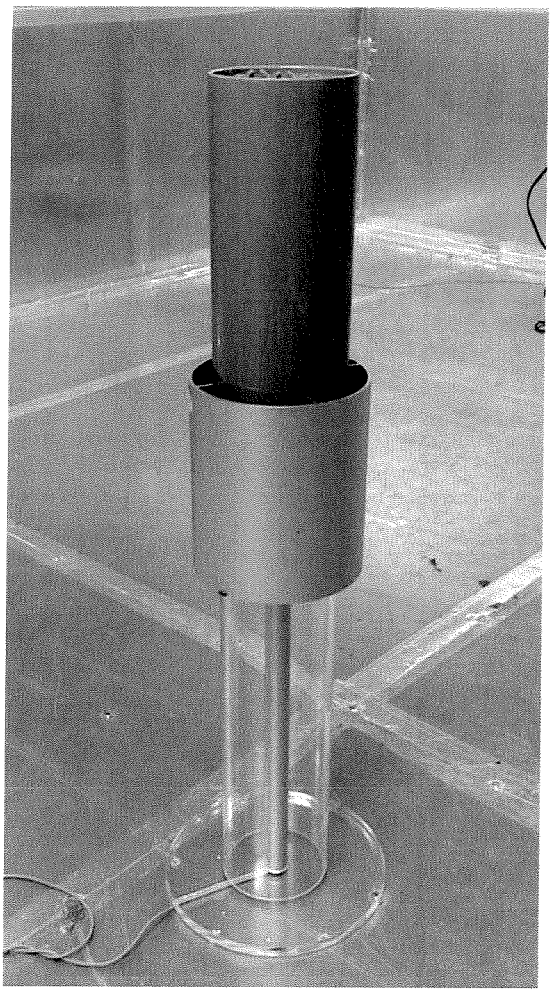

Efficiency of the LightAir-ionizer

Requested by: LightAir AB

Requested by	LightAir AB Urheilupuistontie 21 C 10 FIN-21870 RIIHIKOSKI
Order	Discussions Hannu Salminen/Matti Lehtimäki, e-mail order 15.10.2007
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Efficiency of the LightAir-ionizer

Aim of the study

The aim of the study was to clarify the efficiency of LightAir ionizer for fine particles in indoor air. Besides this, the study also aimed at clarifying the efficiency in relation to the efficiencies of conventional room air cleaners.

Devices

The study was made by using the following devices:

- air ionizer (Ionflow 50, LightAir Ab Sweden)
- room air cleaner #A,
- room air cleaner #B,
- room air cleaner #C and
- room air cleaner #D.

The room air cleaners have been treated anonymously in this study, i.e. they have been marked as #A, #B, #C and #D. This is due to the fact that this study did not deal with all relevant properties of the room air cleaners.

Test method

The air cleaning performance of the devices were measured in a 35 m^3 test room by using so called decay method and fine KCl (potassium chloride) aerosol. The measurement results were used to determine the clean air delivery rate (CADR) for each device.

The details of the measurement methods are discussed in Appendix 1.

Limitations

This study includes two major limitations. Firstly, the measurements were focused at very fine particles only (estimated size range 0.02-0.03 µm). Secondly, the room air cleaners were operated at the lowest air speed because the study aimed at the comparison of devices at lowest possible noise level.

Because of these limitations, the results cannot be generalized, i.e. the performances of the devices for larger particles may differ from the results obtained in this study. In addition, it is very probable that the efficiencies of the room air cleaners are higher when operated at higher air flow rates.

Results

According to the study, the CADR value (size range 0.02-0.03 µm) of the LightAir ionizer used in this work was 36 dm^3/s. The corresponding values obtained with the room air cleaners varied in the range 7.7 – 24 dm^3/s.

More detailed results are presented in Appendix 1.

Discussion

According to the results, the LightAir ionizer used in this study removed fine particles from the room air more effectively than the room air cleaners operated at their lowest air speed settings.

This is an unofficial translation of the Finnish research report VTT-S-00553-08. In case of interpretation disputes the Finnish research report applies.

