

## Testing of electrostatic filter - Ozone emission

(2 appendices)

A test of ozone emissions from electrostatic filters was carried out by request from Expansion Electronic S.r.l. The purpose with the tests was to find out the amount of ozone the filters generate and how that relates to the volume airflow through the filters and the relative humidity.

### Tested items

Expansion Electronic S.r.l., FE600, 592 x 592 x 218 mm, Electrostatic filter, 1-3 filters. Pictures of the test items are found in appendix 1.

The items were handed to SP by Expansion Electronic S.r.l. on March 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 23-24, 2015.

### Test method

The filters were mounted in a duct section manufactured by Expansion Electronic S.r.l., this duct section was connected to a test rig according to EN779:2012. Approximate 2.5 m downstream the filters and in the middle of a cross section a measuring probe was installed, connected to an instrument that measures the ozone concentration continuously.

The tests were divided in three setups; setup one: one filter, setup two: two filters in series and setup three: three filters in series. For each test setup the ozone emission was measured at five different volume air flows (850 m<sup>3</sup>/h, 1700 m<sup>3</sup>/h, 2550 m<sup>3</sup>/h, 3400 m<sup>3</sup>/h and 4250 m<sup>3</sup>/h) with a relative humidity of 40%. Additional tests were performed for one volume airflow (2550 m<sup>3</sup>/h) with a relative humidity of 30% respective 60%.

The airflow was adjusted for each setup and measuring point. The ozone concentration was measured until a stable background level was reached. The filter/s was/were turned on and the ozone concentration was measured during approximate five minutes from that a stable level

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was reached. The filter/s was/were turned off and the ozone concentration was measured until the background level was reached.

**Test conditions**

The relative humidity was within 1 percentage point from the setup value.  
 The temperature was 21.5 °C – 22.7 °C.  
 The atmospheric pressure was 987 mbar – 987.4 mbar.  
 Unfiltered indoor air was used in the tests.

**Test results**

The results are presented table 1-3, and in figure 1. The tables show the ozone concentration downstream the filter when it is turned on, when it is turned off (background) and the difference between those.

The reported values are the average during the measuring time.

The results are valid only for the tested items.

**Table 1.** One filter.

Setup			O3 <sub>downstre am</sub> [ppb]			O3 <sub>background</sub> [ppb]			ΔO3 [ppb]		
Number of filters	Relative humidity	Volume air flow									
1	40%	4250 m <sup>3</sup> /h	15.1	±	1.0	9.8	±	1.0	5.3	±	1.7
1	40%	3400 m <sup>3</sup> /h	14.7	±	1.0	8.4	±	1.0	6.3	±	1.7
1	40%	2550 m <sup>3</sup> /h	18.2	±	1.0	10.0	±	1.0	8.3	±	1.7
1	40%	1700 m <sup>3</sup> /h	24.7	±	1.0	11.7	±	1.0	13.0	±	1.7
1	40%	850 m <sup>3</sup> /h	30.3	±	1.0	10.0	±	1.0	20.3	±	1.7
1	30%	2550 m <sup>3</sup> /h	15.4	±	1.0	6.6	±	1.0	8.7	±	1.7
1	60%	2550 m <sup>3</sup> /h	14.7	±	1.0	6.4	±	1.0	8.3	±	1.7

**Table 2.** Two filters.

Setup			O3 <sub>downstre am</sub> [ppb]			O3 <sub>background</sub> [ppb]			ΔO3 [ppb]		
Number of filters	Relative humidity	Volume air flow									
2	40%	4250 m <sup>3</sup> /h	22.7	±	1.0	11.7	±	1.0	11.0	±	1.7
2	40%	3400 m <sup>3</sup> /h	25.9	±	1.0	12.2	±	1.0	13.7	±	1.7
2	40%	2550 m <sup>3</sup> /h	32.1	±	1.0	13.0	±	1.0	19.0	±	1.7
2	40%	1700 m <sup>3</sup> /h	41.1	±	1.0	12.8	±	1.0	28.3	±	1.7
2	40%	850 m <sup>3</sup> /h	63.8	±	1.0	12.0	±	1.0	51.8	±	1.7
2	30%	2550 m <sup>3</sup> /h	33.7	±	1.0	11.4	±	1.0	22.4	±	1.7
2	60%	2550 m <sup>3</sup> /h	27.3	±	1.0	9.7	±	1.0	17.6	±	1.7

