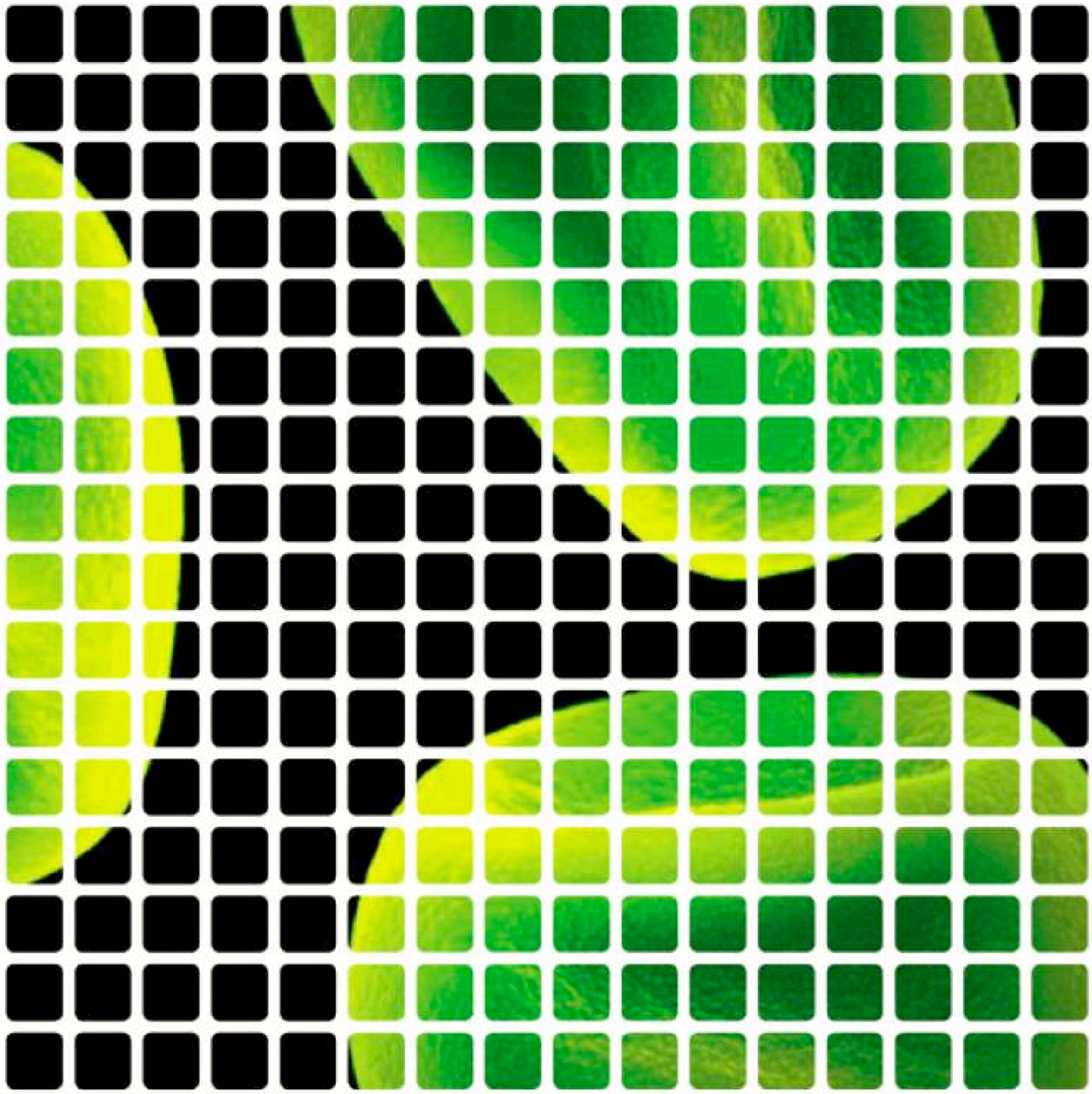
Reduction Test for particle decrease



Reduction Test of LightAir ionizing air cleaner

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Date: 2005 03 25

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SUMMARY

LightAir is a good ionizing air cleaner with collector. It cleans well across all particle sizes, which is unusual for this type of air cleaning. LightAir cleans the air very well within the smallest particle spectrum that can enter the lower parts of the lungs (which causes the most severe health problems). The results of this particle reduction test are consistently good considering the ionizing technique. Even in comparison with Ulpa filters and other mechanical filters the cleaning is good. LightAir handles the larger particles that stay in the upper part of the respiratory organs more than well, which is surprising. This is also a very good quality aspect since larger particles often settle very quickly and therefore never reach the collector. After the test we could clearly see a thin layer of dust on the collector.

TEST CONDITIONS

Test leader Anders Hedström from NIAQ (Nordic Institute for Air Quality) carried out the test of the LightAir ionizing air cleaner. This LightAir air cleaner was of table top/floor type with a round acrylic transparent foot and decorative LED lights.
The test was conducted as a 20 minutes particle reduction test in a 7,5 m2 office room with a window and normal ventilation outlet/inlet. Normal activities were carried out in the surrounding office (computer, fax, telephone, dustbin, etc.). During the actual test the door to the office room was closed to receive reliable test results.
The LightAir air cleaner was placed on a sideboard at around a 100 cm height. All the testing instruments were also placed in the room. The test leader gathered information on the air quality in the room before the LightAir air cleaner was put on and after. He also informed and illustrated to the rest of the group how the test was going to be carried out.

METHOD

The first part of the test was a 10 minutes reference measure (see appendix) that shows how the air quality was before the air cleaner was turned on. After the 10 minutes had passed the air cleaner was put on and the particle reduction test was running for 20 minutes.
The test was conducted with particle counter OPC, CPC, ozone counter and a mass counter that measures what types of particles the tested air contains. This real time test was carried out with all the different measuring techniques correlated. The reason for this was to receive a clear picture of what particles LightAir air cleaner was good or less good at eliminating.

