 22.5 - 22.6 °C	Test air relative humidity: 39.9 - 40.6 %	
Dilution upstream: 10	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 334 Pa	MPPS: 0.190 µm	Efficiency at MPPS: 87.30 %	Efficiency$_{95\%min}$ at MPPS: 87.03 %	Filter class, EN 1822: E10*

Test air flow rate: 3400 m^3/h	Atmospheric pressure 995.0-995.4 mbar	Test air temperature: 22.5-22.6 °C	Test air relative humidity: 38.4-39.7 %	
Dilution upstream: 10	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 216 Pa	MPPS: 0.21 µm	Efficiency at MPPS: 94.73 %	Efficiency$_{95\%min}$ at MPPS: 94.59 %	Filter class, EN 1822: E10 *

Test air flow rate: 2550 m^3/h	Atmospheric pressure 995.7 mbar	Test air temperature: 22.4-22.5 °C	Test air relative humidity: 40.0-42.1 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	0.25 µm
Initial pressure drop: 123 Pa	MPPS: 0.23 µm	Efficiency at MPPS: 99.37 %	Efficiency$_{95\%min}$ at MPPS: 99.35 %	Filter class, EN 1822: E11*

Test air flow rate: 1700 m^3/h	Atmospheric pressure 995.7-995.8 mbar	Test air temperature: 22.2-22.3 °C	Test air relative humidity: 39.7-40.5 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 58 Pa	MPPS: 0.19 µm	Efficiency at MPPS: 99.968 %	Efficiency$_{95\%min}$ at MPPS: 99.965 %	Filter class, EN 1822: H13*

Test air flow rate: 850 m^3/h	Atmospheric pressure 996.0 mbar	Test air temperature: 22.6-22.7 °C	Test air relative humidity: 38.2-40.3 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 17 Pa	MPPS: 0.330 µm	Efficiency at MPPS: 99.990 %	Efficiency$_{95\%min}$ at MPPS: 99.989 %	Filter class, EN 1822: H13*

* It was not established that the measuring range of the instrumentation included the minimum of the fractional efficiency curve and the position of the most penetrating particle size (MPPS). The reported results are based on measurements of particle sizes 0.1 -1.5µm. The reported results are based on the overall efficiency. EN1822-4 was not performed.

Note: The performance results are only valid for the tested item and cannot by themselves be quantitatively applied to predict efficiency and lifetime in service