Tampere, 15.02.08

Senior research scientist — Arto Säämänen

Chief research scientist — Matti Lehtimäki

APPENDICES

Appendix 1: Measurement methods and results

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Appendix 1: Measurement methods and results

1 Measurement methods

The next chapters present a short description of the measurement methods which were used in this study. The primary target of the measurements was the air cleaning performances of different air cleaning devices. In the case of LightAir ionizer, the experiments were supplemented with the measurement of electric field and the high voltages of the device.

1.1 Clean air delivery rate

Clean air delivery rate CADR is a quantity which illustrates the air cleaning performance of an air cleaning device. CADR is equal to the air flow rate which fulfils the following requirements

- the air flow is completely free of the impurities under consideration
- the air flow becomes completely mixed to the space under consideration
- the air flow provides equal air cleaning effect as the air cleaner under consideration.

In practice, the CADR value is determined as follows:

- test room is filled with test particles
- the concentration decay is measured as a function of time
- the concentration decay characteristics is used to determine the corresponding CADR value

1.2 Test arrangement

The measurements were made in 35 m^3 test room with electrically conductive surfaces. The room was equipped with a ventilation which provided HEPA filtered air flow 4.9 dm^3/s corresponding to the air change rate of 0.5 1/h. With this air flow, a slight positive pressure was generated inside the room in order to eliminate all disturbing leakage air flows. The room was also equipped with a reference air cleaner, i.e. combination of a HEPA filter and a fan, which made it possible to generate an air flow which corresponds to the CADR value of 45 dm^3/s. This device was used to clean the room air from particles prior starting of a new measurement. In addition, this device was used as a reference air cleaner which were used to check the proper functioning of the measurement system.

The measurements were made with potassium chloride aerosol which was produced with a pneumatic aerosol generator. The aerosol was generated from a dilute KCl solution. The solution was made by including a tiny amount of potassium chloride in distilled water (0.1 g/dm^3). The KCl particles which were formed from the droplets after the water evaporated, were led into the test room via Kr^{85} aerosol neutralizer. This guaranteed that the test particles did not carry any significant net electric charge. The duration of the particle generation in each test was 15 min.

The concentration of particles was measured with a PORTACOUNT condensation particle counter. The characteristic feature of this device is that it measures particle number concentration in the size range above 0.02 µm (approximately). The number size distribution of the test particles was biased strongly towards the lower size limit of the instrument. This means that the results obtained with the condensation particle counter illustrate the performance of the air cleaners for particles in a relatively narrow size range close to the lower size limit of the instrument, i.e. size range of 0.02-0.03 µm.

The measurement set-up included a sampling system which was used to direct the sample air flow periodically through a HEPA filter. This arrangement was used to check that the instrument provided zero readings from clean air, i.e. it guaranteed the reliable operation of the condensation particle counter.

1.3 Voltages and electric field

The air cleaning performance of the LightAir ionizer depends on the ionizing and collection voltages. Therefore, the study included measurements which provided information about the most important electrical properties. No information about the voltages of the LightAir ionizer were available and it was realized that these voltages cannot be reliably measured with conventional techniques. Therefore, a special test set-up was constructed to allow voltage measurements without causing any practical load for the high-voltage electronics. This required a test device with an extremely high input resistance and a tolerance of very high voltages. The measurement was accomplished with the combination of ELTEX electric field meter and a special high-voltage probe.

The voltage measurements were observed to be quite complicated because several hours were required before the voltages reached steady-state condition. Some complexity was also caused by the fact that separate measurements were needed for the ionizer voltage and the collection voltage, i.e. the simultaneous measurement of both voltages was not possible.

The voltage measurements were supplemented with electric field measurements made with ELTEX field meter. The electric field generated by an air ionizer can be quite complicated and it depends on the location in the room. In this study, the measurements were limited to determine the electric field at the transversal distance of 1 m from the ionizing electrodes. The purpose of this measurement was to provide a result which illustrates the operation of the ionizer and makes it possible to exactly specify the test conditions.

