REPORT

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Testing of air purifiers

(1 appendix)

Work requested

On behalf of LightAir AB, SP has tested the performance of a number of air purifiers with respect to their particle reduction performance and energy use.

This report describes the test procedures and results for the tests of particle reduction performance and energy use. A parallel report (SP no. P8 04370A-en-rev1) describes the testing of sound power level.

Items for testing

A total of seven air cleaners was tested:

> LightAir IonFlow 50 and six other air purifiers coded as EX, BO, SH, DA, BA and AP respectively were tested.

Appendix 1 describes the principle function of each air purifier. The coding and this description was provided by LightAir AB.

The air purifiers were delivered to SP by LightAir AB on August 13th 2008, and were without visible defects on arrival.

Date and place of testing

Testing was performed between August 13th and August 22nd 2008 at and by SP's Energy Technology Department in Borås.

Test procedure

The test method, described below, has been developed in collaboration with LightAir AB.

Each air cleaner to be tested was placed on a pallet, 72 cm above the floor, in the middle of a test chamber 3,5 m x 3,0 m x 2,5 m in size, and constructed from a wooden frame with polyethene plastic sheet walls. The chamber included a speed-controlled fan for the supply air, connected to a HEPA filter, a humidifier and an oscillating fan, directed slightly upwards, that was running throughout the test operation. The number of airborne particles was measured by an Electrical Low Pressure Impactor (ELPI), having 13 impactor stages, with the following interval of particle sizes:

0,007-0,028 µm; 0,028-0,056 µm; 0,056-0,094 µm; 0,094-0,156 µm; 0,156-0,264 µm; 0,264-0,384 µm; 0,384-0,616 µm; 0,616-0,953 µm; 0,953-0,161 µm; 1,61-2,4 µm; 2,4-4,01 µm and 4,01-10 µm.

A probe connected to the ELPI was positioned in the chamber at a height of about 150 cm.

Prior to each measurement test, the air in the chamber was cleaned to less than 100 particles/cm^3. Three burning candle-lights were used as the source of pollution, to give an initial particle count of about 80 000 particles/cm^3. Temperature and humidity was measured.

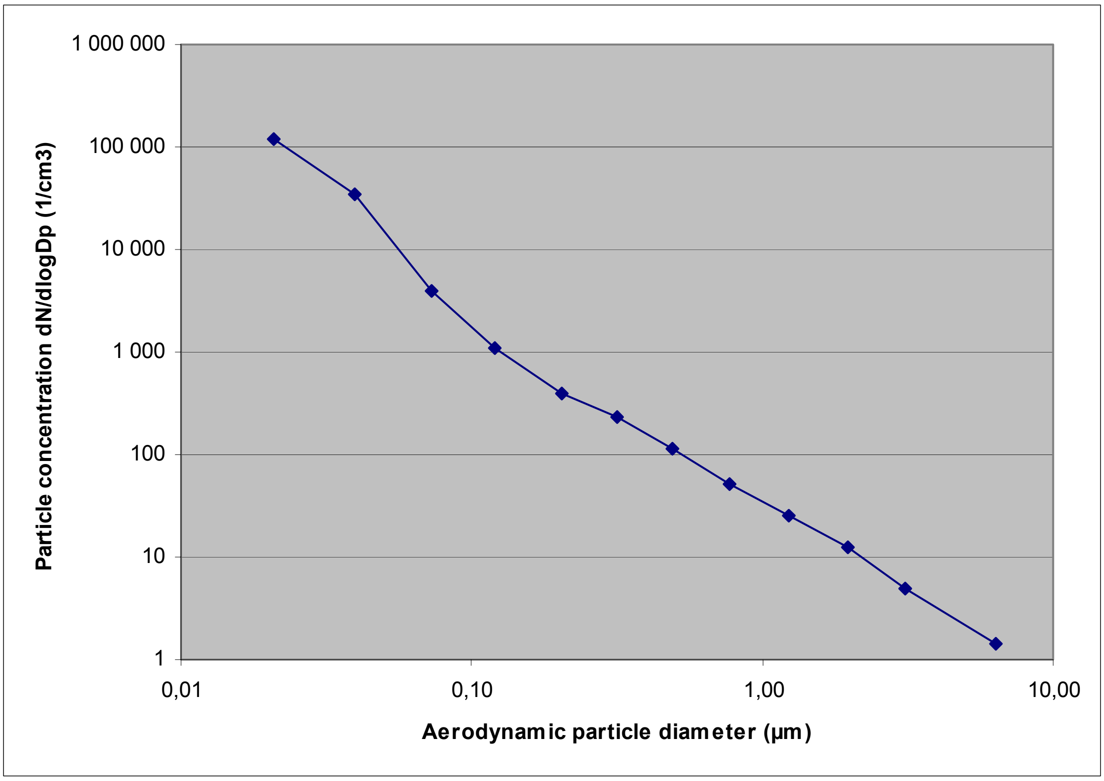

Fig. 1. Particle size distribution from candle-lights at a representative measurement

Measurement of natural decline

Sedimentation, agglomeration and the fastening of particles to surfaces[1] result in a natural decline in the particle concentration in the chamber.

