Performance of filters has the top priority in the Air-conditioning (AC) inspections

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Energy conservation is closely linked to sustainability. In today's energy debate, governments are leaning heavily on commercial and industrial building owners to shrink energy consumption.

Building ventilation systems are energy-intensive and we have calculated – in the case of Sweden, for example – that as much as 1.4TWh of energy is needed to move air through filters in all the country's air handling systems. A projection over the entire European market evaluates fan energy consumption at 31.5 TWh for building ventilation.

Using the correct filters with the required particulate efficiency and lowest possible pressure drop will reduce the energy consumption of HVAC systems sharply while maintaining a healthy indoor climate for occupants and enhancing the sustainability performance of buildings. Experience shows that selection, (according to EN 13779), of the right filters with the right pressure drop can have a significant impact on this power consumption and the carbon footprint of buildings in the European Union.

Quality low-energy air filters may cost a little more, but their longer term benefits pay off every time, usually several times over – in terms of
- reduced energy consumption,
- higher Indoor Air Quality IAQ,
- fewer filter changes,
- less waste.

Part I: Air-conditioning inspections: a quick win for a better indoor environment and energy savings

The EU EPBD legislation, Article 9 (article 15 in the Recast EPBD, 2010) makes inspections of air-conditioning (AC) systems mandatory for compliance.

AC inspections performed by Camfil Ltd in the UK have confirmed the potential of quick wins that inspection of filters could provide to building tenants and maintenance companies. They deliver the required indoor air quality with optimum energy efficiency.

Land Securities, the largest commercial property company in the UK, now own and manage more than 2.7 million square metres of commercial property, from London offices and high street shops to major shopping centres and out-of-town retail parks.

The initial evaluation of air filters on a pilot site in London involved collecting performance details on the standard air filters in use at the time, and comparing them to an alternative selection of improved performance air filters.

The power use of a filter or any other component in air handling system can be calculated from the equation below

$$P = \frac{\Delta p \cdot q}{\eta}$$

P = power consumption of the component in Watts with a component with pressure drop Δp in Pascals when the air flow through the component is q in m^3/s and the over all efficiency of fan is η

This pre-study identified the following savings:

- Replacement air filters, 15%
- Reduction of labour to change filters, 64%
- Reduction of energy to move air through the filters, 16%
- Reduction in tonnes of CO_2, 16%

These savings were available by fitting new filters into the existing filter holding frames as part of the normal maintenance regime. No further investment was required and the new filters were fitted in September 2009.

Prior to this implementation, the air filters were routinely replaced as part of an established Planned Preventative Maintenance (PPM) regime. During this trial project Camfil demonstrated that using low-energy air filters not only reduced the energy consumed, but also doubled the service life of the filters. Consequently, the annual air filter cost was reduced, together with a reduction in labour and waste cost. Crucially, because the low-energy air filters are better engineered, the air being supplied into the buildings is now much cleaner (four-fold decrease in the amount of particulate in the air).

This project has now been rolled out with estimated total savings in the London portfolio alone of 290 350 euros and 650 tonnes of CO_2 in the coming year.

Visual inspection of AHU and filters: a low hanging fruit

Before suggesting fan motor changes, new electrical equipment and dampers, a simple visual inspection needs be performed to help improve the cleanliness and efficiency of air filtration.

This makes common sense because our inspectors have found dirty or damaged filters; filters sized so they do not fit the AHU mountings, permitting air to bypass; and worn-out gaskets that create leaks, allowing airborne dust to foul the heat exchangers and re-contaminate air flow.

The following pictures illustrate these common situations, which were discovered during the AC inspection of an office building in London.

AC inspectors should be aware of the potential energy savings of air filters in order to give added value to their reports. The inspection of the AHU air filtration configuration could be as important as changing to a high-efficiency fan motor. Inspection checklists should always integrate criteria for visual inspection of filters.

Why pay more for higher quality air filters?

