HVAC&R Skills Workshop

MODULE 100

PROUDLY SPONSORED BY DAIKIN

AIR FILTERS – CONSIDERATIONS IN MAINTAINING AIR QUALITY AND ENERGY EFFICIENCY

To some, the humble air filter is commonly misunderstood as merely "a thing in the duct that blocks airflow". While that is somewhat true, the primary function of the air filter is nobler – to protect the people and facility components that are downstream of it. If the filter blocks or is allowed to collect too much particulate material – excessive amounts of fan energy will be consumed and the amount of air being pulled through the filter will reduce – affecting the health and comfort of the occupied space. In short – air filters are a critical component in maintaining the air quality and energy efficiency of a facility.

PULL OUT

FILTER FUNCTIONS

Air filters used for "pre-filtration" have two main functions;

- Improve indoor air quality
- Protect downstream equipment

Generally, these pre-filters are designed and manufactured to be cost-effective and be energy efficient. Protecting downstream components such as secondary air filters and cooling coils allows for better long-term performance and further energy savings.

When it is doing its job, a filter becomes clogged with particulates over time. So, these pre-filters must be replaced to maintain air-flow for efficiency and performance of the system.

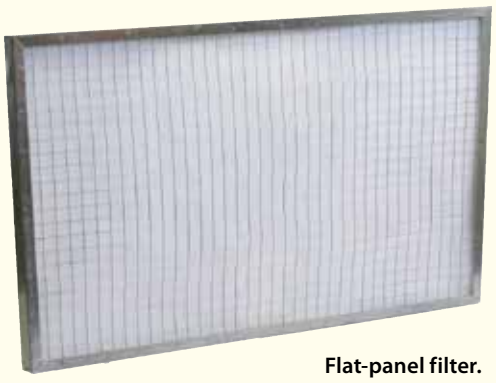
In HVAC systems, it is considered more cost effective (and environmentally safe) to replace and dispose of these pre-filters, rather than clean them on-site (washable air filters).

Washable filters still remain most relevant for kitchen exhaust hoods and some "mist eliminator" applications in seaside areas

COMMON FILTER TYPES

Flat panel filters are the most basic type of air filter, whereby a flat panel of air filtration media is enclosed within a metal frame. They serve to prevent very large particles "rocks" from entering the system and are typically made to order.

Pleated panel filters are really the start of effective particle removal to generate higher indoor air quality. They have a significantly greater surface area and dust holding capacity than flat panel-type filters due to the pleated air-filtration media.



Flat-panel filter.

The higher the number of pleats, the larger the working surface area the filter has. Ultimately, the higher useful surface area maximises the filtration capability of the filter, and reduces its resistance to air-flow. Metal V-form and cardboard disposable are the most common type of pleated-panel filters.

Metal V-form filters. These rugged filters have pleated-air filtration media inserted into a channelled metal frame. A number of methods are typically used to create the pleats within the air-filtration media, including galvanised mesh adhered to one side of the media and zig-zagged steel cage supports within the frame channel.

Some suppliers offer a premium version metal V-form, whereby the pleated filter media is "potted" or bonded (e.g. hot-melt sealed) into the metal channel frame to eliminate potential contaminant bypass.

Standard metal V-form filter.

Premium metal V-form filter.

In general, V-form filters offer respectable dust holding, moderate performance and a useful life. The more advanced forms are very resistant to by-pass, so work at the rated value for all their working lifetime. Metal V-form filters are typically available in standard sizes, with custom sizes made to order.

Cardboard disposable filters are constructed from pleated air-filtration media bonded to a cardboard frame (typically moisture-resistant beverage-grade cardboard).

Diagonal cardboard supports across the filter-face are included for rigidity and durability. Cardboard disposable filters are available in a number of rated efficiencies and standard sizes. Non-standard sizes are typically made to order, with some being modified (cut-down) from a larger size.

Cardboard disposable filter.

Bag Filters have excellent dust-holding capacities and reasonable pressure resistance. They are bulky, and take a significant duct length to house them. Some design versions are tricky to install and remove, and they are available in a vast number of configurations, ratings and sizes. The most common types of bag filters include:

Peaked bag filter – Four peak (full size) or two peak (half size) deep bed-style bag filter mounted to a metal outer frame and inner basket assembly.

