Blueair

Giving you cleaner, healthier air

Blueair White Paper

May 2012

The Growing Threat Of Air Pollution

The air we breathe indoors can be up to 100 times more polluted than the air outside on the street, according to the U.S. Environmental Protection Agency (EPA). Explaining how the air inside homes and workplaces is potentially harmful to human health and wellbeing, this White Paper calls on the European Commission to adopt the Clean Air Delivery Rate (CADR) system used in the USA to give consumers the chance to compare the efficiency of air cleaners and make the right choice.

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Sold in over 50 countries around the world, Blueair air purifiers deliver cleaner indoor air for enhanced user health and wellbeing in homes and offices more efficiently than any competing product. A Blueair air purifier works silently to remove allergens, asthma triggers, viruses, bacteria and other airborne pollutants from all indoor environments. Founded in 1996, Blueair has production facilities in China, Sweden and the USA. For more information about Blueair, please visit www.blueair.com.

1. Executive summary

The air we breathe in our homes or offices can be up to 100 times worse than the air outside, according to the U.S. Environmental Protection Agency (EPA).[1] With people in industrialized countries spending around 90% of their time indoors, at home, work and leisure, indoor air pollutants pose a very real threat to human health and wellbeing.

[1] http://www.epa.gov/air/basic.html

Research studies around the world have linked indoor air pollution to such health effects as headaches, respiratory problems, chronic coughs, eye irritation and lethargy. Those suffering ailments such as asthma, allergies and lung diseases are extremely vulnerable to indoor airborne pollution, as are infants that can spend almost 24 hours a day indoors during the winter months.

The threat posed by indoor air pollution is a bigger problem today than ever before even if many people believe it does not apply to them. However, there are many sources of polluted indoor air beyond emissions from traffic and industrial plants. For instance, few people spend much time thinking about the chemicals released into the air they are breathing by hairsprays, oven cleaners, pesticides, laundry aids, floor and furniture polish and even air fresheners. In addition, the way we construct buildings nowadays more efficiently in order to cut energy loss also results in reduced ventilation, which enables potential pollutants to build up.

Thankfully, there are choices consumers can make to avoid degradation of their indoor air quality. Apart from the obvious choice of controlling the source of the air pollution and ensuring fresh air ventilation, not always an easy choice in major urban areas, a simple and proven alternative is an air cleaner fitted with filters providing HEPA performance, a remedy recommended in the American Thoracic Society's American Journal of Respiratory and Critical Care Medicine.

At Blueair, we believe that everyone should have the right to breathe air as pure as nature intended. We have produced this White Paper in order to draw attention to the very real, if not broadly understood problem of indoor air pollution and the solutions that are readily available. We call on the European Commission to help Europe's consumers make the right choice by adopting the Clean Air Delivery Rate (CADR) system of comparing the efficiency of different air cleaner that has been developed by AHAM, the U.S. Association of Home Appliance Manufacturers.

Johan Wennerström,
R&D Manager, Blueair AB, Stockholm, Sweden

2. Our need to breathe clean air

We humans generally spend about 90% of our time indoors at home or work breathing air that is up to 100 times more polluted than the air outside in the street.

Clean air, both outdoors and inside a home or office, is essential to good health and wellbeing. However, studies reveal that most people are in the dark about the negative effects bad indoor air quality can have on their health. The lack of public awareness is worrying in the light of reports from such prestigious organizations as the U.S. Environmental Protection Agency stating unequivocally that air pollution is a significant cause of health problems.

In Europe, the European Commission has stated indoor or outdoor air pollution is a major environmental health concern as it can lead to serious health effects, such as respiratory disease, including asthma and lung cancer. The Commission noted that indoor air 'may contain over 900 chemicals', yet has admitted air quality inside a home or office has not received the same attention as outdoor air quality.[2]

In Sweden, where Blueair was launched in 1996, the Swedish Ministry of Environment has also warned that excessive levels of air pollution pose problems to health and wellbeing, including respiratory problems and allergies as well as cancer or even premature death. This conclusion has been reciprocated by the World Health Organization (WHO), which has also studied the impact on human health caused by indoor air pollution.