Appendix 1

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

EN1822-5: Particle measurements

Air filter: FE600, 3 filters in series

Test No: SP201504171

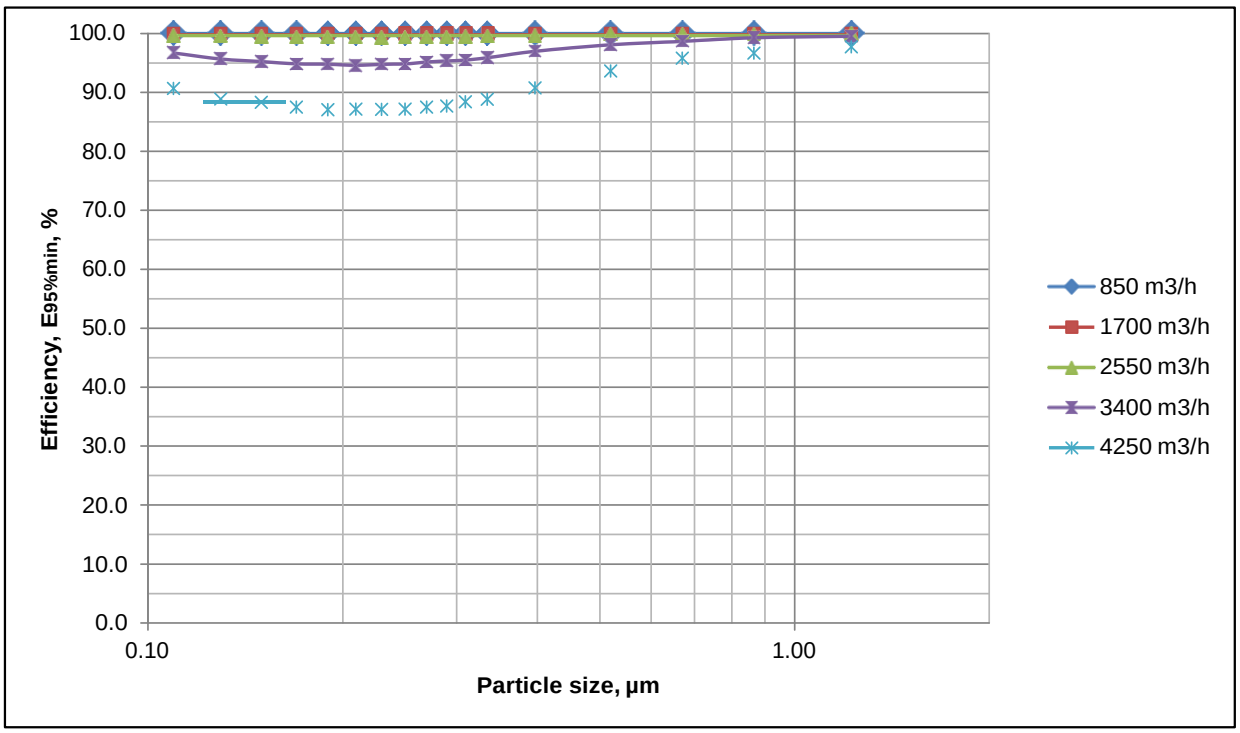
Test Aerosol: DEHS

Air flow rate: 850 - 4250 m^3/h

Particle size				Efficiency %									
Interval µm			Mean µm	850 m^3/h		1700 m^3/h		2550 m^3/h		3400 m^3/h		4250 m^3/h	
				E	$E_{95\%min}$	E	$E_{95\%min}$	E	$E_{95\%min}$	E	$E_{95\%min}$	E	$E_{95\%min}$
0.10	-	0.12	0.11	99.991	99.990	99.977	99.975	99.69	99.68	96.76	96.68	90.83	90.66
0.12	-	0.14	0.13	99.992	99.991	99.974	99.972	99.57	99.55	95.77	95.66	89.10	88.88
0.14	-	0.16	0.15	99.992	99.991	99.973	99.971	99.50	99.48	95.34	95.22	88.53	88.30
0.16	-	0.18	0.17	99.991	99.990	99.970	99.968	99.43	99.41	94.97	94.84	87.73	87.48
0.18	-	0.20	0.19	99.991	99.990	99.968	99.965	99.39	99.37	94.91	94.77	87.30	87.03
0.20	-	0.22	0.21	99.991	99.990	99.970	99.967	99.39	99.36	94.73	94.59	87.42	87.15
0.22	-	0.24	0.23	99.990	99.989	99.968	99.966	99.37	99.35	94.91	94.76	87.38	87.10
0.24	-	0.26	0.25	99.992	99.99	99.970	99.967	99.39	99.37	94.98	94.84	87.44	87.15
0.26	-	0.28	0.27	99.990	99.989	99.970	99.967	99.39	99.37	95.30	95.16	87.76	87.47
0.28	-	0.30	0.29	99.991	99.990	99.971	99.968	99.43	99.40	95.48	95.33	87.98	87.67
0.30	-	0.32	0.31	99.991	99.990	99.971	99.968	99.49	99.47	95.65	95.49	88.71	88.38
0.32	-	0.35	0.33	99.990	99.989	99.976	99.974	99.54	99.51	96.00	95.87	89.10	88.84
0.35	-	0.45	0.40	99.992	99.991	99.978	99.977	99.68	99.67	97.03	96.97	90.86	90.72
0.45	-	0.60	0.52	99.992	99.991	99.982	99.980	99.85	99.84	98.14	98.08	93.78	93.64
0.60	-	0.75	0.67	99.992	99.990	99.985	99.981	99.91	99.90	98.74	98.66	95.95	95.78
0.75	-	1.00	0.87	99.991	99.989	99.987	99.984	99.93	99.92	99.32	99.26	96.81	96.65
1.00	-	1.50	1.22	99.995	99.992	99.985	99.979	99.96	99.94	99.59	99.52	97.90	97.71