Four-peak bag (Full size).

Two-peak bag (Half size).

Three-pocket bag (Full size).

Pocketed bag filter – Three pocket (full size) or two pocket (half size) deep bed-style bag filter mounted to a metal outer frame and inner basket assembly.

Two-pocket bag (Half size).

Multi-pocket filter – Typically six/eight pocket (full size) or three/four pocket (half size) deep-bed bag filter bonded to a metal header frame.

WHAT ARE THE CHARACTERISTICS OF A QUALITY DISPOSABLE CARDBOARD PLEATED AIR FILTER?

Surface area

Pleated air filters have a greater surface area and dust holding capacity, as compared to flat panel-type filters. The higher the number of pleats, the larger the surface area it can contain. Ultimately, the higher surface area maximises the filtration capability of the pleated air filter and reduces the energy consumption.

Filter media quality

Synthetic filter media are resistant to moisture build-up and ideal for preventing the proliferation of mould and mildew. Pleated air filters must be able to sustain a high-efficiency performance, with a relatively low-pressure drop, to be effective in air filtration, so premium quality media should be used.

Quality cardboard frame

Strong, durable cardboard frames should withstand the force of the air stream and support the filter media. Beverage board-grade cardboards are resilient against water infiltration that can lead to premature structural deterioration. A stable housing module helps to achieve a longer service life. Poorly designed filters, can collapse prematurely, creating major problems for downstream equipment.

Quality media bonding

Pleated air filters should be safely and tightly bonded to the cardboard frame to prevent air bypass (where contaminants can escape through the small gaps on the sides of the filters).

The combination of all of these design considerations helps to achieve an appropriate airflow static and load capacity that maximises energy efficiency, change out periods of disposable filters, and loading.

What is the impact of selecting quality disposable cardboard pleated air filters over cheaper alternatives?

There are many cheap cardboard pleated air filters available in the market today, which use inferior quality components and construction methods. These cheaper alternatives often provide poorer performance, risk product deterioration and mould (a known health risk), and have a shorter service life that requires more frequent change-outs.

The long-term costs associated with inferior quality product include increased energy consumption, more frequent product replacement, increased load on more expensive downstream filters, and potential contamination of expensive equipment or components. There is also potential for poorer air quality or health risks associated with product deterioration and mould.

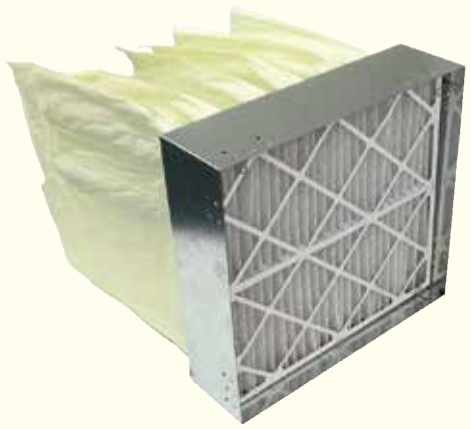
Buying sub-par disposable air filters might be a tempting idea because of lower upfront charges.

However, it does not lower energy costs or guarantee longer service life, high-quality performance, protection of expensive components or better air quality.

Multi-pocket bag (Full size).

COMBINATION FRAMES

Many commercial HVAC applications require staged filter sequencing, such as a combination frame assembly. This typically includes a cardboard disposable pre-filter and pocketed bag or multi-pocket bag filter installed within a metal holding frame. Corner clips or P-clips are commonly used to secure the filters in place.



Combination frame assembly (Cardboard disposable pleated filter and multi-pocket bag filter secured to 100mm holding frame with corner clips).

Filter sequencing works like a set of sieves – the first stage (cardboard disposable) collecting larger particles and the second stage (bag filter) collecting finer particles. Special applications that require ultra-clean air quality, such as clean-rooms, would require a third stage (HEPA).

AIR FILTRATION MEDIA

HVAC air filtration media is available in cotton-polyester blends or pure synthetic blends. Filter media manufactured from 100 per cent synthetic fibres are recommended for use within HVAC applications, as they are resistant to moisture build-up and will prevent the proliferation of mould and mildew.