The health effects from indoor health pollutants experienced soon after exposure, or even many years later, have been detailed by the U.S. EPA.[3]

Immediate effects

Immediate effects may show up after a single exposure or repeated exposures. These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified. Symptoms of some diseases, including asthma, hypersensitivity pneumonitis, and humidifier fever, may also show up soon after exposure to some indoor air pollutants.

Long-term effects

Other health effects may show up either years after exposure has occurred or only after long or repeated periods of exposure. These effects, which include some respiratory diseases, heart disease, and cancer, can be severely debilitating or fatal. It is prudent to try to improve the indoor air quality in your home even if symptoms are not noticeable.

[2] http://ec.europa.eu/health/opinions/en/indoor-air-pollution/index.htm#1
[3] http://www.epa.gov/iaq/ia-intro.html#Indoor%20Air%20Pollution%20and%20Health

3. Causes of indoor air pollution

An estimated 300 million people worldwide suffer from asthma. In France alone, 1 in 4 people suffers from respiratory allergy, immune response related to inhaled allergens such as pollen, dust mites and animal dander.[4]

Homes, offices, schools, gyms and other buildings where human congregate for work, rest or play all suffer from some degree of airborne pollution, which should not come as a surprise considering indoor air may contain over 900 chemicals, particles and biological materials with potential health effects.[5]

Obviously some groups, such as children, pregnant women and the sick or elderly, are more at risk than other, but the reality is that just about everyone may be harmed by the release of particles or gases into the air they are breathing. The modern emphasis on increased insulation technologies to promote energy efficiency also serves to reduce ventilation, which can lead to a steady accumulation of airborne pollutants in rooms and buildings.

Indoor air pollution can stem from many different sources, inside and outdoors. Traffic and industrial pollutants are obvious sources of particles but the other causes come from such items as bacteria, mold, dust mites, pollen, household cleaning and personal care products, paint strippers, pesticides, burning oil, gas, wood or coal, smoking and even furnishing and building materials.

The European Commission has said the combined effects of various indoor air pollutants (chemical substances, allergens and microbes) may well combine to cause more (or less) harmful effects than the sum of the effects caused by each chemical separately. An EC study[6] noted how many of the most common products in our homes are prime sources of volatile organic compounds (VOCs):

"Volatile organic compounds (VOCs) are emitted by many consumer products and decomposing materials. Three of the most worrisome are formaldehyde, benzene, and naphthalene. Some volatile organic compounds may react with ozone to produce secondary pollutants, including fine and ultrafine particles. Some of these secondary pollutants cause irritation and poor perceived air quality at concentrations that can be found in indoor air."

[4] http://www.eargenda.com/tag/respiratory-allergies
[5] http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_055.pdf
[6] http://ec.europa.eu/health/opinions/en/indoor-air-pollution/l-2/6-harmful-chemicals.htm#0

4. Challenges

It is ironical that modern cars are fitted as a matter of standard with air filters to protect drivers and passengers, but little is done on a similar scale to improve healthy air conditions inside our homes and offices where we spend most of our time at work or leisure. A simple, straightforward solution for anyone concerned about the air they breathe indoors is, besides source control, to ensure that the rooms they are using are well ventilated with clean air or contain an air purifier.[7]

We know there are many different air purifiers in the marketplace today, some are frankly better than others at removing airborne pollutants in whatever size or form they come. We fervently believe the public should be able to make informed choices based on independent testing of individual air purifiers by an ethical and well-respected third party. Air purifiers should be proven to be excellent at removing harmful indoor pollutants to the highest possible degree relevant to the size of the room as well as change the entire air in a room at the rate of five times an hour. All air purifiers should meet at the very basic level the desire of the consumer for a product that enhances health and wellbeing at an affordable price.

[7] R. C. Brown, 1993. Air filtration - An Integrated Approach to the Theory and Applications of Fibrous Filters.