CONCLUSION

LightAir has a very good ionizing technology. There are many advantages with this technology that mechanical air cleaning technologies do not have. The operational advantage of simplicity and good construction is only one out of many aspects giving the ionizing technology advantages before mechanic filtration. The LightAir air cleaner is also completely free from ozone production, which is very unusual, almost unique, for any ionizing air cleaning devices.
There are possibly some disadvantages with ionizing technology. We are not sure today what effect charged particles could have on our mucous membranes. There are also some question marks about how these ionizing devices handle bacteria that cannot be charged.
However the most important aspect is that the overall cleaning of the air was carried out in an impressively effective way in a normal office environment.

GENERAL INFORMATION

People in the industrialized world spend approximately 90% of their life indoors. The basic conditions for good indoor air quality is clean air, not to be mistaken for fresh air. Fresh air is what we call the air that enters through the ventilation system from the outside. To get clean and healthy air you need highly effective air cleaning is required.

The ultra fine particles composed of extremely small components create new, unknown air environments that are very difficult to analyze. The scientific know-how dealing with these environments and particles is complicated, but we know today that these particles cause many of our respiratory problems. Especially the smallest particles that enter all the way in to the alveolus in the lungs where they cause damages and long-term illness like allergy, asthma, lung cancer and also heart and vascular deceases

Short-term health effects can occur in terms of tiredness, headache, respiratory infections, skin and eye problems.

The fixed ventilation systems in buildings are necessary to supply oxygen and extract humidity and other materials. Ventilation filter systems can however not eliminate all particles, especially not the smallest and most harmful ones. An effective gas cleaning or chemical cleaning is not economically reasonable in a ventilation system.

AIRBORNE PARTICLES

From extensive research of air pollution in the outdoor air and large epidemical studies we know that there is a very strong correlation between particle levels and health. The correlation is bigger for small particles (<2,5 mm) than for larger. Already at very low levels of dust outdoors (>15 mg/m3) can negative health effects can be proven.

If our airways and lungs are exposed to high levels of ultra fine particles (0,01-0,1 mm) inflammatory lung deceases can occur. The ultra fine particles pass through our own cleaning/protection system of mucous that normally protects us and eliminates air pollution from the airways. When the ultra fine particles enter the lung tissue in the most sensitive parts of the lung, they trigger substances to oxide and stimulate the production of enzymes that destroys the cell permanently. The ultra fine particles also enter the bloodstream, which causes heart and vascular decease (see appendix 4, Small particles – Big Problem, Vicky Stone and Ken Donaldson, Napier University, Edinburgh)

EPA (US Environmental Protection Agency) has put together a collection of extensive scientific reports that shows that particles are dangerous to our health (see Appendix 5, Selected Key studies on particulate matter and health, 1997-2001).

More than 800 scientific reports have been published since 1996 in this area, partly due to increased allowance from EPA for these kinds of studies. A summary of these reports confirms the correlation between particle pollution and deceases, sickness, hospital visits and early death. The most important points in the reports are:

- Important long term studies are now fully confirmed and validated
- New short term studies confirm cause of death
- New analysis show that a life can be shortened by months and years rather than days due to particle pollution
- Recent studies on test animals and people have shown heart related problems due to particle pollution, which can explain the biological mechanisms leading to death.

ASTHMA SYMPTOMS AND ALLERGIES

Respiratory asthma is a common, often life long and sometimes life threatening decease. During the last decennium several reports have shown the increase of asthma in many countries, mostly among the younger part of the population (Allergy investigation, 1989, Burnley and more, 1990, Magnus and more, 1991). It has been proven that even low levels of organic substances that are normally in indoor air can cause inflammatory reactions in the upper respiratory system (Koren and more, 1992). And the correlation between asthma related symptoms and VOC-levels at home has been proven (Norbäck and more, 1995) as well as the correlation between asthma and mould (Burr and more, 1988). It has been suggested that environmental aspects that can cause inflammation in the respiratory system could be one of the reasons for the increased level of people suffering from asthma (Allergy Investigation, 1989).

INCREASING INTEREST FOR INDOOR AIR QUALITY AMONG THE PUBLIC

The proportion of the Swedish population who believe that the indoor environment is important for the health is 60-70% and it gradually increases according to the Peoples Health Institute (1999). The same report shows that dry air, dust/dirt and noise are among the problems that are mostly mentioned and that people who are seldom outdoors are more sensitive to allergies and asthma.