Camfil Farr in Denmark conducted a trial at a large pharmaceutical facility with its newest low-energy bag filter, the Hi-Flo XLT, which was installed to replace a standard bag filter delivering the same performance. Pressure drop was continuously monitored over a six-month period. As a result,

Table 1. Actual and predicted yearly cost savings savings in Building n°4, AHU n°1 installed week 37(2009). Evaluation performed 24 weeks after installation (1/2y). Simulation used the Camfil Farr Life Cycle Costing software

Life cycle savings	Energy cost		Labour costs		Filter cost		Disposal cost	
	24weeks	1year	24weeks	1year	24weeks	1year	24weeks	1year
	Actual	Predicted	Actual	Predicted	Actual	predicted	Actual	predicted
€ To date	**162**	352	**164**	357	**17**	38	**41**	89
€ Year forecast	**351**		**355**		**37**		**89**	
Total yearly savings forecast = 832 €								

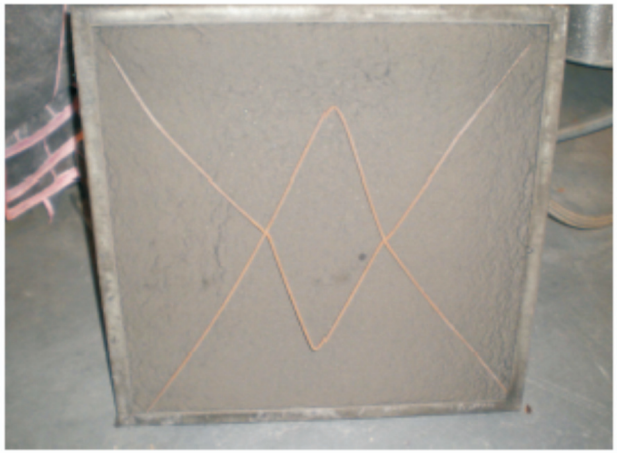

Figure 1. *Pre-filter pads need to be changed with a frequency that prevents them from becoming clogged with dust. The pre filter pad in this photo has clearly not been changed recently and as a result there is not clear route for the air to penetrate through this filter. A filter of this type may put considerable extra load on the fan and motor system when it gets into this condition. It may also create a health or fire hazard.*

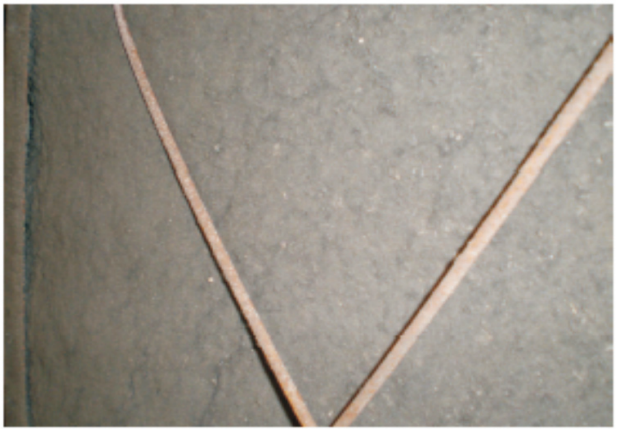

Figure 2. *The upstream face of this filter pad is clearly heavily face loaded. Compare with the downstream face shown below. If this pre-filter additionally becomes wet then the sudden resistance spike can cause motor overheating or dangerous destruction of the filter bank. Fitting pressure drop gauges and regular monitoring can stop this problem at an early stage.*

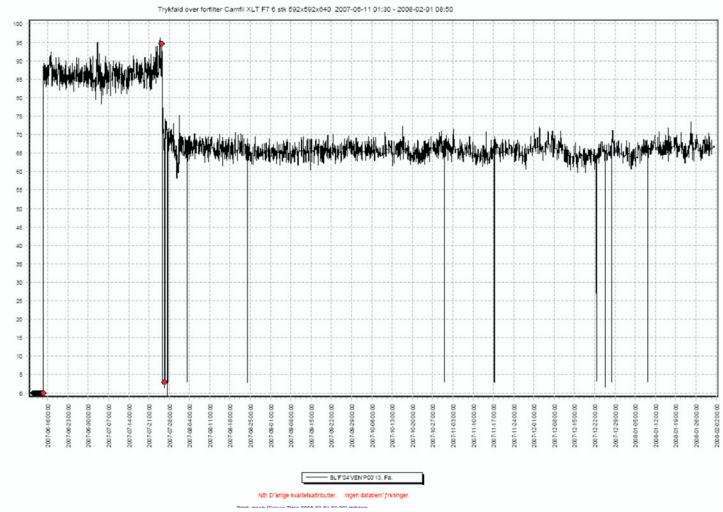

Figure 3. *This photo shows two problems. Firstly the gap at the and each row shows an easy route by which the air flow can bypass the filter bank. Secondly nearly all the large sized filters are fitted with the pockets presented horizontally making them choke off the pockets below as gravity pulls them down. Every time two pockets touch there is no air flow through the media in contact. This increases air resistance and energy consumption as a result.*

pressure drop decreased 20% and remained stable until the end of the Hi-Flo XLT filter's life.