Each day's measurements were started by measurement of the natural decline. Three candle-lights were lit and placed in the chamber until the selected particle concentration was reached. The candle-lights were then removed, and the air mixed for five minutes, after which the test measurements of particle concentration was started.

Measurement of particle reduction and energy use

The chamber was opened, the air cleaner put into it, and the chamber closed. Three candle-lights were lit and placed in the chamber until the selected particle concentration was reached. The candle-lights were then removed, and the air mixed for five minutes, after which the air purifier was started, the power supply voltage adjusted and energy demand read off. Measurement of the particle concentration was started, and allowed to continue until the air in the chamber was clean (less than 500 particles/cm^3), but in no case for more than two hours.

Test conditions

Conditions during the test were a temperature interval of 21,8 °C - 24,4 °C, relative humidity 38,3 % - 48,7 %, and power supply voltage 230 ± 1 V.

Results

Table 1 shows the results of energy use.

Table 1. Power demand of each air cleaner

Air purifier / operating mode	Power [W]
LightAir Ion Flow 50 / -	7,5
EX / Low	36,5
BO / Low (still)	29,5
SH / Quiet	7,5
DA / Low	7,0
DA / Medium	9,5
BA / Silent	18,7
BA / Low	22,9
AP / -	45,0

The results for particle reduction performance are shown in diagrammatic form (Figures 1 - 10), with the particle concentration as a function of time, and as a table (table 2).The particle concentration represents all particle sizes. Each diagram also shows the natural rate of decline of particle concentration, being a mean value from three representative measurements. To make a better comparison between the air cleaners the start values have been adjusted to the same level.