E Efficiency, %

$E_{95\%min}$ Efficiency as lower limit value for the 95% level of confidence, %



Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

EN1822-5: Air flow rate and pressure drop

Air filter: FE600, 3 filters in series

Test no.: SP201504171

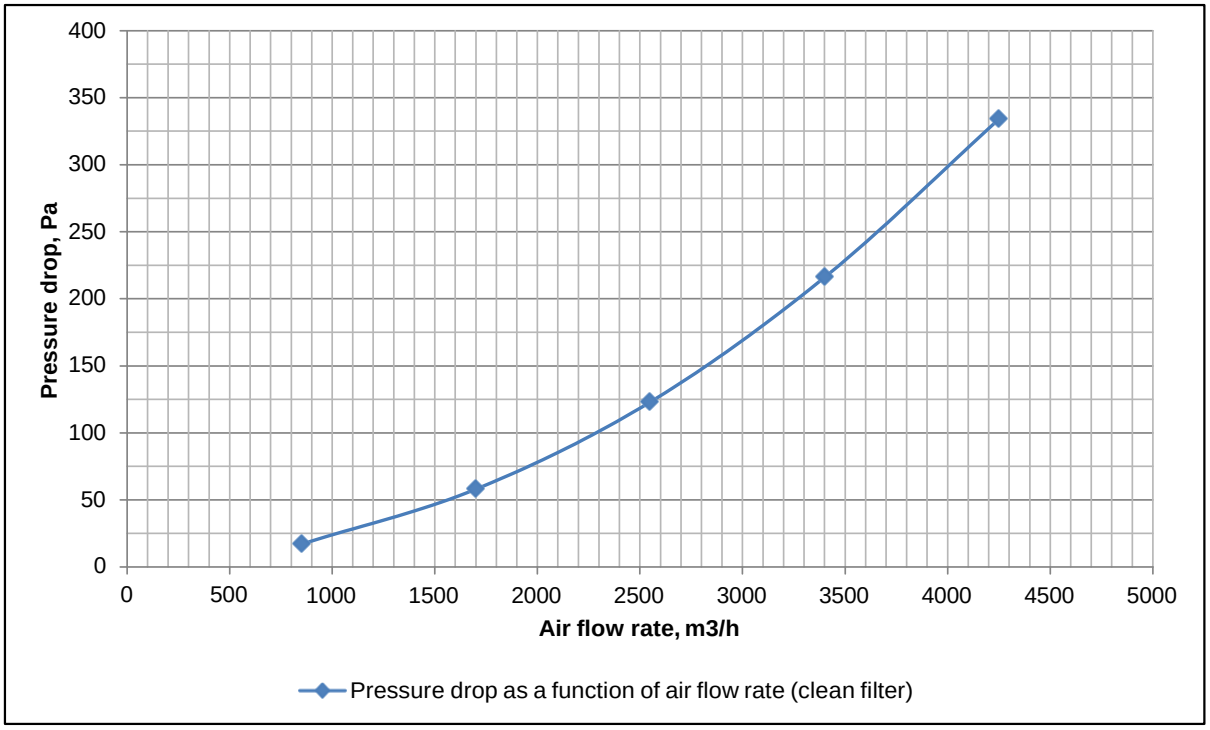
Test aerosol: DEHS

Air flow rate: 850 - 4250 m^3/h

Date	Air flow meter				Filter							
	t_f	p_{sf}	dp_f	q_m	t	φ	p_a	ρ	q_v	q_v	Δp	$\Delta p_{1.20}$
	°C	Pa	Pa	kg/s	°C	%	kPa	kg/m^3	m^3/s	m^3/h	Pa	Pa
Clean filter												
23/04/2015	22.1	30	32	0.28	22.1	41.6	98.8	1.161	0.237	853.2	17	17
23/04/2015	22.0	54	127	0.55	22.0	42.8	98.9	1.162	0.472	1699.6	57	58
23/04/2015	22.6	80	283	0.82	22.6	40.4	98.9	1.160	0.708	2547.7	120	123
23/04/2015	22.8	182	503	1.10	22.8	37.1	98.9	1.159	0.945	3400.9	210	216
23/04/2015	23.0	125	784	1.37	23.0	39.9	98.9	1.158	1.181	4250.5	325	334
Clean filter pressure drop is proportional to $(q_v)^n$, where n = 1.83583												

Symbols and units

dp_f	air flow meter differential pressure, Pa	q_m	mass flow rate, kg/s
m_{tot}	cumulative mass of dust fed to filter, g	q_v	air flow rate filter, m^3/s and m^3/h
Δp	measured filter pressure drop, Pa	t_f	temperature at air flow meter, °C
$\Delta p_{1.20}$	filter pressure drop at air density 1.20 kg/m^3, Pa	t	temperature upstream of filter, °C
p_a	absolute air pressure upstream of filter, kPa	φ	relative humidity upstream of the filter, %
p_{sf}	air flow meter static pressure, kPa	ρ	air density upstream of filter, kg/m^3



Appendix 2

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

GENERAL

Test no.: SP201504171	Date of test: 17/04/2015 - 23/04/2015	Supervisor: CM
Test requested by: Expansion-Electronic S.r.l.		Device receiving date: 24/03/2015
Device delivered by: Expansion-Electronic S.r.l.		

DEVICE TESTED

Model/Type: EKO-FE600, 2 filters in series	Manufacturer: -	Construction: Electrostatic filters
Article number: -	Serial number: -	Filter dimensions (width x height x depth): 592 x 592 x 218 mm
Type of media: -	Net effective filtering area: - m^2	

TEST DATA, RESULTS

Test air flow rate: 2550 m^3/h	Atmospheric pressure 1006.3 mbar	Test air temperature: 22.3-22.5 °C	Test air relative humidity: 39.3-41.3 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	0.25 µm
Initial pressure drop: 80 Pa	MPPS: 0.21 µm	Efficiency at MPPS: 96.08 %	Efficiency$_{95\%min}$ at MPPS: 95.95 %	Filter class, EN 1822: E11*

Test air flow rate: 1700 m^3/h	Atmospheric pressure 1006.4 mbar	Test air temperature: 22.3-22.5 °C	Test air relative humidity: 40.4-42.3 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 38 Pa	MPPS: 0.19 µm	Efficiency at MPPS: 99.70 %	Efficiency$_{95\%min}$ at MPPS: 99.69 %	Filter class, EN 1822: E12*

Test air flow rate: 850 m^3/h	Atmospheric pressure 1006.4 mbar	Test air temperature: 21.8-22.3 °C	Test air relative humidity: 38.4-39.2 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 12 Pa	MPPS: 0.330 µm	Efficiency at MPPS: 99.93 %	Efficiency$_{95\%min}$ at MPPS: 99.92 %	Filter class, EN 1822: E12*

* It was not established that the measuring range of the instrumentation included the minimum of the fractional efficiency curve and the position of the most penetrating particle size (MPPS). The reported results are based on measurements of particle sizes 0.1 - 1.5µm.