5. The performance challenge

It is important that the air purifier's performance meets the consumer's need for health, comfort and economy. Primarily through the reduction of particles.

At Blueair, we believe all air cleaners should be independently tested by an ethical and well respected third party to assess how good they are at removing harmful indoor pollutants to a high level relative to the size of the room. Every air cleaner should be able to change the air inside a room at least five times per hour in order to meet consumer requirements for health, wellbeing and low operation cost.

Performance challenge

There can be a big difference in the efficiency of different air cleaners when it comes to removing particles and other stuff from the air.

High filtration

Efficiency does not necessarily mean that the system is effective in reducing the particle concentration in the room. High filtration efficiency means that the filter has very high ability to remove the pollutants that pass through the filters. But if the airflow through the filter is low, possibly because of dense filter media, less amount of air and pollution would actually pass the filter to be cleaned. This in turn would leave a high proportion of air in the room still unfiltered and polluted.

Noise issue

Dense filters have low airflow because of the densely packed fibers in the media restricting the air. To increase the airflow, a strong fan is required. However, strong fans cause a lot of noise. This is not desirable as air purifiers will be operating in bedrooms, living-rooms, offices and other environments where the sound can be disruptive.

Energy consumption challenge

For optimum performance, an air purifier should be running 24 hours a day and seven days a week. Runing less than that is not effective owing to the remaining sources and ever changing environment. Therefore, low energy consumption is essential not only for the domestic bill, but also for the environment.

Quality and price

Air purifiers come in different guises and price levels. It is important to choose an air purifier that meets the consumer's requirements in terms of quality of clean air and sustainability of the unit. The chosen purifier must clean your air without compromising performance, economy or design.

Technologies

To understand how the four requirements described above can be achieved it is important to know what different processes and technologies are used in air cleaners. The two most common technologies used in air cleaners are mechanical filtration and electrostatic precipitators.

6. Technologies

Mechanical filtration

Mechanical filtration such as high efficiency particulate air (HEPA) filters captures particles from the air by size exclusion using a fan to move the air through the filter. Mechanical filtration uses four different forces to capture particles: straining, inertia, interception and diffusion,[8] where the three last mentioned is illustrated in fig. 1.

Straining

Big particles are trapped in the filter media like mosquitos in a mosquito net, they are too big to be able to penetrate the holes in the filter media.

Inertia

Heavy particles do not follow the airflow pattern around the filter fibers; instead they follow a straight line and collide with the filter fibers.

Interception

Medium sized particles can be trapped by just touching the filter fibers when they pass close to a fiber.

Diffusion

Small particles drift randomly in the air. Some particles are so small that they move excessively which increases the probability of particles touching the fiber when moving. Even when touching the filter on the reverse, particles get stuck and trapped to the fiber.

The smaller the particles are (< 0.3 µm), the higher is the filtration efficiency for diffusion.

Mechanical filters are very efficient in removing particles such as pollen, dust, molds and other airborne pollutants. High filtration efficiency for a mechanical filter media is achieved by packing fibers densely. However, dense filter media will lead to high air flow restriction which in turn would require a strong fan, consuming much energy and producing high noise levels, to push air through the filter.

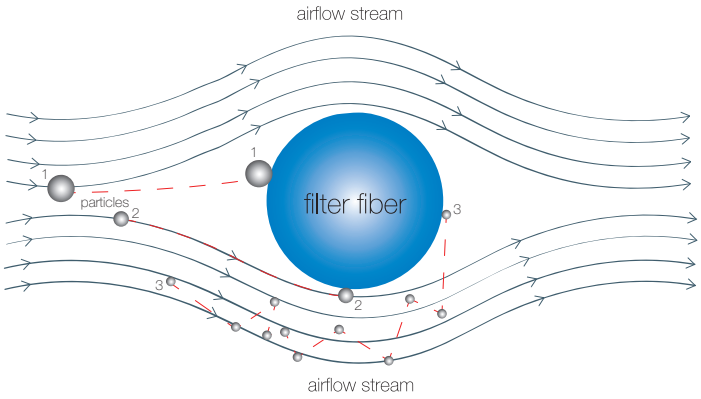

Fig 1
1. Inertia. Heavy particles leave the airflow stream to follow a straight pattern and collides with the filter fiber.
2. Interception. The particle passes close to the filter fiberand gets trapped.
3. Diffusion. Small particles drift randomly in the air and because of excessive movement they get trapped on the front or back of the filter

[8] http://www.epa.gov/apti/course422/ce6a1.html

Electrostatic precipitators

Electrostatic precipitators charge particles electrically with either a positive or negative charge. The particles are then attracted and retained by oppositely charged collection plates[9] (fig. 2).