[1] Nordtest Method, NT VVS 106

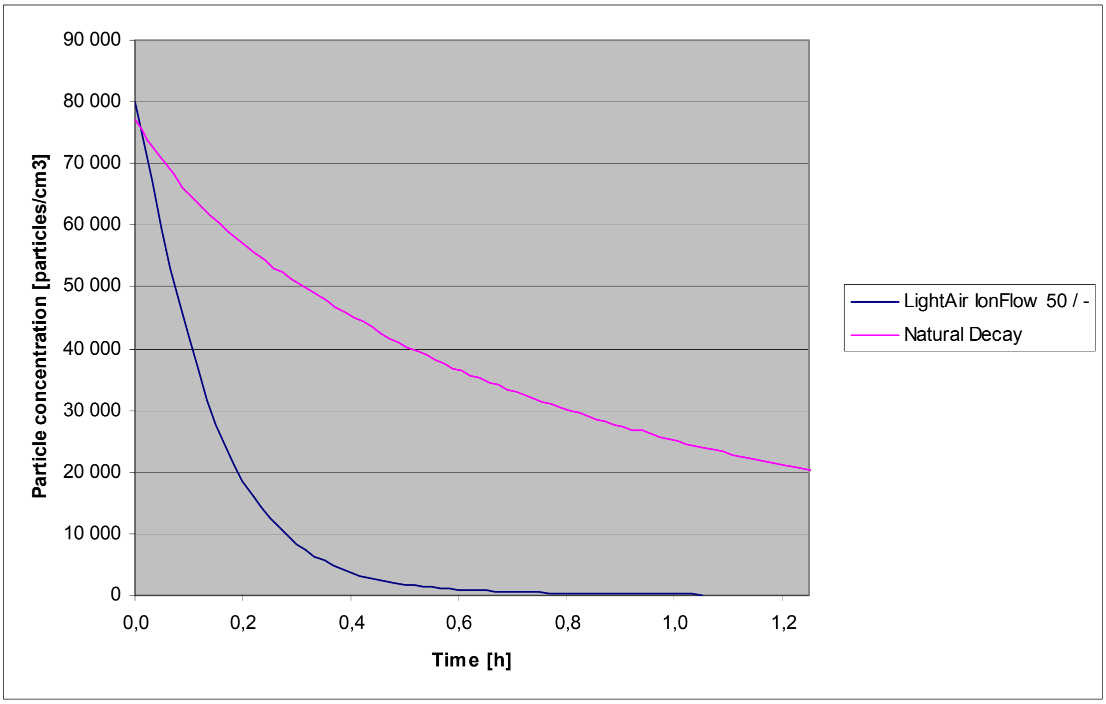

Fig. 2. Particle reduction for LightAir IonFlow 50

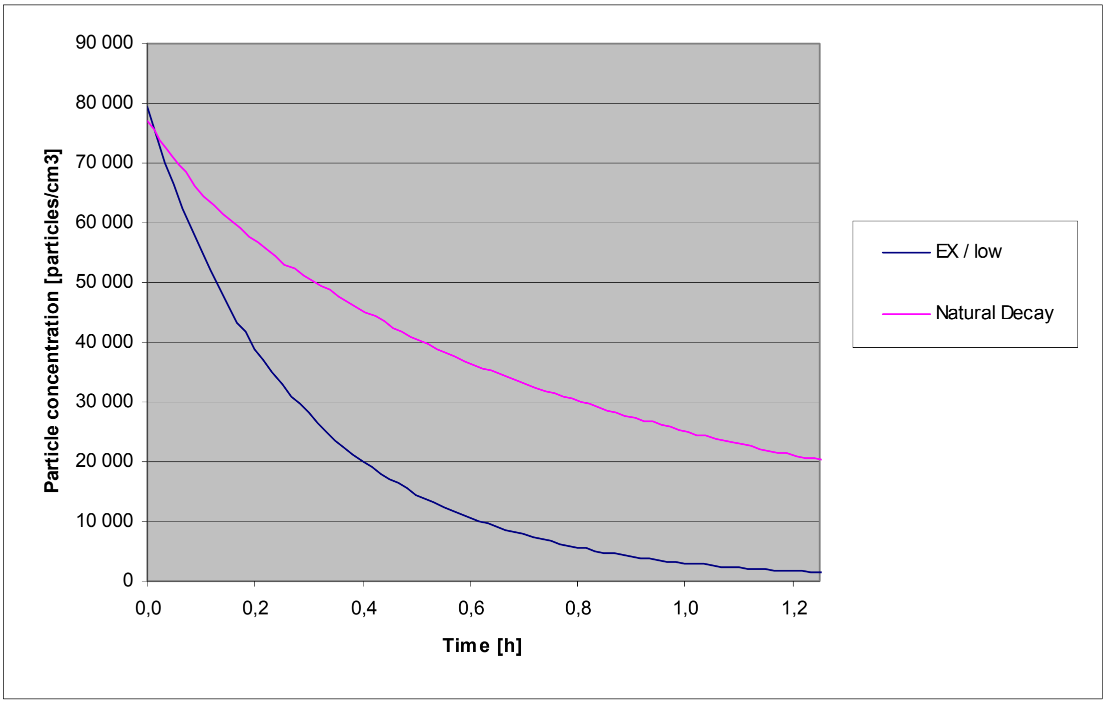

Fig. 3. Particle reduction for EX / low

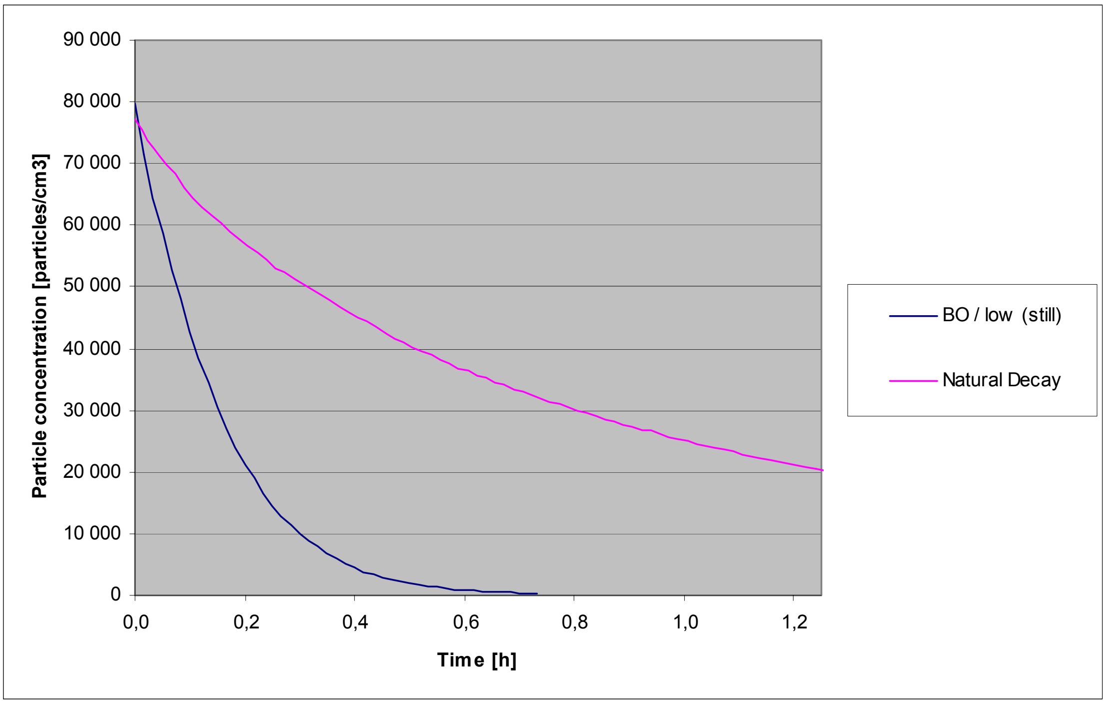

Fig. 4. Particle reduction for BO / low (still)