Quality air filtration media will ideally sustain a high-efficiency performance, with a relatively low-pressure drop, to be effective at air filtration.

More advanced filters, which are used in special applications (HEPA filters), are carefully constructed from "silica-based" materials and binders to form a "paper-like" surface for removal of very fine particles. Any of these specialty filters require special handling methods and processes.

FILTER SIZE AND RATINGS

Nominal filter dimensions can vary by manufacturer, so when dealing with replacement filters, it is essential to know actual filter dimensions and the quantity required before you re-order.

Accepted filter performance rating systems are EN779:2012 (G1 to F9), ASHRAE 52.2 (MERV 1 to 16) and the new and controversial ISO16890. Based on the successful removal of airborne particles by size, these ratings provide a relative measure of filter effectiveness; whereby lower-rated filters remove larger-sized particles and higher rated filters remove smaller-sized particles.

Higher-rated filters will remove more airborne particles. However, this is almost always at the cost of energy and more frequent filter changes. Similarly, lower-rated filters will impact air quality, duct cleanliness, heat-exchanger performance, and in some cases – safety.

Inspection of your current filters will reveal their rating, and you should replace these filters with (at minimum) a comparable-rated filter. With large installations, it is worth checking the original filter specifications to confirm the right filters are still installed.

Over time, it is worth consulting with a knowledgeable and trustworthy filter manufacturer, to see if higher performance filters can result in higher IAQ and lower energy costs. Often by making a change to a modestly more expensive filter that provides lower pressure drops and larger dust holding capacities, you can actually reduce total costs of your clean air equation.

FILTER CAPACITY

While nominal dust-holding capacities obtained from controlled laboratory testing are useful when comparing similar filters within a manufactures range, comparisons between different filters or manufacturers can be misleading. This is due to differences in test conditions, dust ranges and other factors.

Similarly, real-world dust, temperature, humidity and other contaminations are difficult to directly relate to this laboratory test data. As such, you should seek advice from suppliers with reputable technical knowledge and experience. Ultimately, with replacement filters, actual historic data will be your best guide.

Finally, all filters have a finite capacity and benefit from staged filter sequencing i.e. pre-filters followed by higher efficiency final filters. Staged filter sequencing allows inexpensive filters to be sacrificed to maximise the life of the more valuable final filter.

As mentioned before, if the filter looks "dirty" with collected dust, it's far beyond the cost-effective change-out point.

FILTER LIFETIME

In a well-designed system, static pressure is a recognised measurement to indicate appropriate filter change-out times.

For example, if the static pressure across a G4 filter was measured above 175Pa, it is demanding to be changed. While this filter is still providing good air quality improvements, the excess energy used in airflow would cost more than the filter is worth to change.

The appropriate static change-out value for filters change significantly depending on the airflow rate, type of filter, grade of filter, hours of use per day and the dust concentration of the air being filtered. A common value if 125–150Pa is often seen as appropriate. Magnehelic gauges or other sensor methods connected to the BMS are worthwhile additions to a filter housing to give an indication on filter performance.

In general, it's always better to change filters early, rather than late.

ENERGY EFFICIENCY

With steady increases in energy costs and priorities to decrease energy usage for greener buildings, effective air filtration is an increasingly critical component of the energy efficient facility. Accurate tracking of static pressure via a software or manual system will be a significant component in the overall energy assessment.

With older buildings, an overall review of the filter-types and ratings, fan settings and system construction will reveal valuable opportunities for energy savings that would be comparable to LED-lighting conversions.

FINAL THOUGHTS

Buying decisions should start with obtaining the right filter, and then conducting service changes at the appropriate time. Supplier considerations should include stock availability, breadth of range, credible support, warranty and overall cost. Similarly, local and knowledgeable support is an important factor, when changes or upgrades are being considered.

The humble filter is often a forgotten part of the facility, but the people and equipment that it protects are critically important.

So, when did you last check your filters? ■

MORE INFORMATION

This month's Skills Workshop was provided by Airepure Australia.

For more information, visit www.airepure.com.au or call 1300 886 353

Next month: Refrigerant factsheet