Air cleaners using electrostatic precipitators are good in cleaning the air with low noise while consuming little energy. However, electrostatic forces are not very efficient in collecting large and heavy particles. The unit also needs regular cleaning and because of the high voltage ionize fields, electrostatic air cleaners often emit ozone as by-product. Ozone is deemed to be hazardous to human health and scientifically there is no safe concentration limit. So even if the emission is below public health standards it can still be harmful. Ozone can also react with chemical emissions creating chemical compounds with detrimental health effects. Despite its toxicity, ozone can still function as an odor reducer, which neither electrostatic nor mechanical filtration alone can. However, this is not a preferable way.[10]

The recommended non-toxic way to reduce odors is to use adsorbent material such as activated carbon. Activated carbon is a natural material for air filter and has a very porous structure that can adsorb gaseous pollutants including odors.

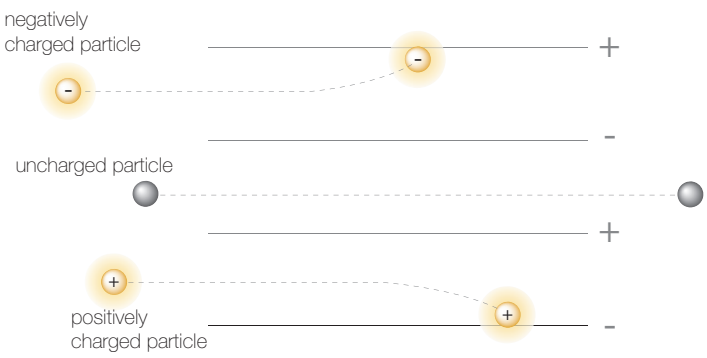

Fig 2
Charged particles are attracted to the oppositely charged collector plates while uncharged particles only pass the plates.

[9] http://www.epa.gov/apti/course422/ce6a1.html
[10] http://www.epa.gov/iaq/pubs/ozonegen.html

7. Solution

When choosing an air cleaner, performance should be considered first. A unit's pollutant removal performance is best shown with its Clean Air Delivery Rate (CADR), a standardized measurement system developed in the USA by the independent Association of Home Appliance Manufacturers (AHAM) that helps to determine an air cleaner's efficiency in removing pollutants from the air.

CADR measures the reduction of the three most common indoor air pollutants at home: smoke, dust and pollen. These three pollutants represent different sizes of particles with pollen being large sized pollutants, dust medium and smoke small. The unit for CADR is cubic feet per minute (cfm) which tells us that the higher the numbers are, the faster the unit cleans the air in the room.[11]

CADR test standard, called ANSI/AHAM AC-1-2006, is the only air cleaner standard that is recognized as an American national standard. It has been developed by the Association of Home Appliance Manufacturer (AHAM), an organization that oversee standards, testing and verifications for air cleaners together with other appliances. AHAM is an independent organization, which ensures that the testing results are accurate and impartial.[12]

How to estimate the CADR of unrated air cleaners

CADR are rated within the range of 10 to 450 cfm for tobacco smoke, 10 to 400 cfm for dust and 25 to 450 cfm for pollen. These numbers are tested and certified on air purifiers by AHAM. The membership of AHAM and its CADR programme is voluntary which makes it difficult to know how to compare products that are not tested and certified. But CADR could easily be estimated by the following procedure:

1. Find out specifications for efficiency and airflow of the air purifier. Efficiency represents the proportion of pollutants removed (%) and airflow represents the volume of air that passes through the unit per time unit (cfm).