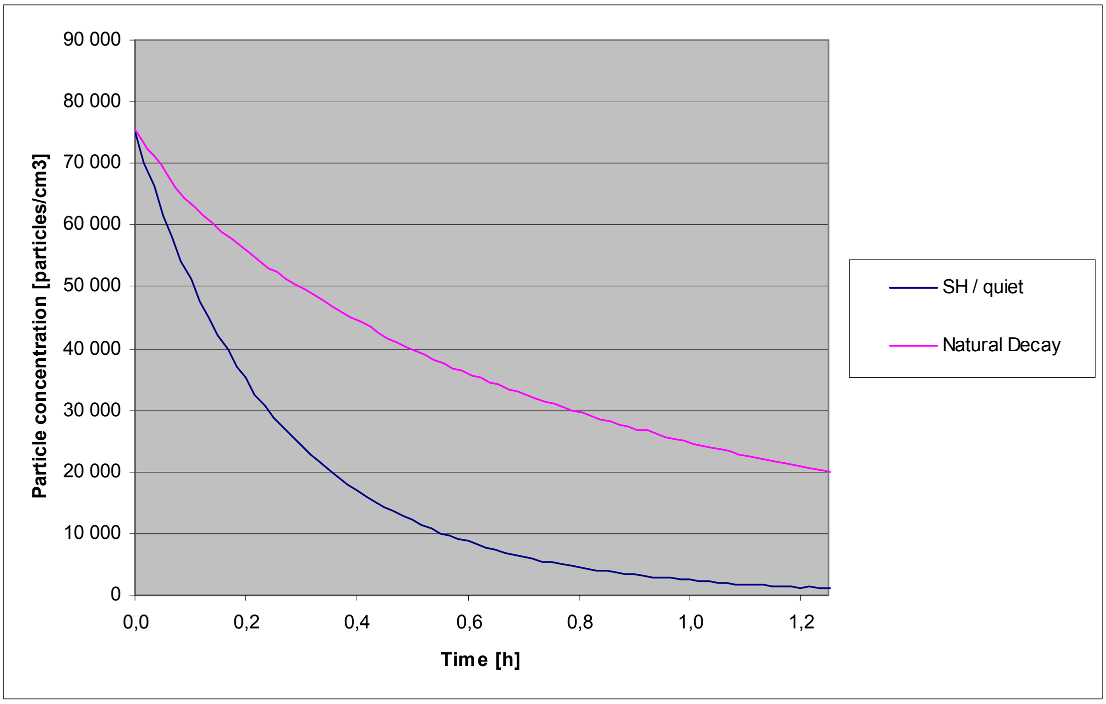

Fig. 5. Particle reduction for SH / quiet

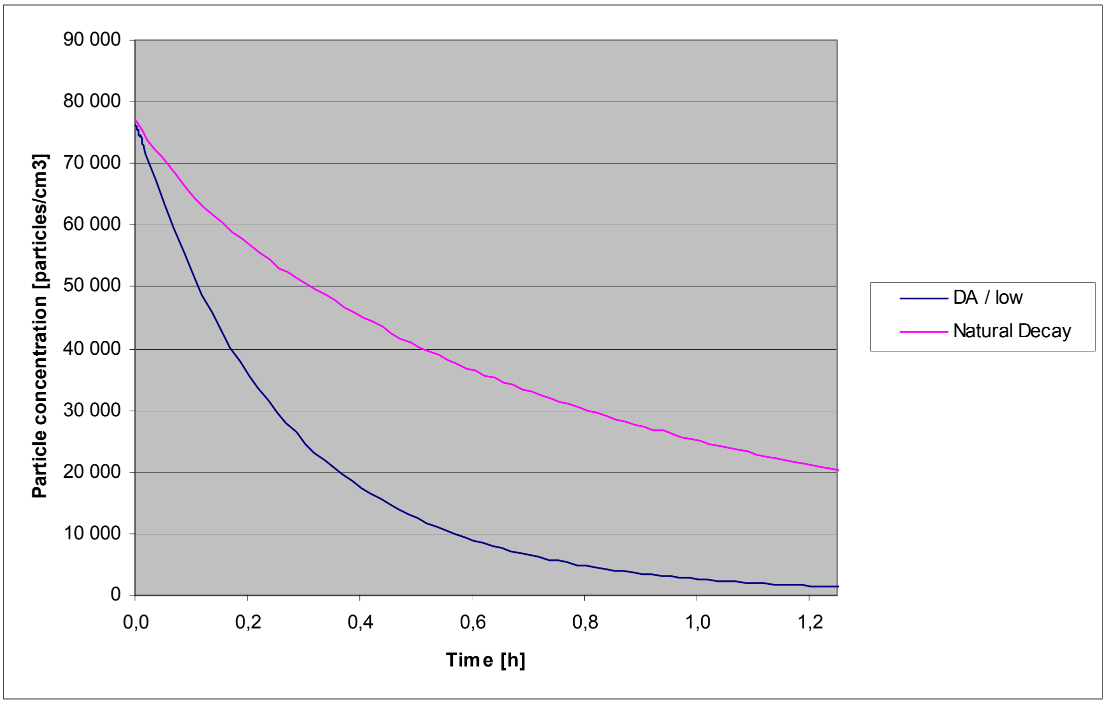

Fig. 6. Particle reduction for DA / low

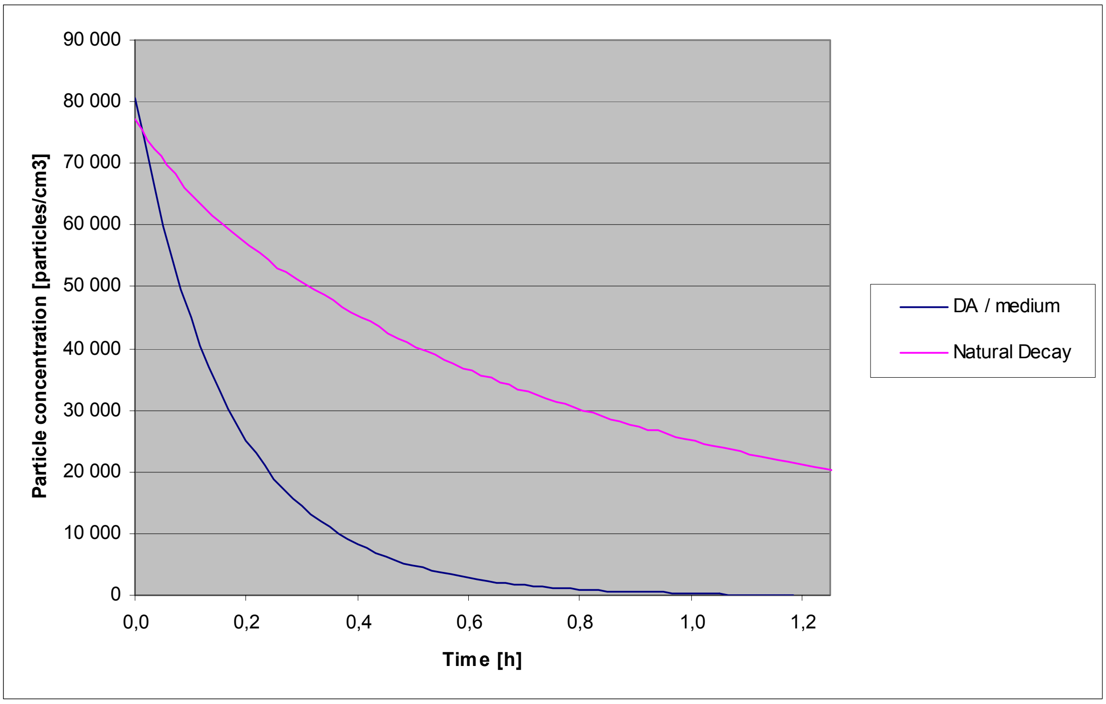

Fig. 7. Particle reduction for DA / medium

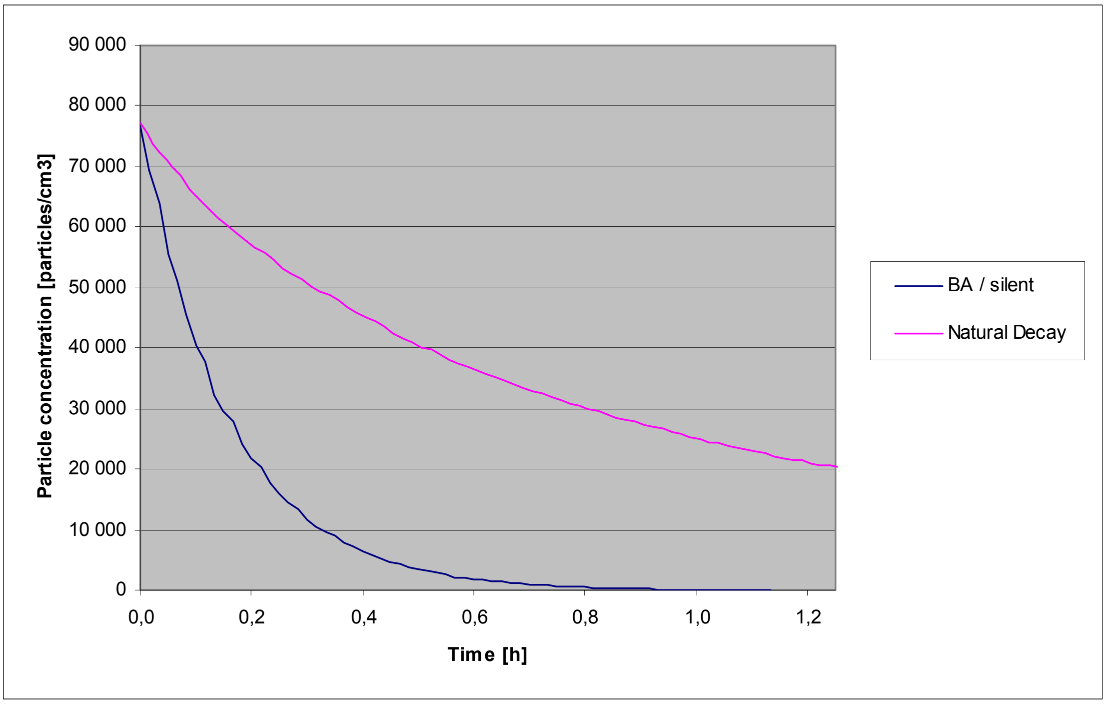

Fig. 8. Particle reduction for BA / silent

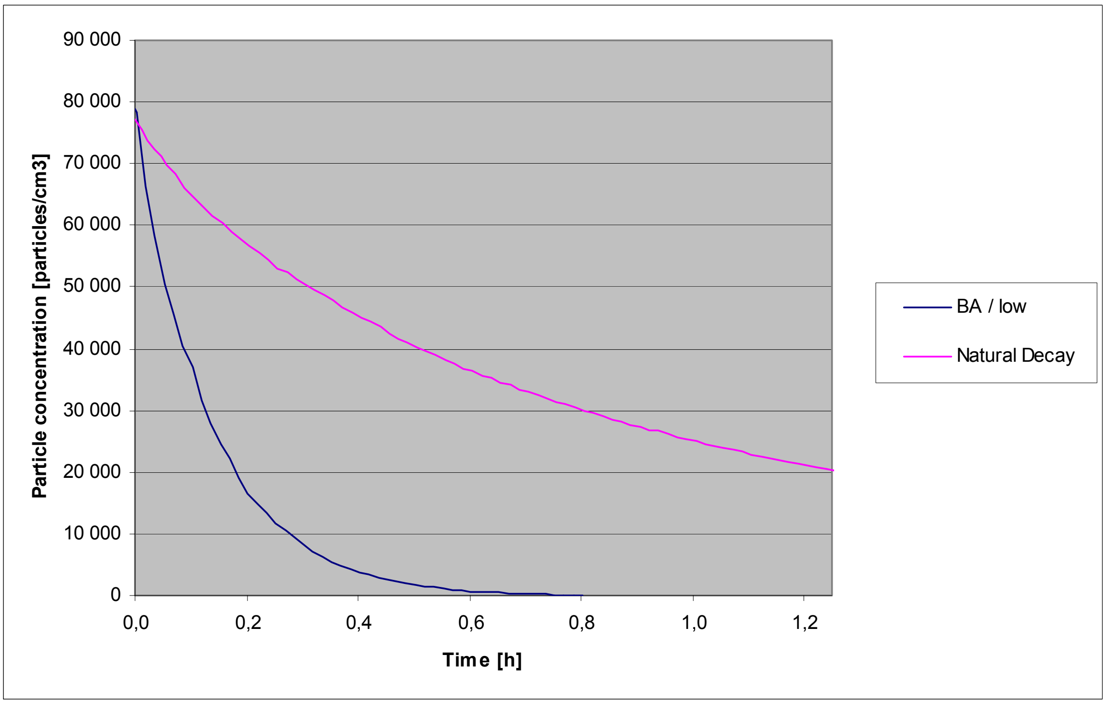

Fig. 9. Particle reduction for BA / low

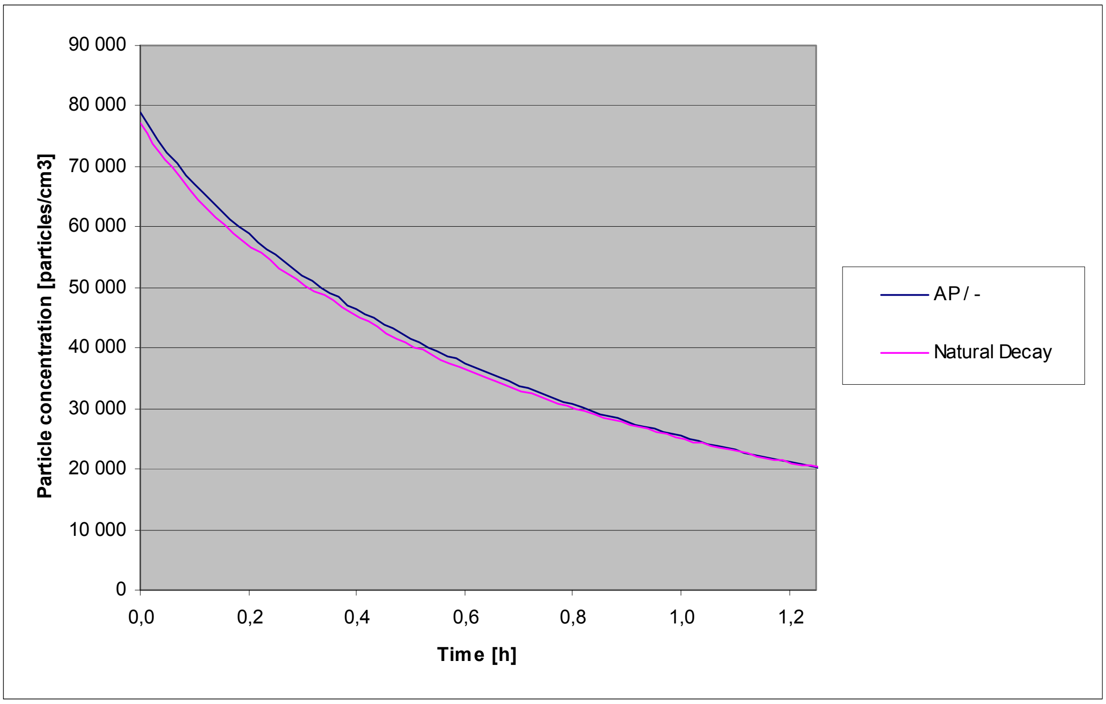

Fig. 10. Particle reduction for AP / -

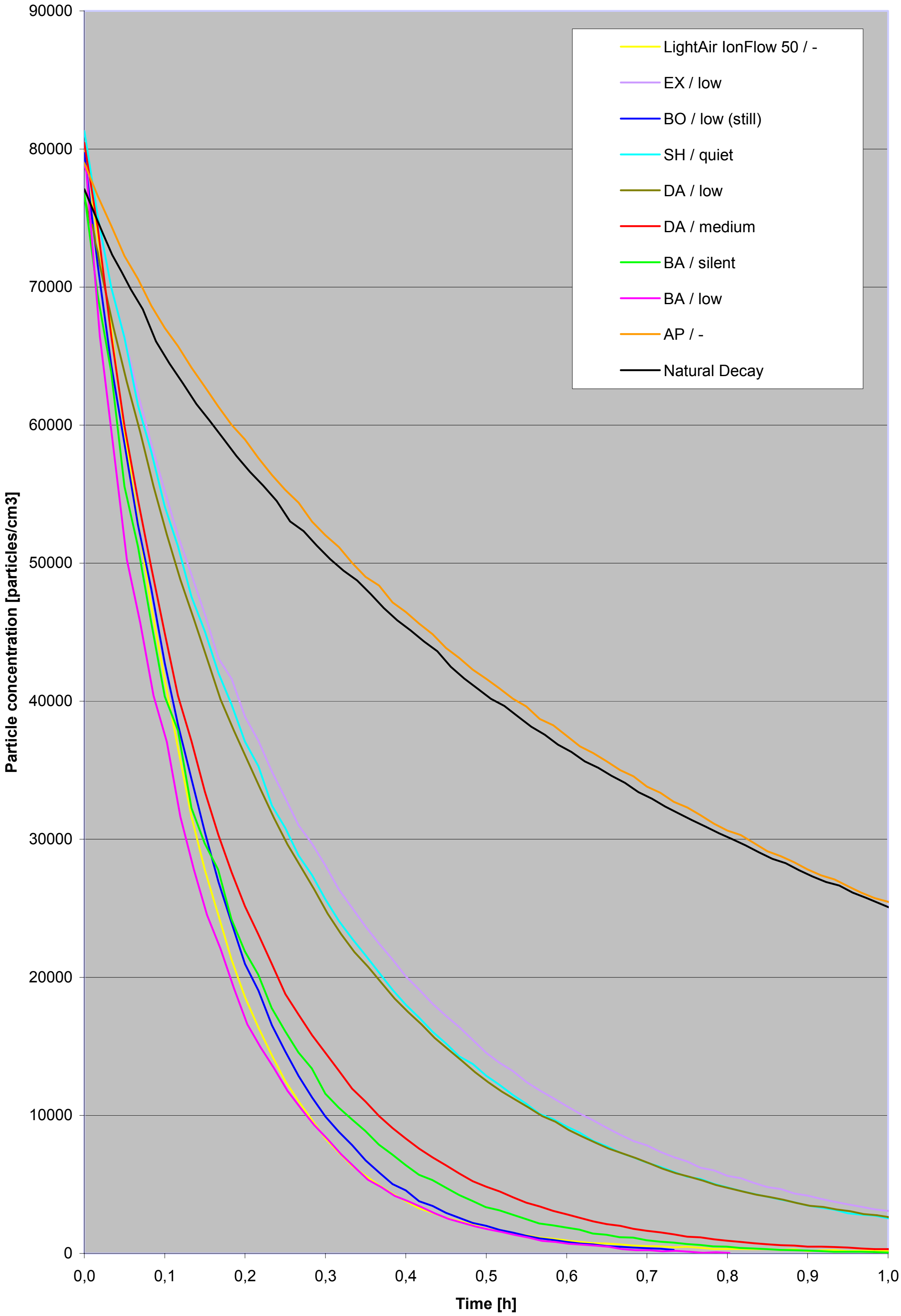

Fig. 11. Reduction of particles for all air purifiers

Table 2. Particle reduction in % at 0,25; 0,5 and 0,75 h

Air purifer	Particle reduction [%]		
	0,25 h	0,5 h	0,75 h
Natural decay	32	49	60
LightAir IonFlow 50 / -	83	98	99
EX / low	58	81	92
BO / low (still)	80	97	100
SH / quiet	62	84	93