Note: The performance results are only valid for the tested item and cannot by themselves be quantitatively applied to predict efficiency and lifetime in service

Appendix 2

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

EN1822-5: Particle measurements

Air filter: FE600, 2 filters in series

Test No: SP201504171

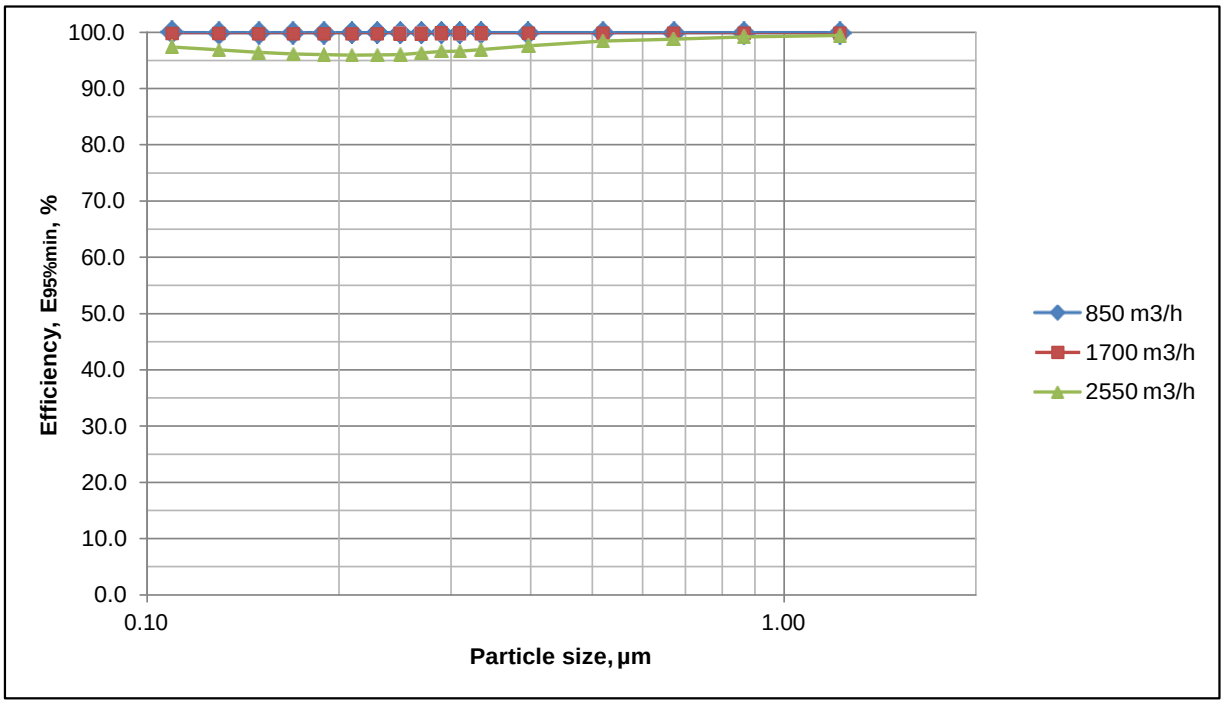
Test Aerosol: DEHS

Air flow rate: 850 - 2550 m^3/h

Particle size				Efficiency							
Interval µm			Mean µm	850 m^3/h		1700 m^3/h		2550 m^3/h			
				E	$E_{95\%min}$	E	$E_{95\%min}$	E	$E_{95\%min}$		
0.10	-	0.12	0.11	99.94	99.93	99.77	99.76	97.47	97.39		
0.12	-	0.14	0.13	99.94	99.93	99.76	99.75	96.97	96.88		
0.14	-	0.16	0.15	99.93	99.93	99.74	99.73	96.52	96.42		
0.16	-	0.18	0.17	99.93	99.93	99.72	99.71	96.25	96.14		
0.18	-	0.20	0.19	99.93	99.93	99.70	99.69	96.15	96.03		
0.20	-	0.22	0.21	99.93	99.93	99.71	99.69	96.08	95.95		
0.22	-	0.24	0.23	99.93	99.93	99.71	99.70	96.10	95.98		
0.24	-	0.26	0.25	99.93	99.93	99.72	99.71	96.18	96.05		
0.26	-	0.28	0.27	99.93	99.93	99.73	99.72	96.46	96.33		
0.28	-	0.30	0.29	99.93	99.93	99.75	99.74	96.72	96.59		
0.30	-	0.32	0.31	99.93	99.93	99.75	99.73	96.76	96.62		
0.32	-	0.35	0.33	99.93	99.92	99.77	99.76	97.03	96.92		
0.35	-	0.45	0.40	99.94	99.93	99.80	99.79	97.67	97.61		
0.45	-	0.60	0.52	99.94	99.93	99.83	99.83	98.49	98.43		
0.60	-	0.75	0.67	99.94	99.93	99.84	99.83	98.89	98.81		
0.75	-	1.00	0.87	99.93	99.92	99.84	99.83	99.28	99.21		
1.00	-	1.50	1.22	99.94	99.92	99.84	99.80	99.52	99.42		