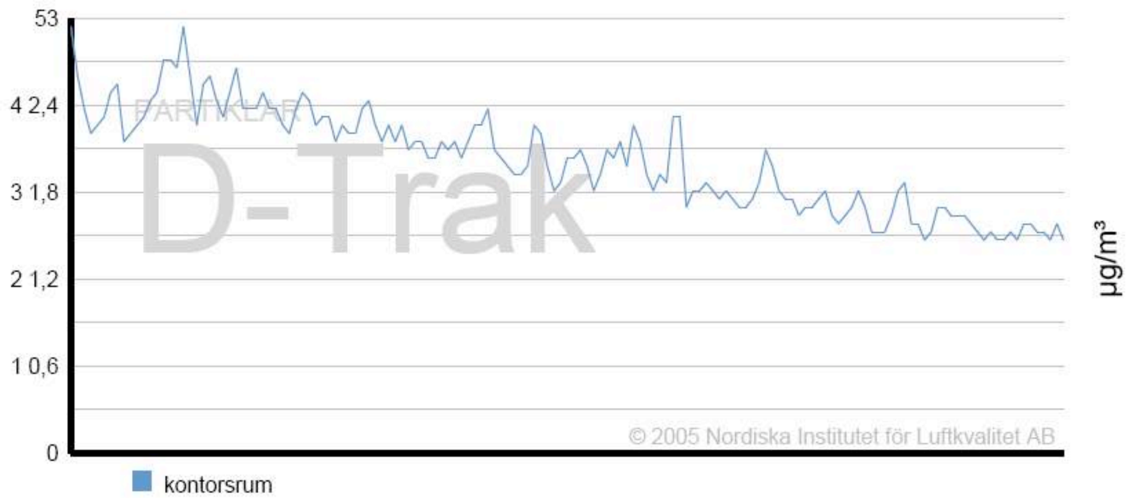
PASSIVE SMOKING

One of the major known indoor air pollution is tobacco smoke. An increased level of respiratory infections leading to pneumonia or bronchitis has been confirmed for people who are affected by passive smoking (Sundell J, Kjellman M, 1995). And passive smoking is a very common background cause for children developing asthma.

THE IMPORTANCE OF HOUSE CLEANING FOR INDOOR AIR ENVIRONMENT

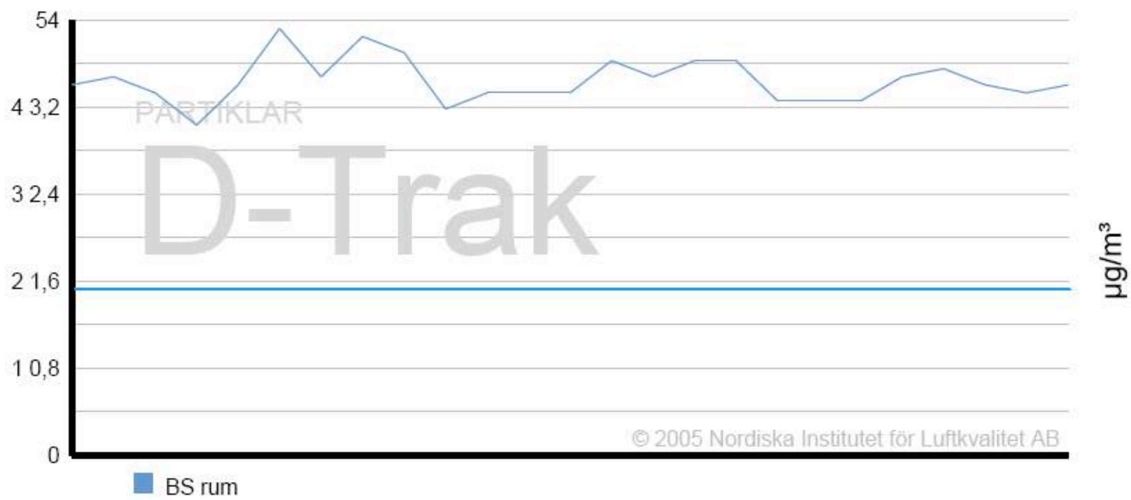
I is well known since many years that house cleaning is of great importance to the indoor environment. Dust and particles indoors emanate from materials in the building, like for example from wearing down floors and carpets, isolation material etc. (Lundqvist, 1986). But most of the indoor dust is created by people and their activities. Dust indoors in non-industrial premises generally consists of fibers from clothes, allergens from animal fur, food remainders and paper (Lundqvist, 1986). Some dust particles, like animal fur, we carry with us from other environments (Munir and more, 1993). Particles, especially the ultra fine ones are from cooking, smoking, vacuum cleaning etc. These particles are often carriers of allergens and trace elements. Dust can also be a carrier of different chemical pollutants from industrial activities and building/interior materials. Dust contains microorganisms like virus, bacteria and mould, which can grow in parts of buildings where temperature and humidity are favorable and be spread by people. This risk will increase if cleaning is not done properly.

Test Results & References of LightAir ionizing air cleaner

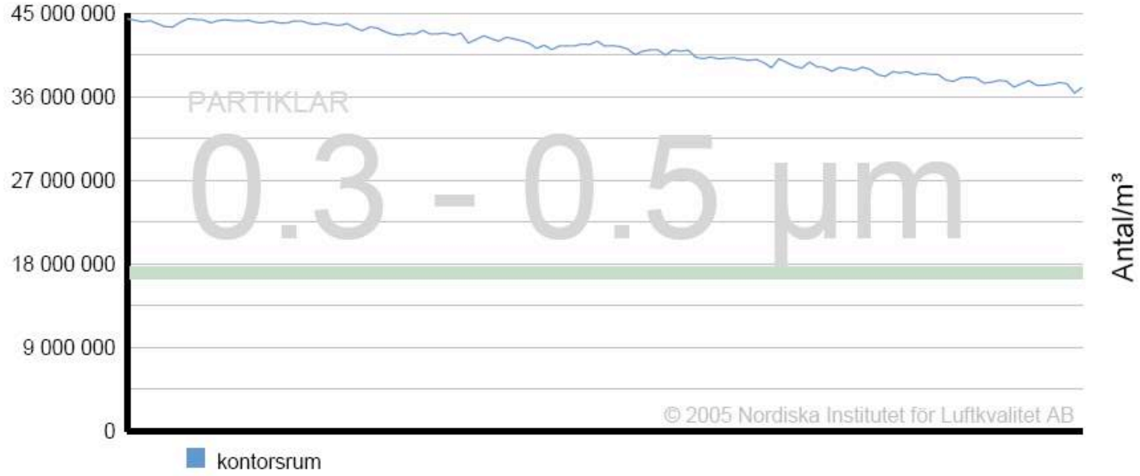


Here we can observe the mass of particles in the air, especially the larger ones. We can see that the particle content of 50 µg/m3 in 20 minutes has been reduced to a level of 25 µg/m3 meaning a mass reduction of 50% which is a very good result. The reason is the efficient collaboration in between the ionizer and the collector and how the voltage affects the air. The efficiency of an ionizer is mostly due to the sharpness of the corona and also the created electrical charge. 20 µg/m3 is considered a low value