2. With the formula below you can estimate the CADR of the unit.

   CADR = [filter efficiency at 0.3 µm]] x [airflow in CFM]

An air purifier with low filtration efficiency can have the same or even higher CADR than an air purifier with higher filtration efficiency. As an example, we have two units with following specification:

Unit 1: Efficiency = 99.97%, Airflow = 125 cfm

Unit 2: Efficiency = 80%, Airflow= 250 cfm

The estimated CADR for the two units will then be:

Unit 1: 99.97% x 125 cfm ≈ 125 cfm

Unit 2: 80% x 250 cfm = 200 cfm

As can be seen from this example, a unit with lower filtration efficiency can have better performance compared to a unit with high filtration efficiency, giving the conclusion that for high performance, a unit must have both high airflow and good filtration efficiency.

What CADR do you need?

AHAM guidelines helps to determine which CADR a specific room size need. One simple way to calculate needed CADR is the 2/3 Rule. The 2/3 Rule means that the air purifier should have a CADR for tobacco smoke equal to 2/3 of the room's floor area. So saying that a room has an area of 120 sq. ft., the CADR for tobacco smoke should be:

120 x 2/3 = 80 cfm

[11] http://www.cadr.org/consumer.htm
[12] http://www.aham.org/consumer/ht/d/sp/i/1074/pid/1074

8. A combined technology

Mechanical filters can have a filtration efficiency as high as 100%. This is for large particles. Efficiency for smaller particles such as cigarette smoke is usually lower as they can penetrate the filter media and follow the airflow through the filter and be re-introduced into the air.

By combining mechanical with electrostatic technology, the filtration efficiency for smaller particles will increase. When charged particles come near filter fibers, attraction forces emerge between the particles and the fibers, making the particles move towards the fibers and adhere to its surfaces instead of following the airflow stream around the filter fibers (fig 4).

The result of combining mechanical filtration with electrostatic technology is an efficiency of 99-100% in capturing particles of all sizes, both large and small (fig 5).

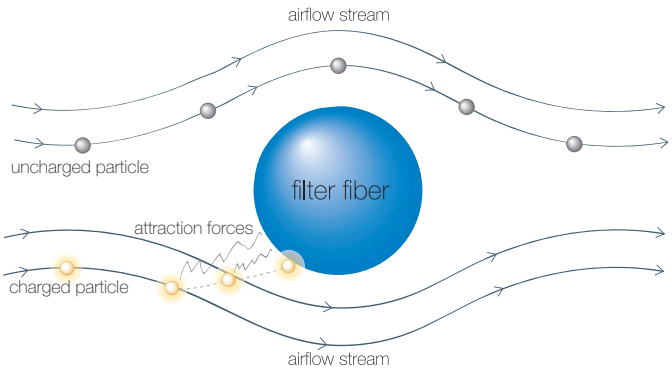

Fig 4 (above)
By combining mechanical technique with electrostatic, charged small particles will be diverted from the airflow stream with attraction forces. If using only mechanical filter, there is nothing that obstructs small particles from passing the fiber.

