



REPORT

Contact person
Tobias Eriksson
Energy and bioeconomy
+46 10 516 57 07
Tobias.Eriksson@sp.se

Date
2015-12-15

Reference
5P08653B

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Nanopas AB
c/o Ivar Frischer
Karl Gustavsgatan 31
411 25 GÖTEBORG

Air cleaner test - Clean Air Delivery Rate (CADR)

(2 appendices)

On behalf of Nanopas AB SP has evaluated an air cleaner where the reductions of particles in a chamber was studied. The output is a calculation of CADR and a graph of the reduction.

Items tested

Nanopas AB, model Nanopas Base 1.0, the model name was provided by Nanopas on November 30, 2015.

Pictures of the air cleaner are presented in appendix 1.

The air cleaner was handed to SP by Nanopas AB on November 20, 2015, and was without visible defects.

Place and date of testing

The tests were carried out at SPs Energy Technology laboratory in Borås between December 3-15, 2015.

Test methods and test procedure

The Clean Air Delivery Rate (CADR, also known as the Equivalent cleaning rate, ECR) tests were performed in accordance with SP-method 2378. The test procedure is based on Nordtest method NT VVS 106 Approved 1995-05 and standard ANSI/AHAM AC-1-2006.

Two different setups were performed. One with a table fan in one of the corner of the chamber, this to simulate a movement in the chamber. The other test was performed without the fan.

The tests were carried out in a test chamber having dimensions of 3.5 m x 3.0 m x 2.5 m, the walls were covered with polyethylene sheet. The air cleaner was placed on small wooden plate, fixed in a stand at a height of approximate 170 cm in the centre of the test chamber. The particle counter sampling probe was mounted at a height of 1.5 m above floor level in the test chamber. By using a HEPA filter the test chamber air was cleaned. When a suitable background particle level was achieved the HEPA filter fan was turned off. Tobacco smoke was produced by lighting a cigarette, the cigarette was burning naturally (non-forced). Four circulation fans were turned on to mix the air in the chamber.

SP Technical Research Institute of Sweden

Postal address
SP
Box 857
SE-501 15 BORÅS
Sweden

Office location
Västeråsen
Brinellgatan 4
SE-504 62 BORÅS

Phone / Fax / E-mail
+46 10 516 50 00
+46 33 13 55 02
info@sp.se

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When the cigarette had provided a required initial particle concentration in the chamber, it was extinguished. The level of the particle concentration in the chamber was adapted to fit the particle concentration limits of the optical particle counter, including a diluter, used for the tests. The air in the chamber was mixed for 2-3 minutes after the initial concentration was reached. The circulation fans were switched off, the concentration was stabilized, and the air cleaner was started.

The measurement started two minutes after starting the air cleaner. Temperature and humidity was measured before the test was started, the relative humidity was adjusted before the test with help of a humidifier. The natural rate of particle decay in the test chamber, i.e. without the air cleaner being in operation, was also measured.

Particle size was measured for particle above 0.3 μm .

The calculation of decay rate is based on the following formula:

$$C_t = C_i \cdot e^{-k \cdot t}$$

Where:

C_t = Concentration at time

C_i = Initial concentration

k = Decay rate constant [$1/\text{m}^3$]

t = Time [h]

The decay rate constant is obtained using the linear regression on $\ln C_i$ and t

The calculation of the effective cleaning rate is:

$$CADR = V \cdot (k_e - k_n)$$

Where:

$CADR$ = Clean air delivery rate [m^3/h]

V = Room volume [m^3]

k_e = Total decay rate constant

k_n = Natural decay rate constant

$CADR$ was measured during the first half hour of measurement.

The operating voltage was 230 V.

The energy consumption was measured during the test.

Results

The results are presented in table 1 (CADR) and in appendix 1 (Reduction of particles). CADR are presented in the range of 0.3-0.5 μm , 0.5-1, 1-5 μm and total amount of particles above 0.3 μm .

Table 1. CADR

Setup	T	RH	P_{tot}	CADR			
	$^{\circ}\text{C}$	%	mbar	m^3/h			
				0.3-0.5 μm	0.5-1 μm	1-5 μm	> 0.3 μm
Without fan	22 - 22.3	51.8 - 53.5	998.2 - 999.2	10.6	11.6	7.7	10.7
With fan	21.6 - 22.2	37 - 54.7	1000.1 - 1004.8	13.8	17.3	11.6	14.2

T = Temperature

RH = Relative humidity

P_{tot} = Atmospheric pressure

The energy consumption was measured to 1.98- 2.02 W.

