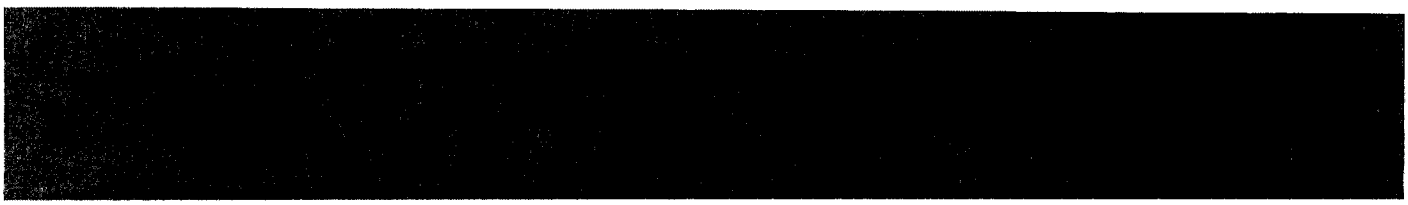
November 2005

Filter efficiency of the VisionAir air cleaner

G.P.A. Kos



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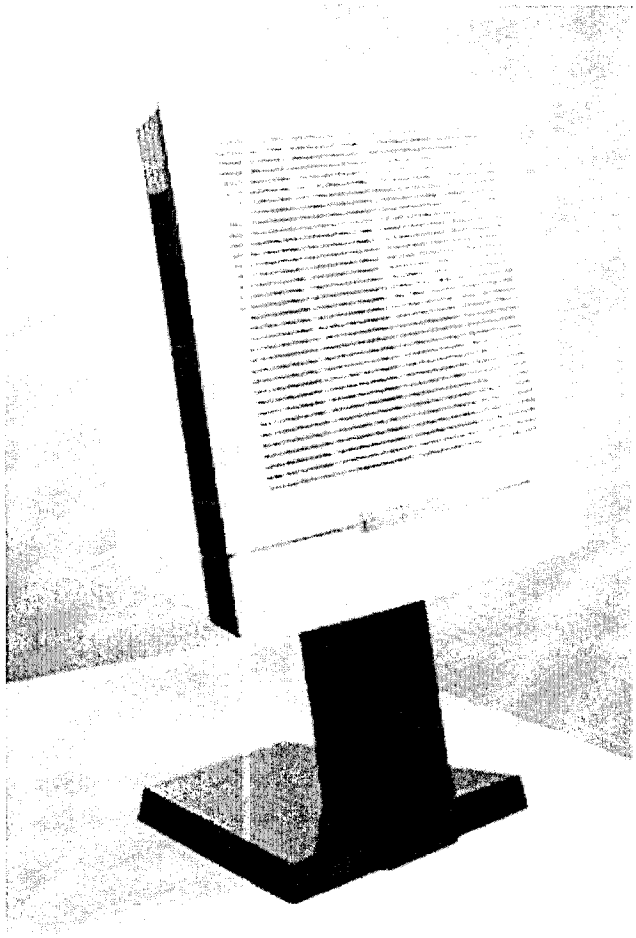

Revisions		
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1. Introduction

The particle removal efficiency of an air cleaner - the VisionAir, manufactured by Euromate B.V. - was established in the large aerosol chamber (20 m^3) at Energy Research Foundation Netherlands (ECN). The aerosol chamber is a flow through system with initially filtered air entering the chamber.

Ammonium sulphate aerosol was generated in such quantities that efficiencies up to class H14 could be verified and the number mean diameter was set at a diameter between 0.2 and 0.3 µm in order to have the ultimate challenge for the filter-unit. This very diameter is the hardest to be removed by fibre filters of the type installed in the VisionAir.

2. Description of the test facility and measuring set-up

The VisionAir was placed in the large aerosol chamber near the measuring tunnel that is in fact the exiting duct of the chamber. The entrance of the chamber is at the opposite site about three meters elevated; both ducts have an area of about 0.25 m^2. An aerosol generator - the ultra sonic generator Hico Ultrasonat 806E - was place in a tower of 1 by 1 by 3 meter that is mounted in front of the entrance. Thus the aerosol is already mixed before it enters the chamber, but will be homogenized even more while descending in the chamber towards the VisionAir. The aerosol was neutralized by a 10-mCi radioactive Kr-85 source and the temperature and humidity during the tests were respectively about 21 degrees and 60%

Above the VisionAir inlet section, inlets for intake of aerosol was mounted, in order to measure the aerosol offered to the entrance of the VisionAir leading to the Las-X.

The Las-X is an optical particle-measuring instrument of Particle Measuring Systems USA) the SMPS is delivered by TSI USA and the measurement is based on electrical mobility of the aerosol. These aerosol instruments can measure respectively from 0.1 µm up to 7.5 µm and from 0.010 µm up to 1.0 µm.

At three sides of the VisionAir the filtered air can flow out, and at one of these sides another inlet was mounted for measurement of the aerosol remaining after the air cleaner. Thus measuring the particles that were not removed by the VisionAir.

A double connection to the Las-X (inlet and outlet of the air cleaner) was connected via a three-way valve that could alternately let the flow come to the Las-X from the entrance or the exit of the VisionAir. During stable aerosol conditions Las-X was used for measuring alternately inlet and outlet aerosol concentrations, so not simultaneously but in sequence.

One difficulty remains in the measurements with the type of optical particle counters like Las-X and that is the reliability of the first channel (0.10 to 0.12 µm): in general this channel is considered as being of lower reliability, because the aerosol size is at the edge of what the instrument can - or can not - register. This means that small fluctuations in laser power, humidity or the generation of the aerosol, can lead to higher fluctuations in this channel in comparison with the other channels. Mostly this channel is discarded in delicate measurements, but in this report the results were maintained, however, should be considered as indicative only. Therefore the efficiency-result is divided in two sections, one containing the first channel and one with this channel excluded.