1.4 Limitations

As mentioned above, the study was focused to a very finely dispersed particles only. The air cleaning performance of air ionizers and some room air cleaners may, however, depend on the particle size. Therefore, the results of this study cannot be generalized because they illustrate the air cleaning performance in a very narrow particle size range only. It is probable that if the work was focused to 0.1, 1 or 10 µm particles, the performance values would differ from those obtained in this study

One of the starting points defined by the orderer of this study, was to compare the performance of the LightAir-ionizer with the performance of conventional room air cleaners. Another starting point defined by the orderer, was the test condition where air is cleaned at very low noise level, i.e. room air cleaners were operated at their lowest air speed settings. Thus, it is probable that if the room air cleaners were operated at higher air speed settings, the performance ratings would have differed significantly from those reported in this study.

2 Summary of the results

2.1 Clean air delivery rate

A summary of the CADR values determined from the decay curves are shown in Figure 1. The bar diagram in this figure shows the CADR value for each device. This figure also shows the CADR value which corresponds to the situation in an empty room, i.e. without any air cleaning device. This CADR

value is due to the ventilation rate of the test room 4,9 dm³/s, and the deposition of particles on the surfaces of the room. According to the measurements, the baseline CADR value corresponding to the empty room was approximately 7,3 dm³/s.

In principle, the baseline CADR value corresponding to the empty room condition should be subtracted from all test results in order to obtain the true CADR values for each air cleaning device. In practice, however, particle deposition on the surfaces may depend on many factors (including air turbulence in the room) and it is difficult to determine the exact baseline CADR value. Therefore, only the contribution due to the ventilation rate 4,9 dm³/s, has been subtracted from the test results. Figure 1 shows the total CADR values for each case and the corresponding values after subtraction of the CADR value due to the ventilation air flow.

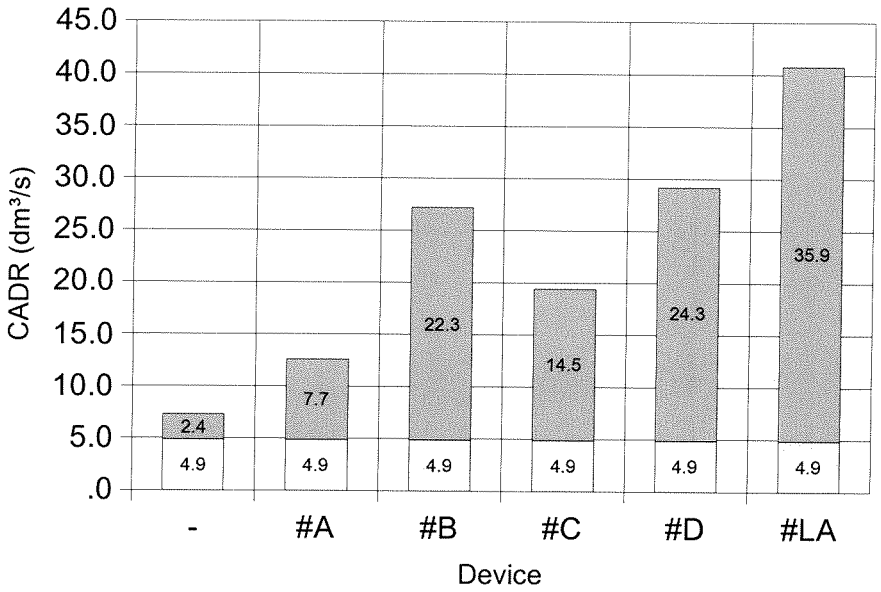

Figure 1: CADR values (estimated size range 0.02-0.03 µm) for empty room (-), room air cleaners (#A, #B, #C and #D) and LightAir ionizer (#LA).

2.2 Voltages and electric field

According to the measurements, the electric field generated by the LightAir ionizer at the distance of 1 m was approximately -4 kV/m immediately after the ionizer was switched on. The electric field changed with time so that after one hour, the electric field was approximately -10 kV/m.

The ionizer voltage immediately after the device was switched on was approximately -9 kV. This was followed by a change in the voltage so that after one hour, voltage had reached the level of -13 kV.

The collection voltage immediately after the device was switched on, was approximately +14 kV. Then, a slight decrease of voltage took place so that after one hour, voltage settled to the level of +13 kV.