Reference:

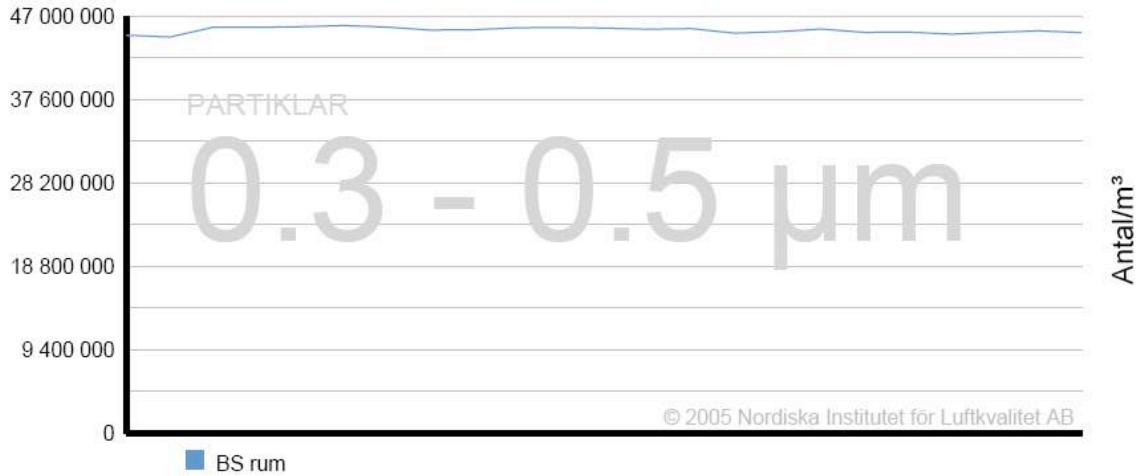


The upper graph shows the reference result that was taken before the reduction test. The graph below shows the average result after 19 minutes of cleaning. As one can see there is a clear improvement within this particle spectrum after cleaning.

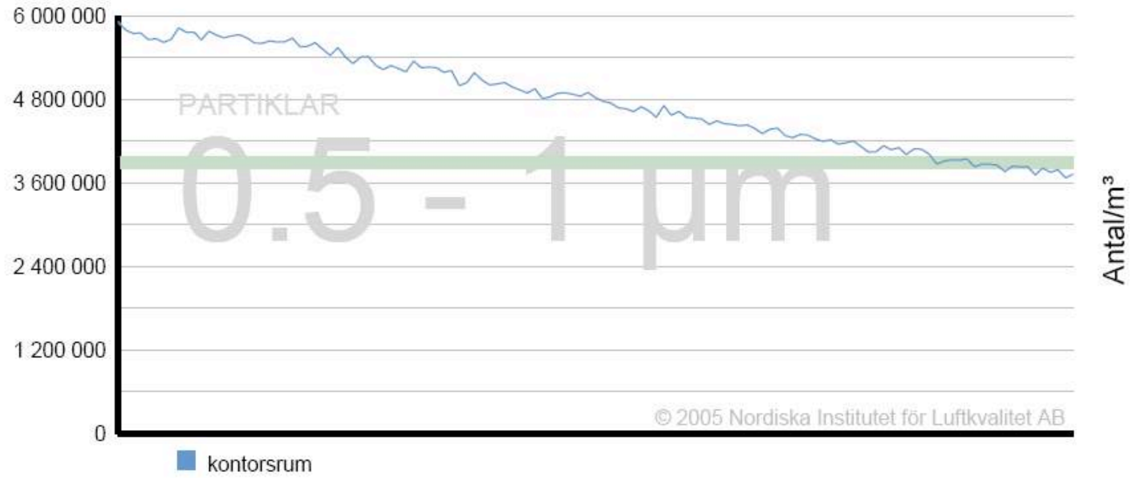


Here we observe the particles which are the most difficult to catch in a conventional mechanical filter. The gray line is the average of normal air. This particle spectrum stays rather constant. The cleaning is about 6,85%, which seems not to be very good. It is however important to understand that this technology makes smaller particles cluster and agglomerate into larger size particles that are continuously refilling this particular spectrum. Enormous volumes of nano particles cluster and aggregate into larger particles so what we see in the graph is the result of the reduction of particles of this size and the simultaneous creation of particles of the same size meaning a drastic reduction of smaller size particles. Therefore to still reach a reduction of 6,85% is in fact very good. Within this particle spectrum there are many controlled tests since mechanical filter have difficulties to trap particles of this size. However these particles are considered not very dangerous to our health as our defense mechanism can handle them effectively.