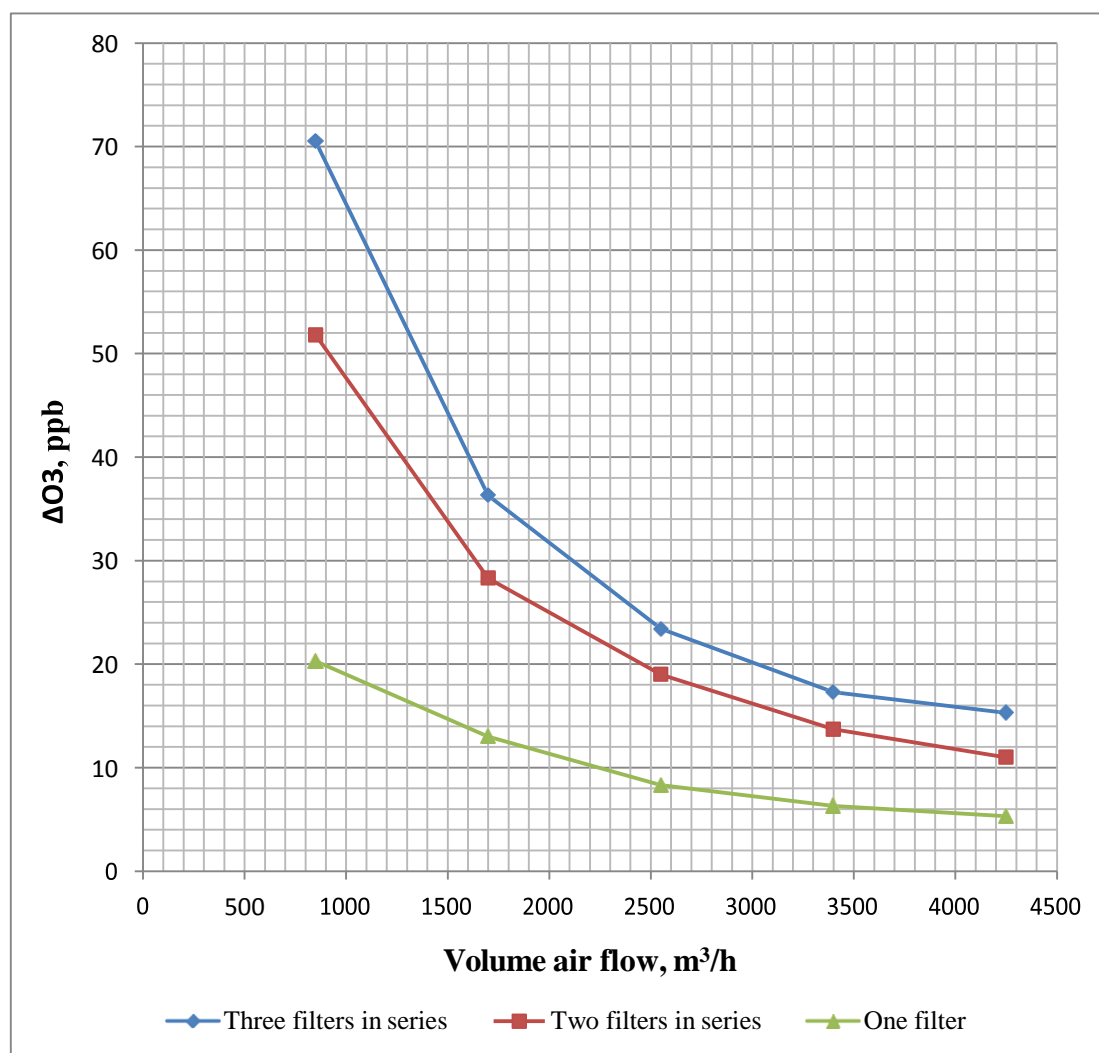
**Table 3.** Three filters.

Setup			O3 <sub>downstre am</sub> [ppb]			O3 <sub>background</sub> [ppb]			ΔO3 [ppb]		
Number of filters	Relative humidity	Volume air flow									
3	40%	4250 m <sup>3</sup> /h	20.4	±	1.0	5.1	±	1.0	15.3	±	1.7
3	40%	3400 m <sup>3</sup> /h	22.9	±	1.0	5.6	±	1.0	17.3	±	1.7
3	40%	2550 m <sup>3</sup> /h	28.5	±	1.0	5.1	±	1.0	23.4	±	1.7
3	40%	1700 m <sup>3</sup> /h	42.4	±	1.0	6.1	±	1.0	36.3	±	1.7
3	40%	850 m <sup>3</sup> /h	77.6	±	1.0	7.1	±	1.0	70.5	±	1.7
3	30%	2550 m <sup>3</sup> /h	35.6	±	1.0	5.8	±	1.0	29.9	±	1.7
3	60%	2550 m <sup>3</sup> /h	34.0	±	1.0	9.0	±	1.0	24.9	±	1.7

O3<sub>downstream</sub> = Ozone concentration downstream when the filter is turned on.

O3<sub>background</sub> = Ozone concentration downstream when the filter is turned off.

ΔO3 = O3<sub>downstream</sub> - O3<sub>background</sub>



**Fig 1.** The ozone concentration as function of the volume airflow. The graphs are valid for the setup with 40 % relative humidity.

## 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
Environment, model O <sub>3</sub> 42M	SP's inventory number 301 185

## Uncertainty of measurement

The uncertainty of the airflow 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  $\pm 3 \%$  RH

The uncertainty of the atmospheric pressure is better than  $\pm 1 \text{ mbar}$

The uncertainty of the ozone instrument is better than  $\pm 1 \text{ ppb}$

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

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### Appendices

1. Pictures of the test items.

Appendix 1



**Fig 1.** FE600, front side



**Fig 2.** FE600, back side



Appendix 1



**Fig 3.** FE600, side view



**Fig 4.** Duct section, side view

Appendix 1



**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



Appendix 1



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