Note that the results given in this report relate only to the actual specific item tested.

Measurement equipment

Temperature- and humidity meter, Testo 635

Multimeter, Metrahit

Diluter, Topas Dil 550

Particle counter Lasair II 310A

Air velocity meter, Testo 435-2

SPs inventory number 900 066

SPs inventory number 901 452

SPs inventory number 202 486

SPs inventory number 201 389

SPs inventory number 900 067

Estimated uncertainties of measurement

Relative humidity $\pm 3\%$ -RH

Temperature $\pm 1\text{ }^{\circ}\text{C}$

Voltage $\pm 0.5\%$

Energy consumption $\pm 5\%$

CADR $< 10\%$

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

Performed by

Examined by

Tobias Eriksson

Markus Alsbjör

Appendices

1. Reduction of airborne particles.
2. Picture of the test item.

Appendix 1

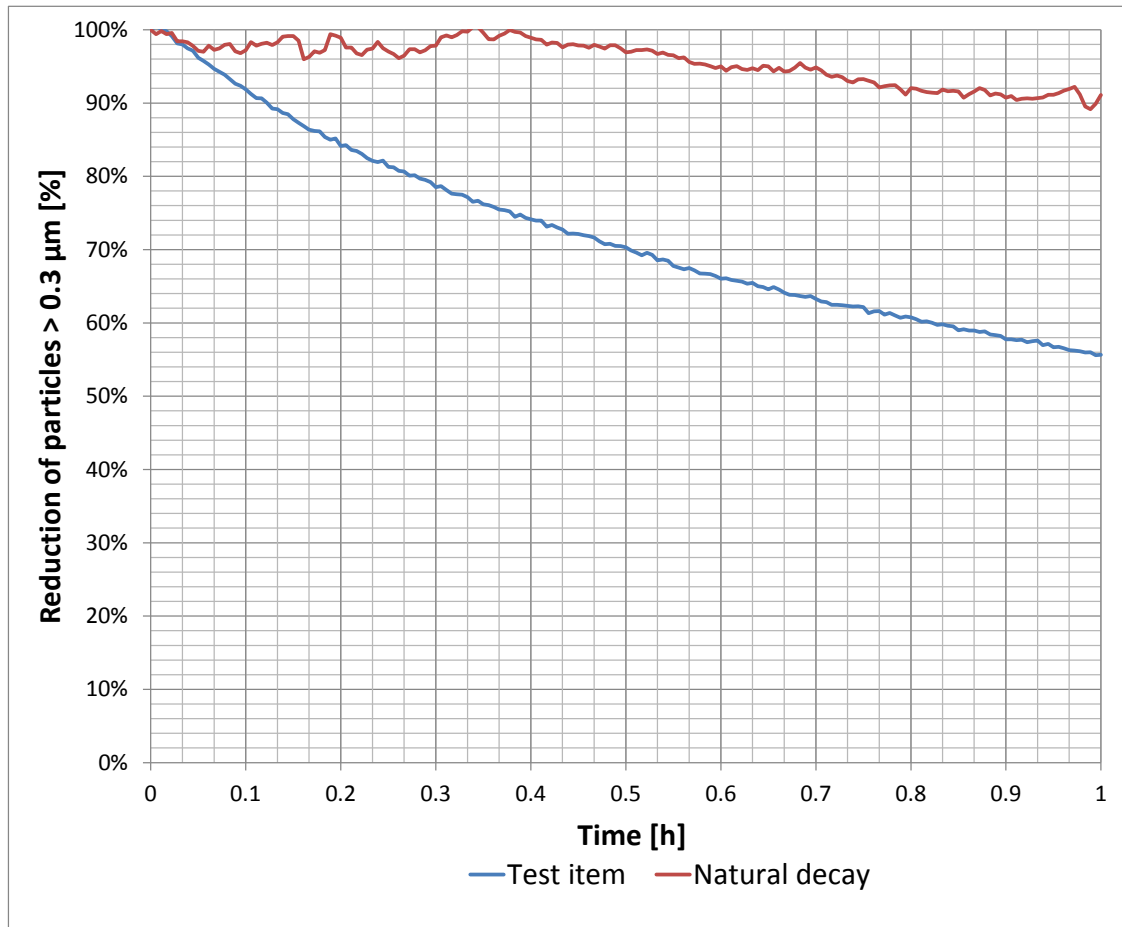


Fig 1. Reduction of particles > 0.3 µm, without a fan, during 1 hour of service.