<u>Reference:</u>

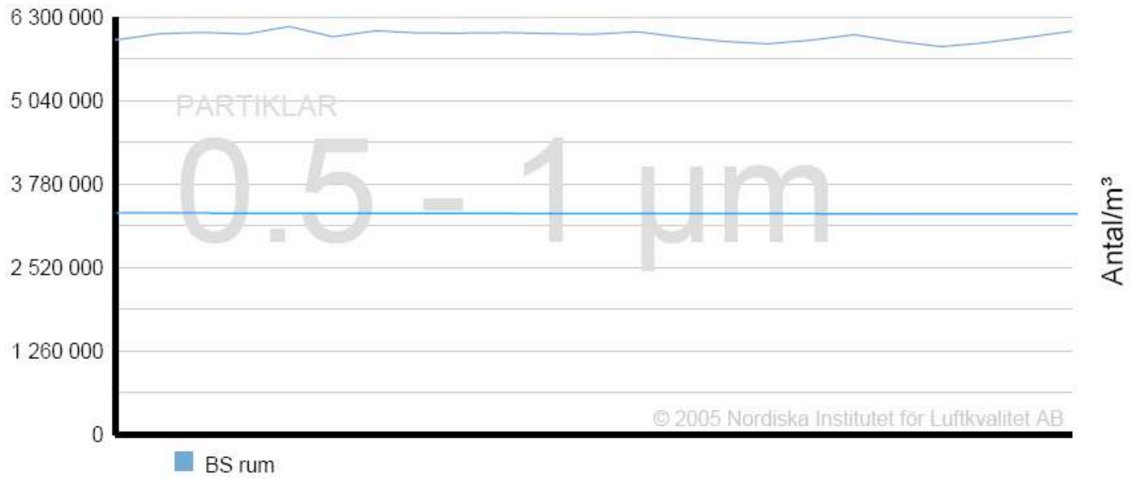


This particle size show that the ionizing air cleaner does not reduce particles, but creates new larger particles of the small particles tested. The reason for this result is that the nano particles tend to agglomerate to larger particles. The bigger particles are however less harmful to humans. The result after cleaning was 40.000.000 particles/m3.

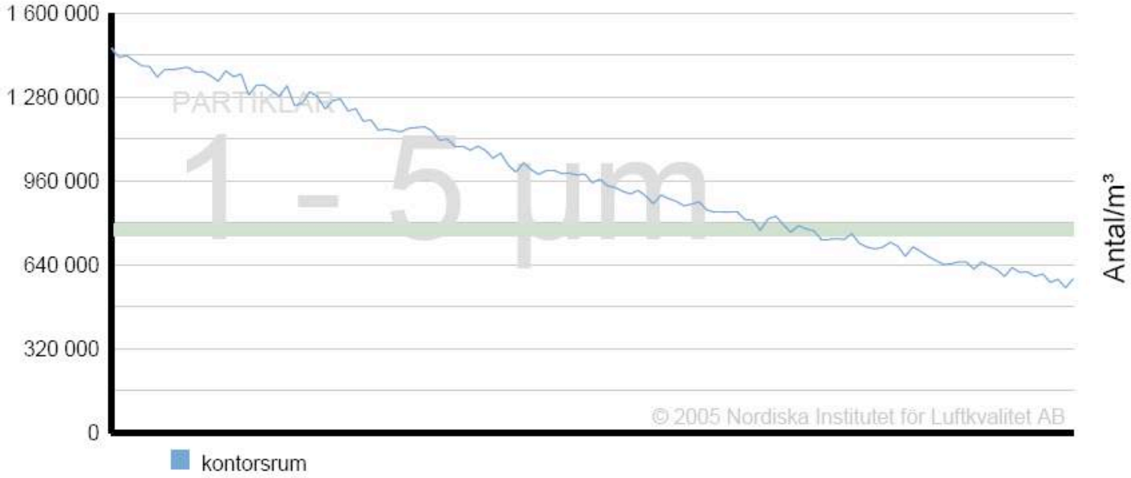


Even in this particle spectrum there are particles that can be inhaled and cause problems but they generally get caught in the upper respiratory system and do not reach all the way out into the alveolus in the most sensitive parts of the lungs. The gray line shows the average of normal air in Stockholm. We can see a reduction from 6.000.000 to 3.500.000 particles per m3 meaning 47% reduction in 19 minutes. This must be considered very good as the technology creates particles also of this size from particles in the nano spectrum.

Reference:

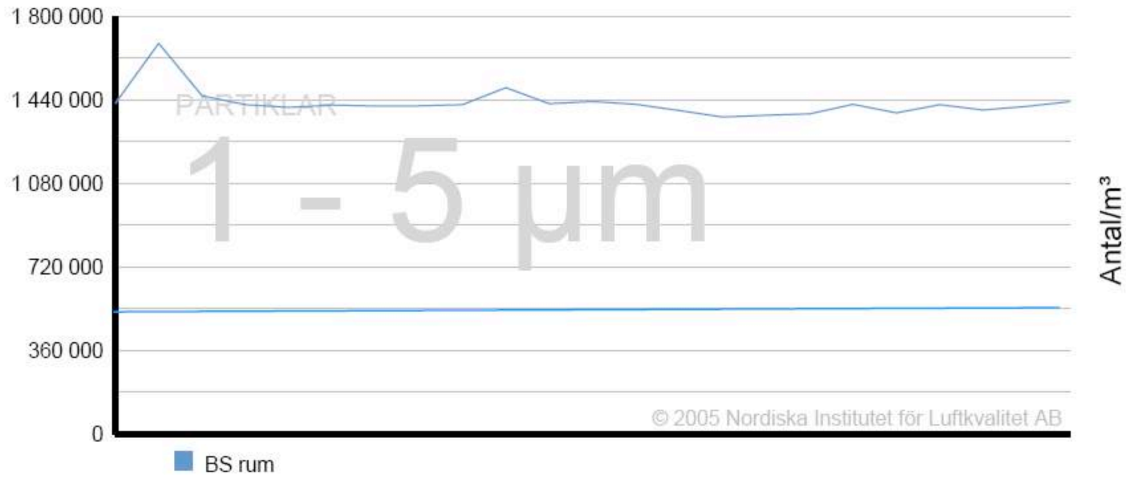


Compare the reference graph, the upper, with the reduction graph, the lower. We can see a clear reduction, which is good. This reference is very stable.

