Controlled Environments

Science-based Savings for Filter Selection and Maintenance

By Sean O'Reilly

As energy prices spiral, the cost to supply clean air and protect people and contamination from a specific manufacturing process increases, along with an awareness and expectation to protect the environment. Despite these challenges, there are substantial and quantifiable energy savings opportunities to be made through the proper selection of air filters.

Selecting air filters based on total cost of ownership (TCO)—or a science-based approach—allows cleanroom operators to decrease time consuming and expensive cleaning and disposal costs, reduce labor costs, count the savings as cost avoidance with extended filter life, and utilize personnel for other activities.

Many companies in the HVAC arena have jumped on the "green" bandwagon, touting sustainable products, especially filters. While the term "green" may be overused—and possibly abused—these days, modeling tools, such as those developed by Camfil Farr, can identify improvements in performance, efficiency, and cost-savings.

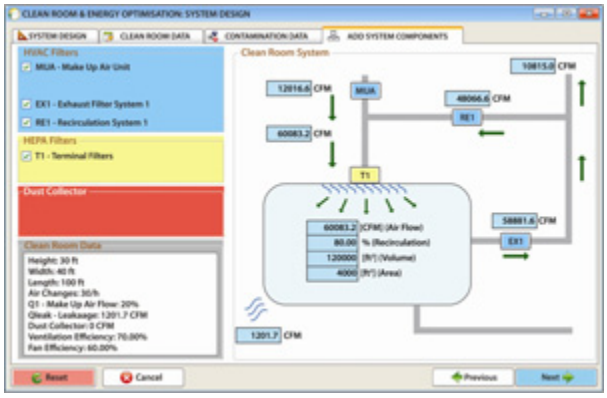
Air filter requirements are based on science and real-life testing, not calculated data. A program of best practices for air filtration needs can be developed with little or no capital investment. There are several key factors in selecting air filters to optimize energy consumption.

Start with understanding what filter efficiency is required to protect the process, environment, or people. Unfortunately, there is a paradoxical relationship between energy savings and filter efficiency. The higher the grade selected (should be a minimum efficiency reporting value of MERV 13 or F7), the higher the energy consumption as the resistance will increase as efficiency increases. Do not use coarse fiber or synthetic media; select glass or fine fibers.

Once the filter grades have been established, along with the number of filtration steps and where these grades are located within the air handling unit, selection should be based on optimizing the pressure drop across each step and crucially establishing a change out point to maximize life at the lowest operating cost based on scientific data.

So when should filters be changed? Two ways typically used: time and pressure drop (or final resistance). HVAC filters can differ from HEPA filters when it comes to when and why to change.

Standard operating procedures or quality assurance may dictate when HEPA filters are changed based on a specific site history or experience. This makes no technical sense from an air filtration point of view. It's more of a risk-versus-benefit decision the particular site has made. While this is understandable at the time, the procedure should be reviewed periodically to take advantage of any potential savings with minimal risk.



Progression screens in CREO software provide graphic representation of selections. The designer can review and make adjustments to reach the desired performance level. Image: Camfil Farr

Ideally, filters should be changed on pressure drop. Often, due to the end users' system and resources, a time-based strategy is selected based on preventive maintenance windows. Still, optimizing lifetime and reduction in energy consumption during the filter's working life is still possible.

In the 1990s, Camfil developed Life Cycle Cost (LCC) software to optimize HVAC or pre-filtration selection. The software—updated over the years—evaluates features of the system in use such as variable frequency drives versus constant volume, and carbon dioxide emission calculations. It also evaluates the key essentials for any air filtration TCO calculation: filter unit cost, labor cost, true average pressure drop, disposal cost, energy cost, and hours of operation.

Scientific data, not calculated data, is a key factor. It is easy to take the simple straight line average from initial differential pressure to final differential pressure and quote an average pressure drop. However, a well-manufactured filter does not load this way; you will see a parabolic loading curve. The LCC software uses data from hundreds of air filters used in many different environments taken from real-life, long-term testing. This data gives the user information—based on science—to aid in making a selection. Also, it takes the guess work out of when and how to change filters.

Filter Lifetime	2 Years	2 Years	1 Year	1 Year	1 Year	1 Year	1 Year	1 Year	1 Year	1 Year
Average Pressure Drop	0.49"	0.77"	1.15"	1.09"	1.21"	1.02"	0.87"	1.34"	1.01"	1.01"
End User Price/2 yrs.	$720	$90	$110	$100	$90	$90	$100	$120	$50	$60
2¢ Energy Cost/ 30 kWh	$317	$300	$248	$199	$282	$663	$567	$871	$617	$670
Additional Energy Cost/ 30 kWh	NA	$383	$431	$382	$465	$346	$250	$554	$340	$353
2 ¢ Energy Cost/ .065 kWh	$206	$325	$486	$455	$509	$401	$368	$566	$427	$455
Additional Energy Cost/ .065 kWh	NA	$719	$280	$249	$303	$225	$162	$360	$221	$267
MLE (Mean Life Efficiency)	76	70	66	74	67	45	47	73	47	76
EU Star Rating	5	4	3	3	2	2	3	3	3	4

Table 1. HVAC air filter selection optimization program comparing a specific final filter (Durafil 4V ES) versus generic final.
Source: Camfil Farr

Note: Comparisons based on 2-year LLC with 2-year installation on 4Vs and 1 year on all others, 2,000

CFM, 6% cost of capital, AP3 at 2,200 hrs., 51-65 AQI, 70% RA, 60% Fan Efficiency

The latest software development from Camfil Farr to support sustainable air filter selection is Clean Room Design & Energy Optimization (CREO) software. Released in April 2012, the software includes features found in LCC Green and an existing cleanroom design software used internally at the company, with some additional features. Options include calculations to increase and decrease air change rates, add or remove people from the room, and particle generation from people and/or the process. Other options are HEPA filter pack depth selection to optimize energy savings above and beyond HVAC filters; simulation of steady state conditions; selection of supply, exhaust, containment (BIBO), and dust collection; and a specification generation tab to capture the design selected.

Table 1 puts the HVAC air filter selection optimization program into perspective, showing the dollar impact savings when comparing a specific final filter recommended by Camfil Farr (Durafil 4V ES) versus generic final filters commonly used in the field.

Summary

Optimizing the filter selection is crucial to maximizing filter life and energy savings. Filter selection and optimization software allows facility operators to select filters based on scientific data. The result, as demonstrated in case studies from different industries, is verified savings in hundreds of thousands of dollars per year on HVAC filters, with little or no capital investment.