E Efficiency, %

$E_{95\%min}$ Efficiency as lower limit value for the 95% level of confidence, %



Appendix 2

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

EN1822-5: Air flow rate and pressure drop

Air filter: FE600, 2 filters in series

Test no.: SP201504171

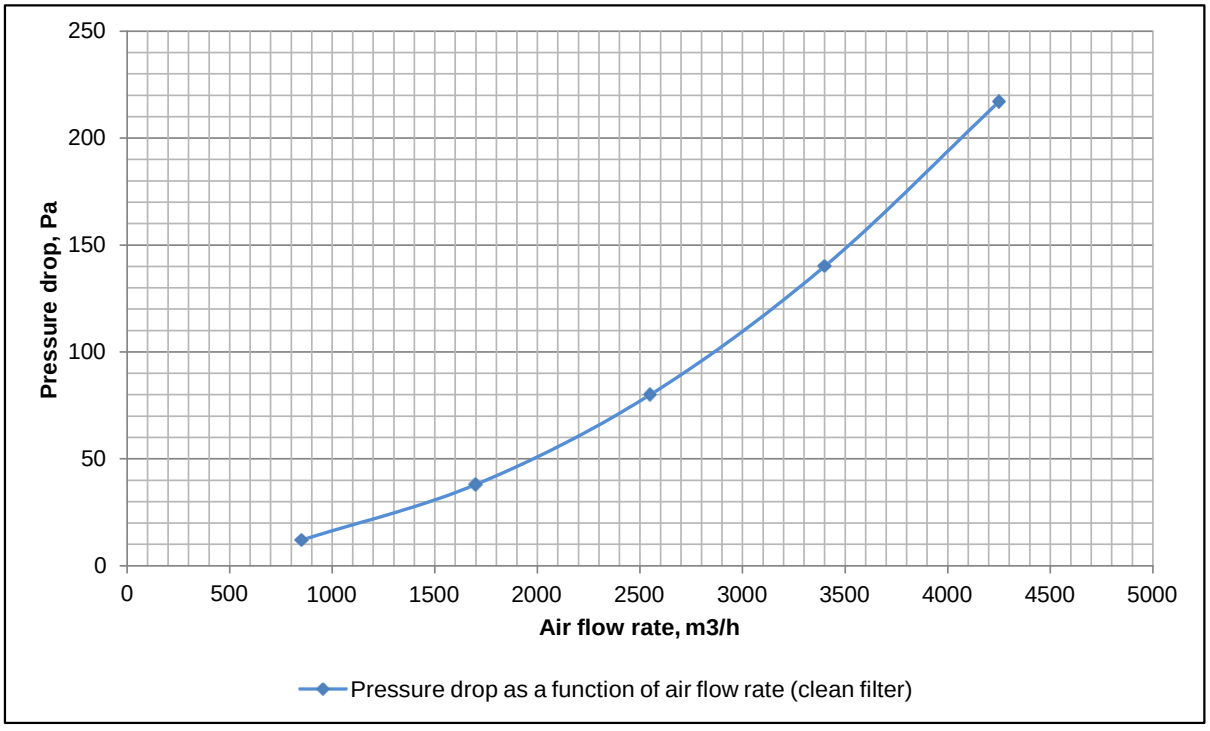
Test aerosol: DEHS

Air flow rate: 850 - 2550 m^3/h

Date	Air flow meter				Filter							
	t_f	p_{sf}	dp_f	q_m	t	φ	p_a	ρ	q_v	q_v	Δp	$\Delta p_{1.20}$
	°C	Pa	Pa	kg/s	°C	%	kPa	kg/m^3	m^3/s	m^3/h	Pa	Pa
Clean filter												
20/04/2015	21.8	-20	33	0.28	21.8	39.2	100.6	1.183	0.237	851.8	12	12
20/04/2015	21.9	-64	129	0.56	21.9	41.6	100.5	1.182	0.472	1698.1	38	38
20/04/2015	22.4	-119	288	0.83	22.4	44.4	100.5	1.179	0.708	2549.2	79	80
20/04/2015	22.5	-189	511	1.11	22.5	38.1	100.4	1.178	0.944	3399.8	138	140
20/04/2015	22.9	-288	795	1.39	22.9	42.1	100.3	1.175	1.181	4250.2	214	217
Clean filter pressure drop is proportional to $(q_v)^n$, where n = 1.81635												

Symbols and units

dp_f	air flow meter differential pressure, Pa	q_m	mass flow rate, kg/s
m_{tot}	cumulative mass of dust fed to filter, g	q_v	air flow rate filter, m^3/s and m^3/h
Δp	measured filter pressure drop, Pa	t_f	temperature at air flow meter, °C
$\Delta p_{1.20}$	filter pressure drop at air density 1.20 kg/m^3, Pa	t	temperature upstream of filter, °C
p_a	absolute air pressure upstream of filter, kPa	φ	relative humidity upstream of the filter, %
p_{sf}	air flow meter static pressure, kPa	ρ	air density upstream of filter, kg/m^3



Appendix 3

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

GENERAL

Test no.: SP201504171	Date of test: 17/04/2015 - 23/04/2015	Supervisor: CM
Test requested by: Expansion-Electronic S.r.l.		Device receiving date: 24/03/2015
Device delivered by: Expansion-Electronic S.r.l.		