DA / low	61	84	93
DA / medium	75	94	98
BA / silent	80	96	99
BA / low	85	98	100
AP / -	31	48	60

Note that the results quoted in this report apply only to the specific items tested.

Test equipment

Particle counter, ELPI (Electrical Low Pressure Impactor),
Dekati (SP inv no. 202 260)
Wattmeter and energy meter, Landis & Gyr, EMU 1.44 (SP inv no. 201 684)
Temperature and humidity sensor, Vaisala, HMP36 (SP inv no. 201 389)

Uncertainty of measurement

Relative humidity ± 3 %
Temperature ± 1 °C
Voltage ± 0,5 V

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Appendix

1. Short technical specification on each represented technology used at the benchmark test at SP in Aug-Sep 2008.

Appendix 1

Short technical specification on each represented technology used at the benchmark test at SP in Aug-Sep 2008

(Provided by LightAir AB)

Ionization (LightAir IonFlow 50)

Ionizing air purifiers generate large amount of electrons which transform into negative ions which charge particles in the air negative. The particles are then attracted by and attached to a positively charged collector. Some ionizers also generate ozone.

HEPA filter (BA)

A true HEPA filter removes up to 99.97% of all particles as small as 0.3 microns. This device creates a fan driven airflow through a very dense mechanical filter which is similar to HEPA. Such filters need to be changed frequently not to loose effect over time. Size, material and construction of the actual filter are important factors for the capacity of particle reduction. Very few portable air purifiers use true HEPA filters.

Conventional electrostatic precipitator (SH)