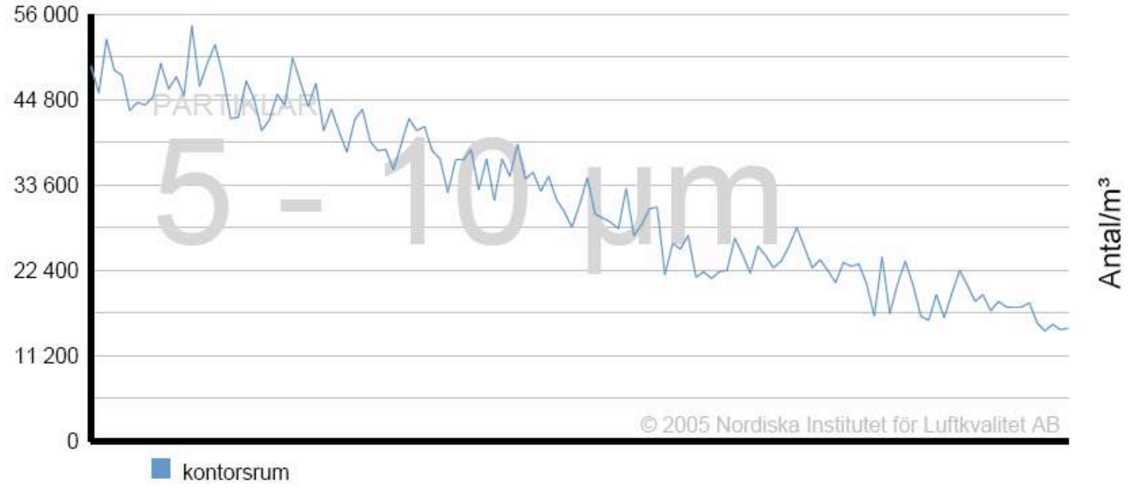


Within this particle spectrum we observe a reduction of 75%, which is good. As these particles can sediment faster than smaller particles they can be more difficult to trap for an air cleaner. The gray line shows an average of normal air in Stockholm. The ionizer continues to show a good result. Within this spectrum you will find bacteria and certain pollen.

<u>Reference:</u>

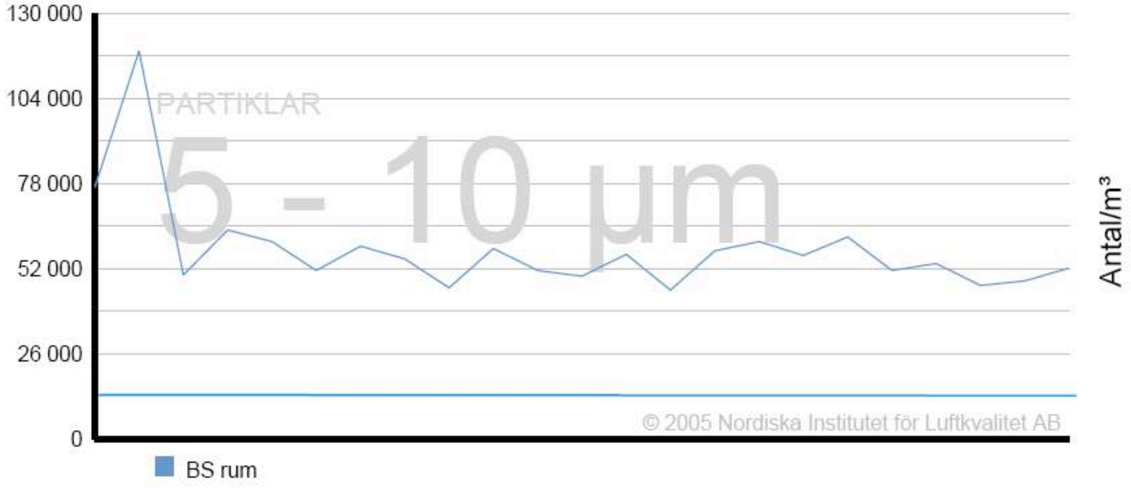


Again, we can observe a stable a apparent level where the particles are of the same number under a longer period of time.

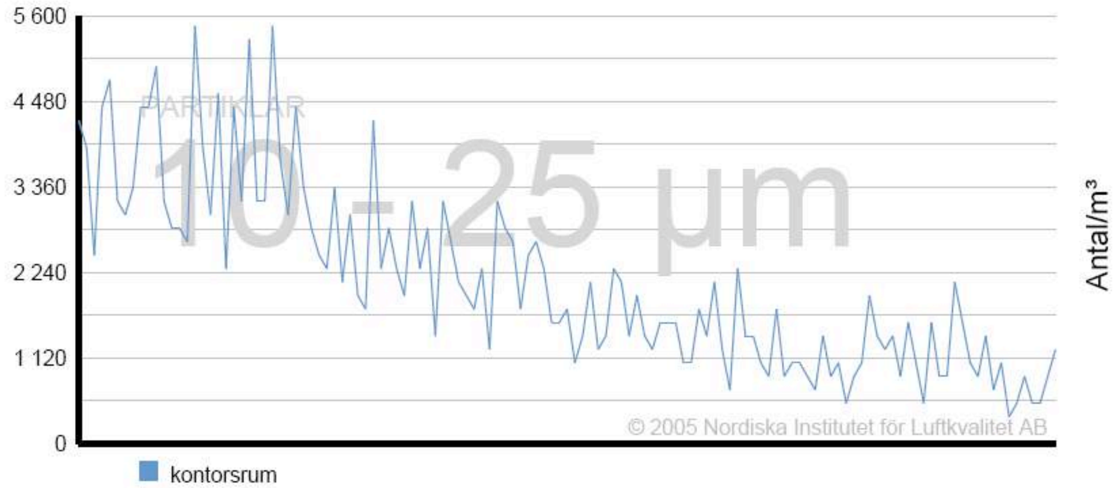


These particles are the first to be seen by the human eye. They sediment fast. We can observe that the ionizer does a good job reducing the number of particles to a level far below the average of good quality air. The reduction of 75% is very good.