DEVICE TESTED

Model/Type: FE600, 1 filter	Manufacturer: -	Construction: Electrostatic filter
Article number: -	Serial number: -	Filter dimensions (width x height x depth): 592 x 592 x 218 mm
Type of media: -	Net effective filtering area: - m^2	

TEST DATA, RESULTS

Test air flow rate: 1700 m^3/h	Atmospheric pressure 1006.1 mbar	Test air temperature: 22.2-22.3 °C	Test air relative humidity: 40.1-41.8 %	
Dilution upstream: 10	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 20 Pa	MPPS: 0.19 µm	Efficiency at MPPS: 94.56 %	Efficiency$_{95\%min}$ at MPPS: 94.36 %	Filter class, EN 1822: E10*

Test air flow rate: 850 m^3/h	Atmospheric pressure 996.3-996.5 mbar	Test air temperature: 22.3-22.5 °C	Test air relative humidity: 38.3-39.1 %	
Dilution upstream: 100	Dilution downstream: 1	Particle measuring: OPC	Test aerosol: DEHS/Polydisperse	Median diameter 0.25 µm
Initial pressure drop: 6 Pa	MPPS: 0.210 µm	Efficiency at MPPS: 99.42 %	Efficiency$_{95\%min}$ at MPPS: 99.40 %	Filter class, EN 1822: E11*

* It was not established that the measuring range of the instrumentation included the minimum of the fractional efficiency curve and the position of the most penetrating particle size (MPPS). The reported results are based on measurements of particle sizes 0.1 - 1.5µm.

Note: The performance results are only valid for the tested item and cannot by themselves be quantitatively applied to predict efficiency and lifetime in service