Hi-Flo XLT uses the latest in glass-fibre media and the bag filter is made with a newly developed seaming technique for optimum air distribution. The filter's stable plastic frame is also aerodynamically designed for this purpose. The plastic can be recycled.

Compared with most standard pocket filters on the market, Hi-Flo XLT can reduce the operating cost of a ventilation system by more than 20 percent since it keeps pressure drop low over a longer period. The ventilation system operates more efficiently, over a longer period of time, and uses less energy as a result. When air flows as freely as possible through the pockets of an air filter, with no resistance, the filter will perform better. In Hi-Flo XLT, this is achieved with perfectly conical pockets based a newly developed seam design and stitching technique.

Clean coils for major energy savings

Camfil Farr in the UK was commissioned by a major London hospital to perform a study aimed

at improving the hospital's energy efficiency. The study demonstrated that the facility could reap major energy savings in its air handling systems by simply cleaning the coils of the AHU.

Camfil Farr performed two coil-cleaning tests in two selected AHUs to determine how this would impact energy consumption. Firstly, pressure readings were taken across the coil sections and then the coil surfaces were inspected for contamination. The coils were then cleaned with a high-pressure steam cleaner to remove heavy deposits of general dirt on the upstream side of the coils, after which new pressure readings were taken in the upstream and downstream sections.

The readings indicated that the initial resistance across one coil, 680 Pa, was reduced to 78 Pa, equal to an estimated energy saving of EUR 872 per year for each m3/s of air flow. The initial resistance on the second AHU coil, 664 Pa, was lowered to 22 Pa, corresponding to energy savings of EUR 930 per year for each m3/s of air flow.

The results of the two coil cleans proved that AHU plants benefit from cleaning and provide far better air flow and reduce energy consumption for the hospital.

These four illustrations of the cost/benefit of paying attention to the filters in an HVAC installation prove that air filters, still often considered as commodities, should be considered as "energy using products" or at least "energy-related products", according to the legislation's terminology.

Filters are often purchased only on price as the unique buyer's consideration. Selecting filters with lower energy consumption can reduce bills and operating costs. It is important to integrate the "service value" provided by filters. The financial benefits of energy savings and maintenance costs are much greater than the initial buying cost.

More case studies from Camfil Ltd are available on : http://www.ac-inspections.co.uk/ and http://www.lowenergyairfilter.co.uk/
Information on Camfil Farr LCC (Life Cycle Costing) software, Product and Corporate information can be retrieved from www.camfilfarr.com

Part II: Could European regulations on Energy performance compromise Indoor Air Quality (IAQ)?

Today, the negative impacts of air pollution on human health, and the focus on Climate Change, requires that we go back to basics, if we want to avoid contradictory decisions from European policy makers.

Why do we use filters?

Air filters are needed to protect people from the harmful effects of air pollution. People exposure to both indoor air pollution and outdoor air pollution that infiltrates buildings can be controlled and dramatically reduced by well designed and well maintained HVAC systems, using the right selection of air filters.

Up to now, the EPBD and other energy-related policies have focussed mainly on energy savings without linking and integrating indoor air quality (IAQ) targets. The required particulate efficiency with minimum energy use is needed for optimised filtration that could effectively protect people. This is valid for commercial, office and residential buildings.

This involves great responsibility and could have consequences for public health: the risk is that professionals could forget that the primary role of ventilation is to create a good indoor environment and especially good IAQ. The narrow focus on energy aspects could only encourage building users and advisors to think that opening windows is good enough to ventilate indoor areas.

New buildings are better insulated and create a hermetical envelope. Specialists and academics agree that the "tighter" a building is, the more important the ventilation becomes to prevent adverse effects from mould, excessive humidity and above all, the accumulation of harmful pollutants inside the buildings

The reality is simple: we spend 90% of our time indoors. Indoor environments can be 50 times more polluted than outdoor environments, because outdoor air pollution infiltrates buildings and the interior environment generates indoor air pollution in the form of combustion particles, chemicals substances and VOCs in addition to pollutants produced by human activity.