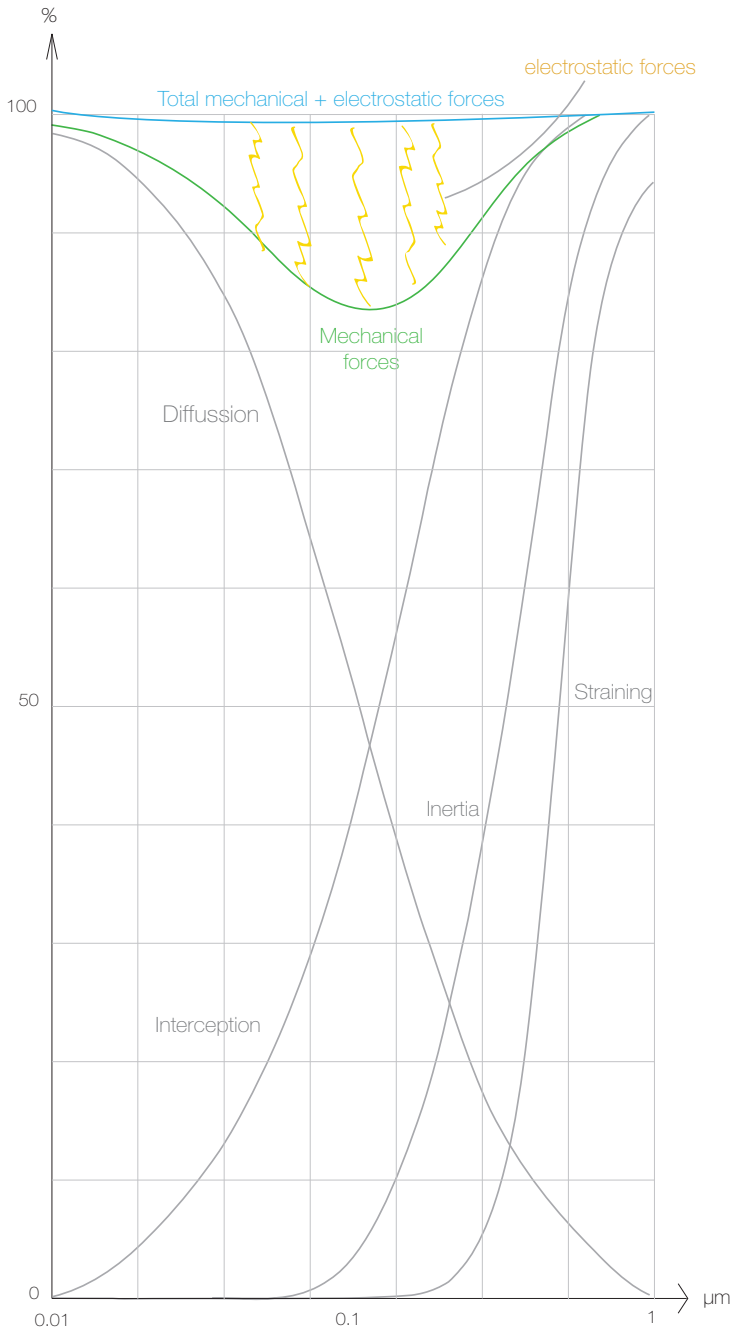

Fig 5 (right)
Straining, inertia, interception and diffusion can be summarized in one mechanical force as shown by the green curve. Adding electrostatic forces enhance the efficiency to 99-100 %.

9. The HEPASilent™ technology

Blueair is one of the few air purification brands to offer a unique and patented filtration process. Air purifiers from Blueair use a combination of mechanical and electrostatic filtration called the HEPASilent™ technology and do not emit ozone as a by-product.

Blueair's HEPASilent™ technology uses an ionizer that charges particles negatively. The charged particles will then be trapped by a gradient structured synthetic mechanical filter (fig 6).

Pollution focus

Blueair uses two types of filters, Particle filter and SmokeStop™ filter.

Particle filter

Consumers can choose Particle filters to remove dust, pollen, bacteria, pet dander, mold spores and other airborne particles.

SmokeStop™ filter

The SmokeStop™ filter is enhanced with activated carbon that in addition to removing airborne particles, will also purify the air of gaseous pollutants such as tobacco smoke, carbon monoxide, ammonia, ozone, VOCs (volatile organic compounds) and odors.