Appendix 3

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

EN1822-5: Particle measurements

Air filter: FE600, 1 filter

Test No: SP201504171

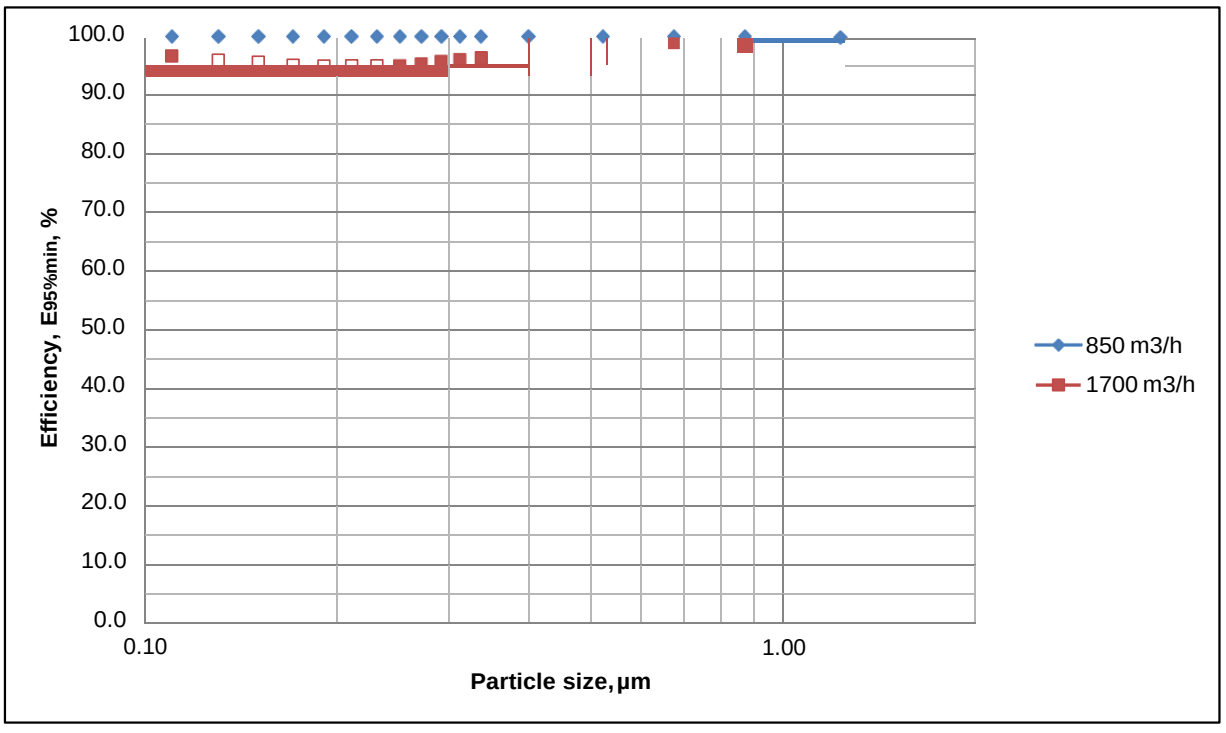
Test Aerosol: DEHS

Air flow rate: 850 - 1700 m^3/h

Particle size				Efficiency %							
Interval µm			Mean µm	850 m^3/h		1700 m^3/h					
				E	$E_{95\%min}$	E	$E_{95\%min}$				
0.10	-	0.12	0.11	99.46	99.45	96.21	96.08				
0.12	-	0.14	0.13	99.45	99.44	95.55	95.40				
0.14	-	0.16	0.15	99.44	99.42	95.23	95.06				
0.16	-	0.18	0.17	99.43	99.41	94.70	94.51				
0.18	-	0.20	0.19	99.43	99.41	94.56	94.36				
0.20	-	0.22	0.21	99.42	99.40	94.60	94.40				
0.22	-	0.24	0.23	99.42	99.41	94.61	94.41				
0.24	-	0.26	0.25	99.42	99.40	94.58	94.38				
0.26	-	0.28	0.27	99.42	99.41	94.88	94.67				
0.28	-	0.30	0.29	99.44	99.42	95.29	95.08				
0.30	-	0.32	0.31	99.44	99.42	95.57	95.36				
0.32	-	0.35	0.33	99.45	99.43	95.83	95.66				
0.35	-	0.45	0.40	99.46	99.45	96.61	96.52				
0.45	-	0.60	0.52	99.47	99.46	97.72	97.63				
0.60	-	0.75	0.67	99.46	99.43	98.38	98.25				
0.75	-	1.00	0.87	99.41	99.38	98.76	98.65				
1.00	-	1.50	1.22	99.31	99.24	98.97	98.82				

E Efficiency, %

$E_{95\%min}$ Efficiency as lower limit value for the 95% level of confidence, %



Appendix 3

Testing organisation: SP Technical Research Institute of Sweden Report no.: 5P03728A

EN 1822-5: DETERMINING THE EFFICIENCY OF FILTER ELEMENTS

EN1822-5: Air flow rate and pressure drop

Air filter: FE600, 1 filter

Test no.: SP201504171

Test aerosol: DEHS

Air flow rate: 850 - 1700 m^3/h

Date	Air flow meter				Filter							
	t_f	p_{sf}	dp_f	q_m	t	φ	p_a	ρ	q_v	q_v	Δp	$\Delta p_{1.20}$
	°C	Pa	Pa	kg/s	°C	%	kPa	kg/m^3	m^3/s	m^3/h	Pa	Pa
Clean filter												
20/04/2015	22.2	-21	33	0.28	22.2	39.7	100.6	1.182	0.237	852.1	6	6
20/04/2015	22.4	-69	129	0.56	22.4	40.7	100.5	1.180	0.472	1699.6	20	20
20/04/2015	22.3	-126	288	0.84	22.3	39.5	100.5	1.180	0.708	2547.7	41	41
20/04/2015	22.7	-217	511	1.11	22.7	41.9	100.4	1.177	0.945	3401.6	71	72
20/04/2015	22.7	-308	796	1.39	22.7	38.0	100.3	1.176	1.181	4250.2	110	111
Clean filter pressure drop is proportional to $(q_v)^n$, w here n = 1.85592												

Symbols and units

dp_f	air flow meter differential pressure, Pa	q_m	mass flow rate, kg/s
m_{tot}	cumulative mass of dust fed to filter, g	q_v	air flow rate filter, m^3/s and m^3/h
Δp	measured filter pressure drop, Pa	t_f	temperature at air flow meter, °C
$\Delta p_{1.20}$	filter pressure drop at air density 1.20 kg/m^3, Pa	t	temperature upstream of filter, °C
p_a	absolute air pressure upstream of filter, kPa	φ	relative humidity upstream of the filter, %
p_{sf}	air flow meter static pressure, kPa	ρ	air density upstream of filter, kg/m^3