It is therefore important that the air we breathe is of good quality with regard to particulate matter (recent studies have shown the indisputable involvement of fine and ultrafine particles in cardiovascular disease), chemical pollutants and microbiological contamination (the hygiene of ventilation systems is determinative).

According to the EU Envie report [1] published in 2009, around two million healthy days are lost every year because of the negative effects of indoor air pollution.

Amongst air pollutants, the Envie report identified ultrafine combustion particles as the main cause of air pollution-related diseases (cardiovascular and respiratory disease). Some experts estimate the health cost of indoor air pollution at 110 billion euros in terms of lost work days, visits to doctors, admissions to hospitals and deaths.

The CAFÉ [2] Project Clean Air for Europe in the 1990s estimated that more than 300,000 deaths could be directly related to air pollution each year.

In December 2010, the World Health Organization (WHO) released its second report on IAQ [3]. The first report focussed on the effects of mould and dampness and prevention measures. The latest is about the most common air pollutants found indoors, in homes, schools, day care centres and offices.

Carbon monoxide, formaldehydes, phthalates, ozone and ultrafine particles have all been identified as harmful. They are susceptible to becoming very reactive and create unpredictable molecular cocktails such as the irritating products of ozone and formaldehyde reaction.

The WHO report on IAQ recommends measures to implement ventilation and filtration strategies that eliminate air pollutants.

The second set of mitigation is related to source-emission reduction of construction material regulations that will be extended to furniture, deodorizers, air fresheners, candles and cleaning products, for example.

As we continuously generate indoor air pollutants, good ventilation remains important even if we can control indoor pollutant emissions.

In March 2010, the ministers and representatives of member states in the European region of WHO have stipulated the following goal in the Parma Declaration [ ]: "Regional Priority Goal 3: Preventing disease through improved outdoor and indoor air quality.

Sustainable policies should always aim to deliver benefits from an economical, environmental and social aspect. Therefore, energy policies for buildings, such as EPBD or the Eco-design of Energy using/related Products Directive, as applied to ventilation devices, should be developed with the careful intention to improve **energy efficiency without compromising IAQ**.

This approach would definitely consider air filtration as a critical component of building energy performance. If this is not taken into consideration, we still might be able to meet the 20/20/20 target set by the European Commission, but it could be at high human cost and it would obviously not be a "sustainable" achievement.

Health and energy policy makers still live in two separate worlds. The principle of sustainability requires that they increase and improve their collaboration and develop common transverse approaches to the regulation development process, whenever human health and the environment are both at stake. The scientific knowledge and technical expertise are available to accomplish this. We need a stronger political will.

Medical research provides new evidences of health benefits of air filtration [5].

Early January 2011, new findings were published online ahead of the print edition of the American Thoracic Society, American Journal of Respiratory and Critical Care Medicine showing that **HEPA Filters Reduce Cardiovascular Health Risks Associated With Air Pollution**, study finds. Using inexpensive air filters may help reduce cardiovascular disease risk that results from exposure to air pollution. Researchers from Canada, have studied healthy adults living in a small community in British Columbia, where wood burning stoves are the main sources of pollution.

They found that high efficiency particle air (HEPA) filters reduced the amount of airborne particulate matter, resulting in improved blood

vessel health and reductions in blood markers that are associated with an increased risk of cardiovascular disease.

"Our results support the hypothesis that systemic inflammation and impaired endothelial function, both predictors of cardiovascular morbidity, can be favorably influenced by a reduction of particle concentration and add to a growing body of evidence linking short-term exposure to particulate matter with a systemic inflammatory response," Dr. Allen said. "Reducing air pollution appears to provide health benefits even if the pollution levels are already relatively low."

HEPA filters offer an accessible option to help reduce the risks of cardiovascular disease that may be associated with inhaling wood smoke, especially as consumers turn more frequently to woodstoves as a source of heat, he added.

"HEPA filters are a potentially useful intervention since they are relatively inexpensive to purchase and operate and can effectively remove tiny particles that can be inhaled, to improve air quality inside homes where the majority of time is spent," Dr. Allen noted. "The importance of residential wood smoke as a source of air pollution is likely to increase due to the rising costs of other fuels".

From ScienceDaily. Retrieved January 25, 2011 from http://www.sciencedaly.com

Filters are the only component in an HVAC system that can be changed at reasonable cost, so why not choose the right filter to save energy without compromising IAQ and health?

Air filtration is definitely a part of the Clean Tech sector.

Peferences

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