<u>Reference:</u>

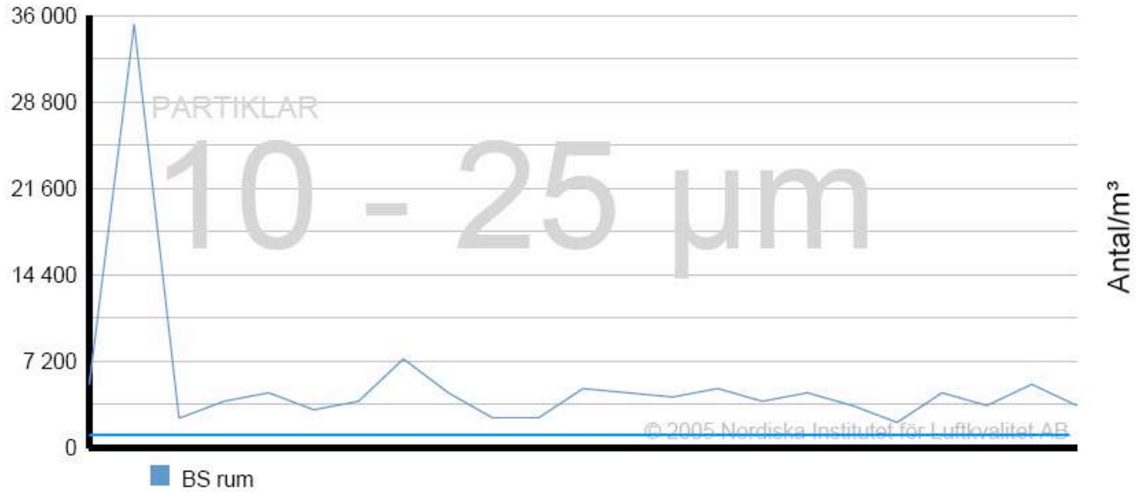


The lower graph shows result after cleaning. Again we can see that the smaller particles to some extent agglomerate. There should also be some sedimentation.

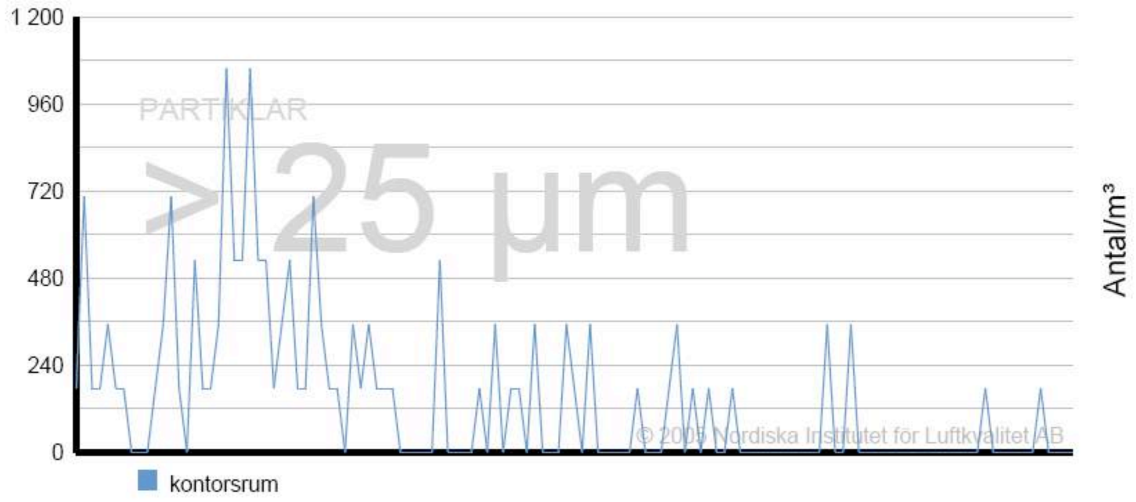


The larger particles are being reduced according to this graph proving the effect of the ionizer. Very good.

Reference:

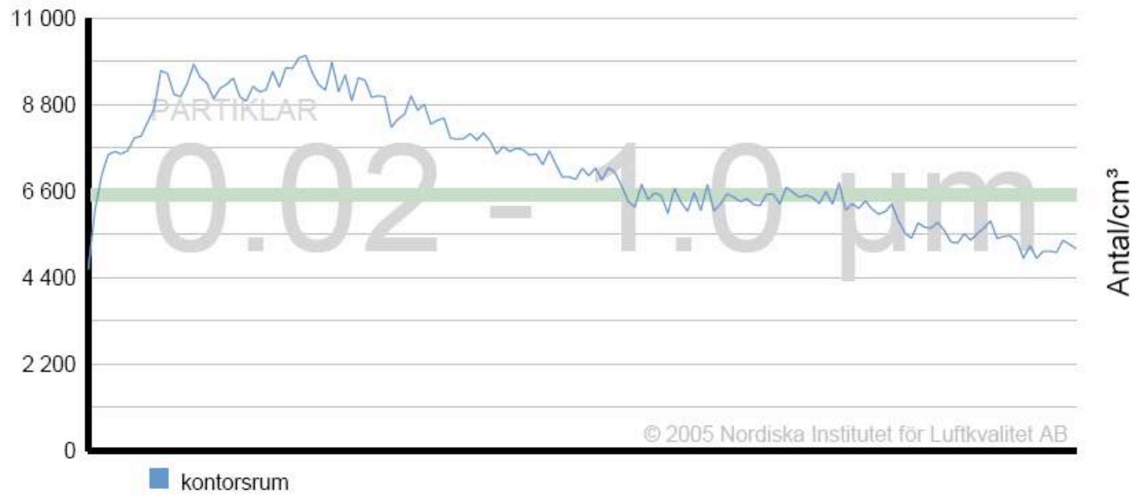


The straight lower graph shows after cleaning. Particles in this size are emitted mostly from paper and similar.



