Case 56

Clean Air without Filters

By Gunter Pauli

This article introduces a creative approach to indoor air quality as one of the 100 innovations that shape "The Blue Economy". This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The world market for filters and filtration systems in 2010 reached $45 billion. The automotive filters represent the largest market segment. The filter as a medium for separate solid suspended particles from water and air amounts to $25 billion in the same year. The fastest growing segment is the liquid cartridge filter, good for $13.6 billion. Other markets include liquid macro-filters ($1.3 billion), fabric based filters ($2.3 billion) and cross flow membranes used in reverse osmosis ($1.9 billion). The Chinese market is with 14 percent the fastest growing consumer of filters in the world. However in 2010 China still represents a net importer of equipment. This is soon expected to be reversed. In view of the continuous expansion of the market, China will become by 2015 the second largest consumer of filters in the world after Japan.

The narrowly defined market for indoor air filters reached $6.6 billion in 2010. A wide portfolio of techniques removes solid particles as diverse as dust, pollen, molds, bacteria and even dust mite feces from the air. The cleansing of the air avoids the distribution of airborne contaminants that could otherwise lead to the sick building syndrome. The air quality improves through simply physical and mechanical barriers, ultraviolet radiation, air sterilization with ozone, activated carbon and electrostatic removal. Commercial and office buildings represent the largest segment, closely followed by industrial facilities. Demand for highly efficient filters is concentrated in the electronics sector, while producers of solar cells have an increasing appetite for filters. While the residential market remains small, the expected growth rate of 5.2 percent is well above the growth of the world economy. The pursuit of healthy indoor conditions, especially in polluted urban environment is translated in this continuous expansion of demand.

The Innovation

The use of filters generates a back pressure. As the filter is designed to remove ever smaller particles, the air flow pressure continues to drop. Thus, the more performant the filter, the more energy is required to maintain the overall efficiency of the air circulation system. This implies that most energy efficient filtration systems, actually are the least efficient separators of particles. The search for innovation has therefore focused on filtration technologies that improve removal while dropping the required energy input. This has lead to innovative approaches like the use of $Ti0_2$ (Titanium dioxide) nano-particles and ozone. While the replacement of a mechanical process with a chemical process successfully reduces the airborne contaminants, these approaches to clean indoor air create hazardous by-products. The substitution of physics with chemistry is an innovation that is best avoided.

Professor Lars Thofelt observed how particles that float around the globe in the atmosphere somehow drop down into the rainforests. He wondered how plants, soil and water interplay in an ecosystem whereby solids are carried thanks to air flows through plants, stick to the leaves and ultimately are washed on the soil where everything decomposes and generates more soil. He observed that the majority of buildings have a warm and dry indoor air and imagined a method to add humidity. This reduces the irritation of the mucous membranes while at the same time it purifies the air. He also noted that tiny particles stick to larger ones. These typically get caught by the ventilation filters but once these bigger ones dry out, the smaller ones are set free again. The natural filtration system of the human body is not capable of blocking these out.

Professor Thofelt went on to design in the early 1990's a miniature version of a rainforest with up to 150 plants. He learned how a healthy rainforest is in balance between regrowth and decomposition. He worked together with Anders Nyquist, the architect who imagined how air in the building could naturally flow through the tropical garden, securing the removal of most large particles before these dehydrate, capturing all the smaller particles with it. The innovative architect who has a track record in eco-buildings that is second to none, achieves this natural flow through capturing the interplay of light and pressure. While plants are welcome in buildings, these have been typically considered a cost. When plants are converted into a filtration system in the building, then this green zone offers multiple functions, thus reducing costs. This is a typical characteristic of the Blue Economy.

The First Cash Flow

Prof. Thofelt went on to create the company Levande Filter AB in Sundsvall, Sweden and built a few test cases to demonstrate the power of a micro rain forest to recreate a health indoor climate that looks and feels good while it reduces the risks of infections and allergies. The demand for chemicals is replaced by an interplay of the law of physics with the predictable functioning of ecosystems. One of the first projects included the Laggarberg School in Timrå, Sweden, some 400 kilometers North of Stockholm (1998). A second case is

the Midlanda Airport (Sundsvall) with a blend of plants, bushes and small trees under the attic, where thanks to the exploitation of the fact that warm air always rises, and misting settles the dust the air is clean. The first experimental projects were completed with a resounding success, leading to a solid documentation that the process is not only effective and beautiful, it saves considerable amount of energy and costs as well. Test results by independent verifiers established that the carbon dioxide level with a maximum value of 735 ppm was reduced thanks to the Living Filter to 300-350 ppm range, which corresponds to good outdoor air. The plants removed CO_2 at the rate of 9.42 grams per hour. Perhaps an even better result is the removal of 7.5 μg of formaldehyde per hour!

The Opportunity

As the track record was established in Northern Europe, a part of the world where indoor quality is very much valued, and where energy savings are embedded in daily life, the team of Levande Filter AB progressed with the design of standard cabinets equipped with automatic watering and timer controlled lighting. The Ford dealership in Umeå decided to place a few cabinets in the workshop. Toluene and hydrocarbons were managed naturally. On the basis of these solid results the company expanded to Finland, the Netherlands and North America.

The presence of plants may be expected in public places, but the growth of bird's nest fern, grapevines, elephant foot tree, Queensland umbrella tree and even pepper and banana trees are a rich learning experience for everyone, especially when the filter is installed in schools. Children are not only picking up the functionality and importance of the rainforest in their environment to preserve health, they learn more about biodiversity than ever expected in a biology class. The interplay of light, moisture, economics, innovations, ecosystems and health becomes a way of life. This is how the Blue Economy succeeds in making health a priority, and its cost affordable, while beauty is the bonus.

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… Further information on the 100 innovations at www.theblueeconomy.org