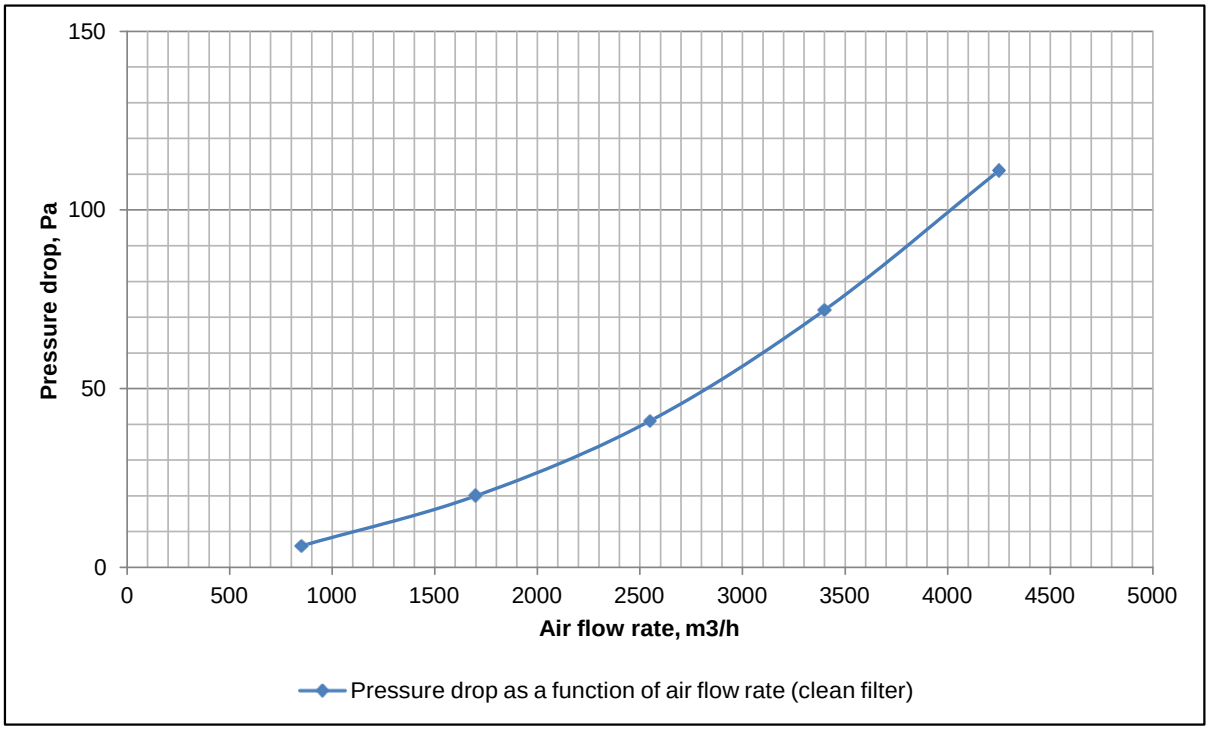


Fig 1. FE600, front side

Fig 2. FE600, back side

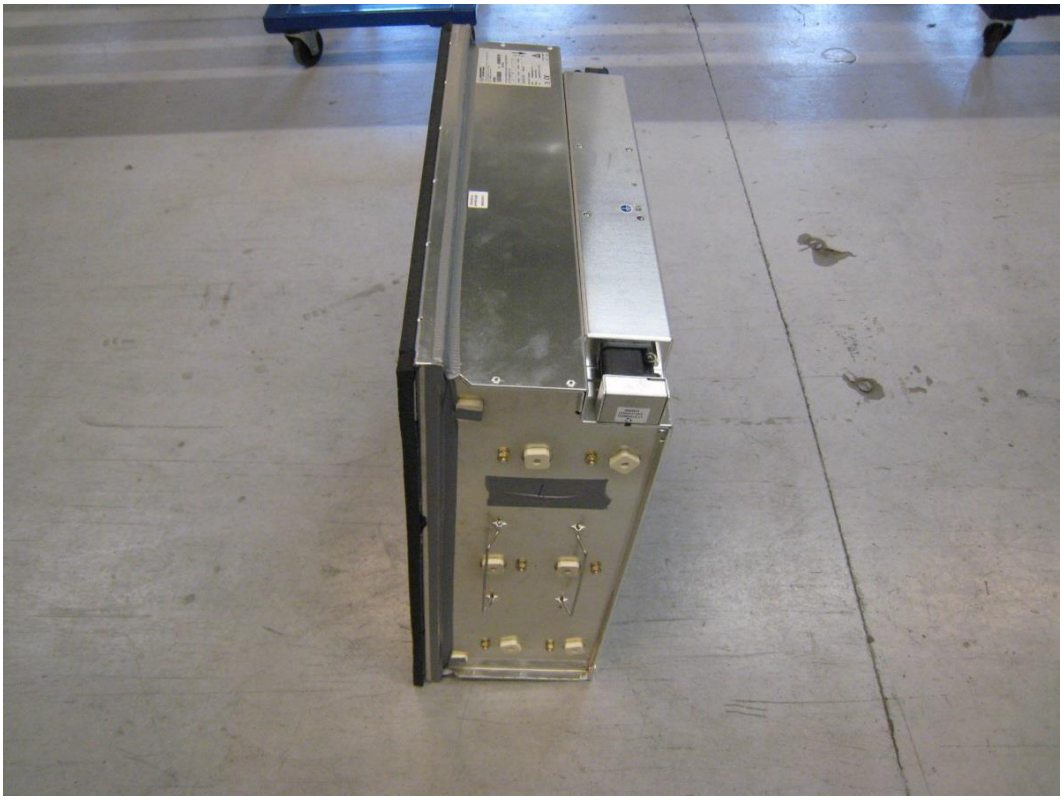


Fig 3. FE600, side view

Fig 4. Duct section, side view

Fig 5. Three FE600 mounted in series in the duct section, side view

Fig 6. Three FE600 mounted in series in the duct section, front side

Fig 7. Three FE600 mounted in series in the duct section, back side