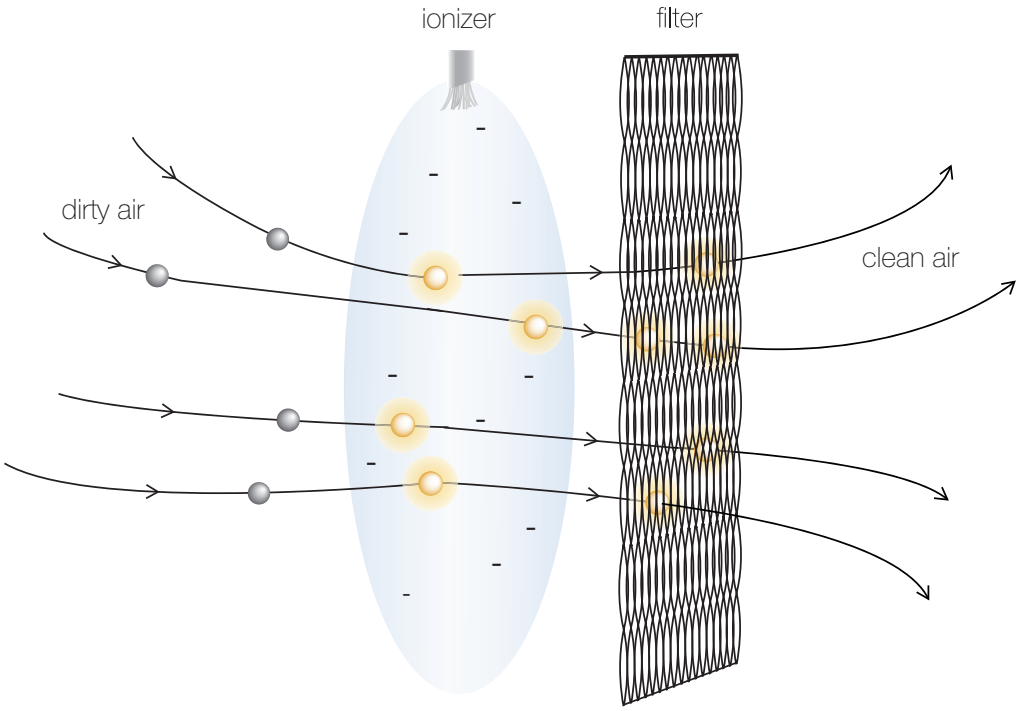

Fig 6
Incoming air brings particles past the ionizer where they are charged and then captured by the mechanical filter, leaving only clean air in the room.

10. Benefits

The HEPASilent™ high filtration system delivers more clean air at a faster rate (high CADR) with low noise levels and using less energy, compared to just a mechanical filter. Blueair air cleaners provide the right balance of airflow, ionizer & filter density.

The HEPASilent™ system uses special design filters with less densely packed fibers that do not reduce airflow. In combination with an ionizer, the filtration efficiency increases, ensuring Blueair units achieve high CADR.

All Blueair units meet the American public and national standards (U.S. Environmental Protection Agency and the Department of Energy) for both low energy consumption and running cost, which has resulted in Blueair air cleaners earning ENERGY STAR certifications.

Zero emissions

Blueair air purifiers do not only remove pollutants from the air. Another major benefit is that they do not emit by-products such as ozone either. Testing has shown that the ozone concentration in the output air is actually lower than in the incoming air. Blueair units are certified by the California Air Resource Board, the most stringent standard for testing ozone as by-product from air purifiers. All units are ARB certified.

Units from Blueair do not contain any hazardous material.

Design

Because an air purifier is a part of the interior décor it should have a design that complements the room. Blueair's design approach has earned the company one of the most prestigious Scandinavian design awards, the Excellent Swedish Design Award, and its air cleaners are displayed at the National Museum of Sweden.