Appendix 1

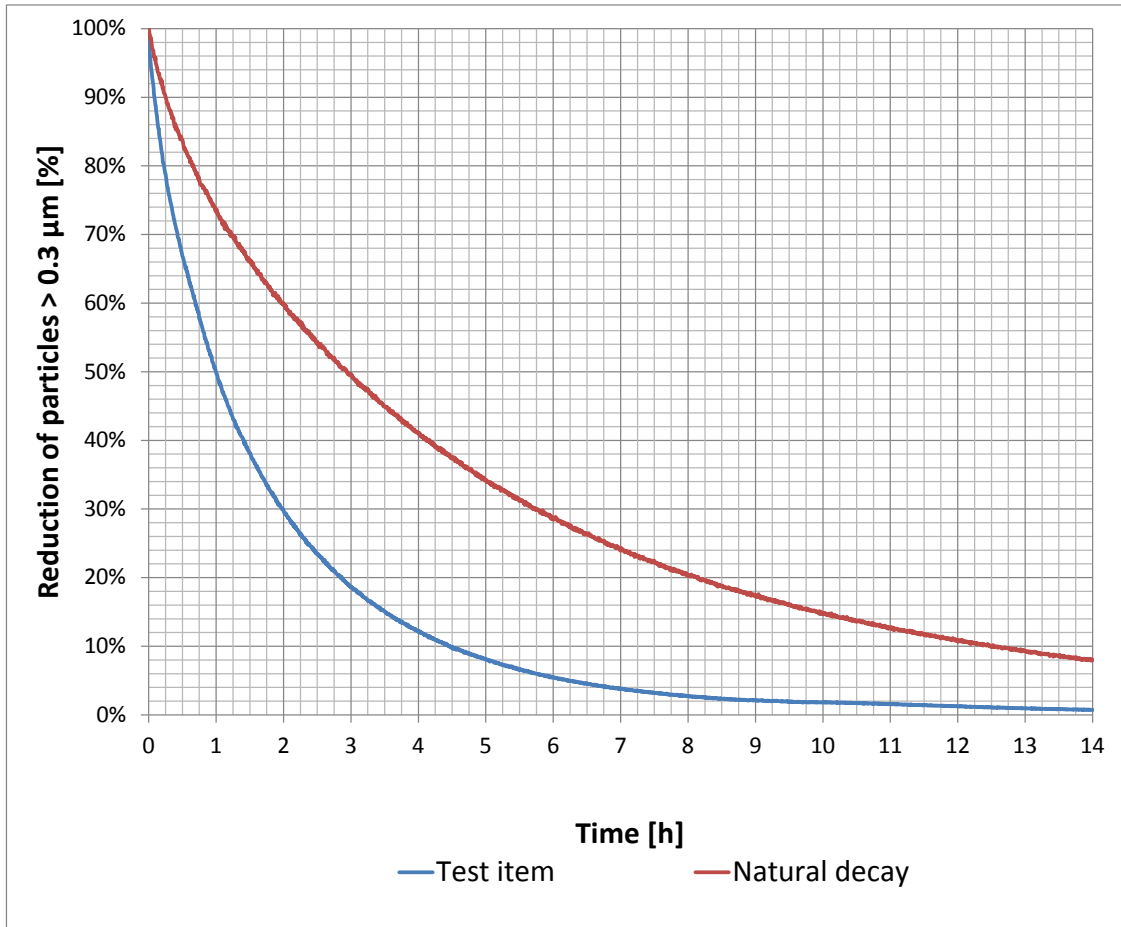


Fig 2. Reduction of particles > 0.3 μm, with a fan, during 14 hours of service.

Appendix 2



Fig 1. Overview of the air cleaner, from above.



Fig 2. Overview of the air cleaner, from beneath,