3. Measuring results, efficiencies

To have a better understanding of the codes used for particle filtering ability of filters, the table beneath summarizes the classes and diverse codes used by different organizations. It does not mean that a filter system necessarily should equal these classes, if a filter with such a quality is mounted: the implementation of a filter requires perfect air tight contacts of the filter with the construction and an unit might be able to produce particles itself, depending of for instance the motor used to force the air through the system.

Classification of HEPA and ULPA filters

Filter class, according to (NEN-EN 1822-1)	Average efficiency of the filter [%]	Comparable classes according to	
		EUROVENT	DIN 24183
H10	85	EU10	Q
H11	95	EU11	R
H12	99.5	EU12	S
H13	99.95	EU13	S
H14	99.995	EU14	ST
U15	99.9995		T
U16	99.99995		U
U17	99.999995		V

The efficiencies realized with the VisionAir system as measured with the Las-X are summarized in the next tables.

The flow of the VisionAir at the different fan speeds when a HEPA 14 filter is mounted

Fan speed	m/s	m^3/hr
Low	0.05	40
Medium	0.14	107
High	0.24	180
Turbo	0.38	285

Efficiency of the VisionAir for the different fan speeds

Las-X	Total particles		Low	Medium	High	Turbo
	from	to	Efficiency	Efficiency	Efficiency	Efficiency
Total	*>0.10 µm*	*and < 10 µm*	*99.93%*	*99.91%*	*99.93%*	*99.95%*
Total	>0.12 µm	and < 10 µm	99.95%	99.94%	99.95%	99.96%

As can be derived from the tables above, the filter efficiency is at least 99.94 %, which places the air cleaner as a whole in the H12 class in the list of efficiency classes generally used for HEPA filters.

The results can be considered in a way often used in the USA, the efficiency according to ASHRAE 52.2 legislations. An overview of these qualifications is to be found in the following table.

Classification of filter systems according to ASHRAE 52.2

ASHRAE 52.2			
		Particle size range	
MERV	3 to 10 μm	1 to 3 μm	0.3 to 1 μm
1	<20%	—	—
2	<20%	—	—
3	<20%	—	—
4	<20%	—	—
5	20-35%	—	—
6	35-50%	—	—
7	50-70%	—	—
8	>70%	—	—
9	>85%	<50%	—
10	>85%	50-65%	—
11	>85%	65-80%	—
12	>90%	>80%	—
13	>90%	>90%	<75%
14	>90%	>90%	75-85%
15	>90%	>90%	85-95%
16	>95%	>95%	>95%
17	—	—	≥99.97%
18	—	—	≥99.99%
19	—	—	≥99.999%
20	—	—	≥99.9999%

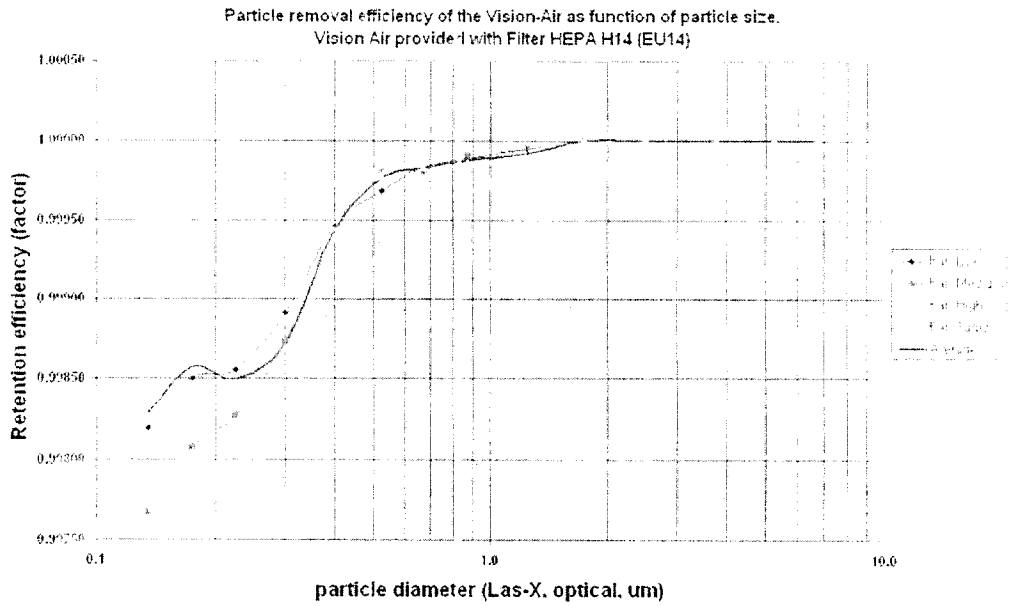
The validity of the VisionAir following these MERV-standards is summarized below.

VisionAir qualification according to MERV

VisionAir	Particle size range			ASHREA 52.2
Fan speed	3 to 10 μm	1 to 3 μm	0.3 to 1 μm	MERV
Low	100.000%	99.998%	99.88%	16
Medium	100.000%	99.998%	99.83%	16
High	100.000%	99.996%	99.88%	16
Turbo	100.000%	99.997%	99.91%	16
Average	100.000%	99.997%	99.88%	16

4. Conclusions

The VisionAir certainly meets minimal the H12 standard that is commonly used for certification of HEPA filters. It meets at least MERV 16 and even in the Lower performance does not necessarily mean that the filter is of a lower quality than labelled: it might be the result of tiny leaks along the filter there where it is expected to be air tight mounted.



The efficiency according to Las-X