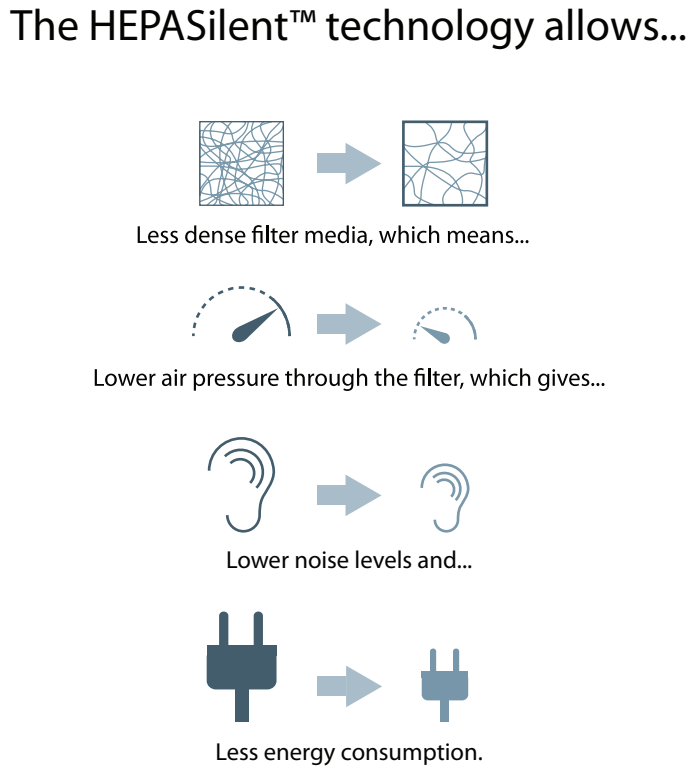

Fig 7
The benefits of the HEPASilent™ technology.

11. Why Blueair?

Blueair has been producing clean indoor air since 1996 and the company's air cleaners can be found in over 50 countries around the world.

Innovated with love in Sweden, a Blueair air cleaner is perfectly engineered and designed so that consumers can rely on it to make their indoor environment cleaner and healthier as well as life more enjoyable, at home, work or leisure.

- We strive continuously to deliver air cleaners that are best in class when it comes to delivering performance that provides tangible health and well being benefits alongside quality design and ease of use functionality.
- Tests in Japan by the well-known Kitsato Research Center of Environmental Sciences have underscored the efficiency of a Blueair air cleaner when it comes to removing bacteria, virus and mold from indoor air.

- Stringent test in China at the Shanghai Institute of Measurement and Testing Technology awarded Blueair top marks for the ability of nits air cleaners to remove gaseous pollutants from chemical-based household and person cleaners, pesticides and aerosols as well as plastics, binders and glues in synthetic building materials, carpetings and furnishing, for example.
- Blueair air cleaners are top performing when it comes to reducing indoor air pollution. The Blueair 600 series has the highest ratings in the industry for air purification.
- There is a Blueair air cleaner for every room size, from small bedrooms to large open spaces up to 65 square meters (698 sq.ft)
- When it comes to energy efficiency, the Blueair ECP10 is rated the most energy efficient air purifier in the world. Even when running 24/7, Blueair air cleaners use less energy than a light bulb on average.
- Blueair air cleaners reduce the amount of hazardous ozone in a room tests by the prestigious Swedish Karolinska Institute in Stockholm have revealed, reducing likelihood of chest pain, throat irritation and respiratory health problems.
- Whisper silent performance is a hallmark of every Blueair air cleaner, which is the result of the unique patented HEPASilent filtration technology.

Blueair is deeply committed to continuous innovation and a greener global environment. Innovated with love in Sweden, no compromises are made when it comes to function, quality, design and service. Blueair believes that clean air is a basic human right.

12. Recommended further information

The U.S. Environmental Protection Agency

http://www.epa.gov/iaq/pubs/careforyourair.html

http://cfpub.epa.gov/airnow/index.cfm?action=particle_health.page1#intro

Residential Air Cleaners (Second Edition): A Summary of Available information. Revised August 2009.

The World Health Organization

http://www.who.int/indoorair/en/

http://www.who.int/mediacentre/factsheets/fs292/en/index.html

http://www.who.int/gard/publications/GARD_Manual/en/index.html

Government Offices of Sweden

http://www.sweden.gov.se/sb/d/8756/a/39683

ENERGY STAR

http://www.energystar.gov/

http://www.energystar.gov/index.cfm?c=products.pr_how_earn

The Association of Home Appliance Manufacturers (AHAM), Clean Air Delivery Rate (CADR)

http://www.cadr.org/sitemap.htm

R. C. Brown, 1993. Air filtration - An Integrated Approach to the Theory and Applications of Fibrous Filters.

Blueair

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