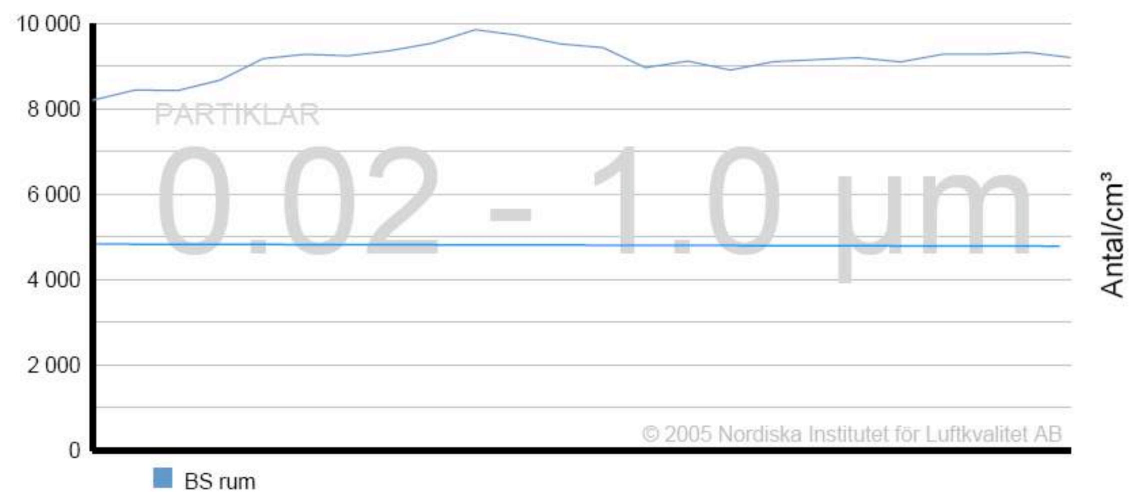
In this spectrum we see the particles meaning dust. The beginning of this graph is especially interesting as it shows the clustering of smaller into larger particles actually temporarily increasing the number of large particles in this spectrum. Then the curve drops rapidly down to almost 100% cleaning in this particle spectrum of dust. This is a remarkable and excellent result by a passive air cleaner. We can also observe that the particle level is kept low after the initial reduction.

<u>Reference:</u>



Here we observe the absolutely smallest particles in the air. These nano particles derive from car exhaust, combustion and photochemical catalytical production.
The gray line is the average of normal air in Stockholm. At the beginning of the graph there were about 9.000 particles per cm3 air, which is 9.000.000.000 per m3. Note that this is in normal office environment in Stockholm. After 20 minutes the level has been reduced to 5.000 particles per cm3, which is a reduction of 47%. The average for an office without air cleaning in Stockholm is about 7.300 particles per cm3. To be able to reach a level of 5.000 particles per cm3 when at the same time the outdoor air was measured to contain 20.000 particles per cm3 is very good In such a short period of time.

<u>Reference:</u>



The upper reference graph show high values. The lower graph show result after cleaning. Note the big difference. It is very difficult to clean within this particle spectrum since the particles are so small and the room can already be considered clean. This is a difficult test for the ionizing air cleaner, which it perform very well (Please see reduction test above).

ADDITIONAL REMARKS & COMMENTS

The decay test was carried out according to the norms of ISO 14644 clean room standard of particle testing and according to the IEST standards for testing of nano particles. The test was carried out in a normal office environment in Stockholm. The evaluation of the LightAir air cleaner has shown that it cleans the air well and does not create any byproducts like ozone. The level of ozone was measured throughout the test whereby no measurable level could be detected. NIAQ test techniques and methods are based on the Swedish Standard SS-EN ISO 14644-1, SS-EN ISO 1644-2, and IEST-G-CC1002.

Airborne Particles in Sick and Healthy Buildings

By Bengt Christensson, National Institute for Working Environment

From extensive testing and measuring of pollution in the outdoor air and extensive epidemiological studies we now know that there is a very strong correlation between particle level and health. The correlation is stronger for smaller particles (< 2,5 µm) than for larger particles. Already at very low outdoor dust levels (>15 µg/m3) negative health effects have been proven.

Particles in the air are a pollution that always exists indoors, but which has not been sufficiently studied. The air quality research indoors has often been focused on hydro carbonic gases, microorganism, formaldehyde, ammoniac, carbon dioxide and different physical parameters.

Characteristic for airborne particles is that they exist in different sizes from hundredths part to tenths part of a micrometer and that their measured levels of particles (both as numbers and mass per volume) are highly dependent on which particle size that is measured and that the occurrence varies enormously in time and space. Skin irritation, eye irritation and irritation in the upper respiratory system can be connected to the presence of particles.

During the last 10 years the National Institute for Working Environment has conducted particle tests in sick buildings and reference buildings. The purpose of the tests has been to establish the relation between health problems and particle levels as well as to establish which particle parameters are important. The purpose is also to determine how particles indoor occur and develop, that is how the mechanism of supply, production and transportation of particles in the building look like. At the moment a 3-year project is conducted in this area financed by BFR (Swedish Council for Building Research). When the result from this project is reported late this fall some of these questions that could be answered.

The report is not yet finished. It is possible that the sick buildings can be divided in at least two categories, polluted buildings and water damaged buildings. In the polluted buildings there are often an increased level of dust, especially of particles larger than 1 µm. The reason could be insufficient ventilation, lack of cleaning, defect or wrong building materials, too many people in the premises, bad judged use of premises and flaky floors. Most often it is a combination of the mentioned reasons.

Small particles (<1 µm) are mainly produced through condensation. Indoor sources could be smoking, lighting fires, candles, cooking, etc. If there are no indoor activities, the particle level is determined by outdoor sources like car exhaust, house warming, industries, etc. The capacity of the supply air filters and the volume of supply air determines how much small particles we have indoors from the outdoor air.