Conventional electrostatic precipitators are based on similar principles as ionization technology. They electrically charge the particles in a fan driven airflow. The particles continue into the counter pole collector cassette where they are attracted and get caught. The collector cassette is generally a conductive construction of metallic plates which must be frequently cleaned to keep the level of performance. Some conventional electrostatic precipitators also generate ozone.

Modified electrostatic precipitator (EX)

Modified electrostatic precipitator is based on the concept of a conventional electrostatic precipitator. However the plates in the collector cassette are made of material with a quite low conductivity (cellulose or plastic).The filter must be cleaned less frequently and keeps a good performance level over time. Some modified electrostatic precipitators could also generate ozone.

Hybrid (DA and BO)

A hybrid air purifier uses a combination of several technologies to capture different sizes of particles from the air. They also use a fan driven airflow and often include ionization of some kind. A hybrid can use a mixture of pre-filters (remove large particles), HEPA filters, electrostatic precipitation, active carbon filters (adsorbing odours and gases), antibacterial/germicidal filters and/or UV light. All filters need to be replaced regularly.

Heat (AP)

Heat is used to make the air move upwards (air convection) through the device where particles and microorganisms are destroyed at high temperatures. Like all devices using an airflow it only cleans the air which actually passes through the unit. In this case the airflow is extremely small.