HVAC air filters
Calculating the cost

Leadership in Filtration

MANN+HUMMEL

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ABSTRACT

A computer program for calculating and optimising the filter cost in a ventilation system has been developed. The total cost for a filter during its service time can be divided into the following parameters:

- Cost for the Filter
- Energy cost for the fan to overcome pressure drop
- Cost for Maintenance (labour cost for changing filters)
- Cost for Waste

The distribution of costs on the different categories depends on which filter class is used, fan efficiency and service time. The dominating part is the energy cost (for a filter with filter class F7 the energy cost is 80 % of the total cost[1]). Using a filter with lower pressure drop (more filter bags) will reduce the cost for energy use, but the filter cost will increase. To get a cost-effective installation, the ventilation system has to be optimised regarding the number of pockets on the filter.

1 Eurovent/Cecomaf, Recommendation concerning calculation of life cycle cost for air filters

Introduction
Why LCC matters

BACKGROUND

In Sweden there is an energy conservation program running in order to minimise the amount of electricity used. For the HVAC industry there has been a focus on the energy consumption, during the service period for HVAC-components. To justify more energy efficient equipment (from an economical point of view), a calculation model has been developed to calculate the Life Cycle Cost (LCC) for components in an HVAC system.

LCC = Investment Cost + Energy Cost (during service time) + Maintenance Cost + Disposal Cost

The idea with this approach is to get as low LCC for a component as possible. By increasing the investment cost, the cost for energy use can be reduced more than the cost increase for the investment. This would lead to a lower total cost for the customer and lower energy consumption. This model can be used for fans, pumps, filters, building insulation, low energy lamps etc.

PROJECT AIM

The aim for this project has been to develop a computer program that optimises the filter cost (energy+ investment cost for the filter) in an HVAC system. The inputs to the program are

> Investment cost for the filter

> Number of filters in the system

> Flow rate

> Dust concentration in the air

> Exchange interval

> Energy cost (caused by pressure drop from the filter)

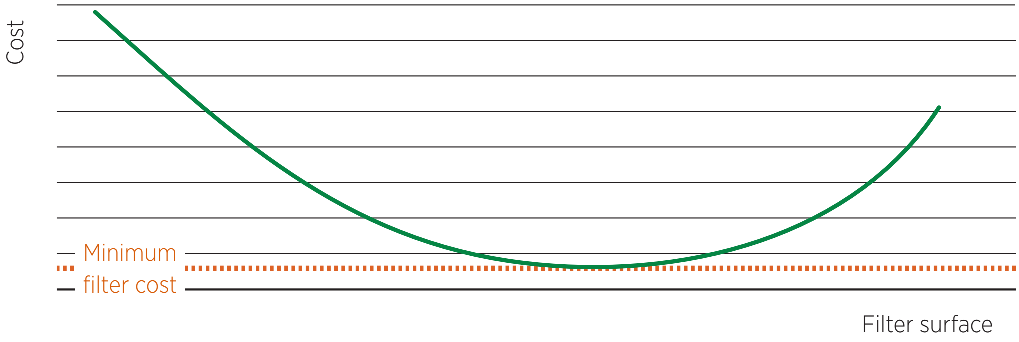
> Fan efficiency

By inserting this data, the program calculates the lowest filter cost for a filter installation. The calculation starts with a 4-pocket filter in the installation. When the program has calculated the filter cost for the installation, it automatically changes one of the filters to a 6-pocket filter (extending the filtration area in order to reduce the pressure drop and lower the energy consumption) and runs the calculation one more time. If this new filter cost is lower than the first calculated cost, the program goes on increasing the filtration surface area until it reaches the lowest filter cost.

Results
Comparing filter classes

If the program found that after the first calculation the cost has increased, it automatically starts to reduce the filtration area by removing filters from the filter installation. When the lowest filter cost is found, it stops and presents the result. The program output is the number of filters and pockets, the energy consumption, and the initial and final pressure drops.

Filter cost vs. filter surface



RESULTS

Calculations have been made for two different filter classes to show the difference in filter cost comparing an optimised installation and a not optimised installation. Further on, the calculations show the difference in filter cost for a filter of class M5 and M6.

Example
Filter Class M6

Number of filters	10 PCs.
Flow rate	10 m^3/s
Dust concentration	15 $\mu g/m^3$
Energy cost	0.05 US$/kWh
Fan efficiency	50 %
Change Interval	12 months
Filter class	M6

As we can see from the example it is possible to reduce the cost by 17% from 2150 to 1750 US$, just by selecting the correct number of pockets for the system. The energy consumption has been reduced from 26800 kWh/year to 17600 kWh/year.

Another important output from the program is that it highlights the differences in cost between different filter classes. When the calculation is made for a filter class M5 we get the results seen in Table 2.

As we can see from the calculation, the total cost (optimised concept) for a filter of class M5 is 1020 US$. Upgrading from M6 to M5 will lead to an increase in costs of 730 US$ (1750-1020 US$). The major part of the cost increase depends on the energy consumption. The difference in energy consumption between an M6 filter and an M5 filter is 9800 kWh/year (490 US$)

Table 1
Filter Class M6

	STANDARD CONCEPT	**OPTIMISED CONCEPT**
	4-POCKET FILTER	**6-POCKET FILTER**
Number of Filters	10	10
Initial Pressure Drop Pa	77	61
Final Pressure Drop Pa (after 12 months)	230	140
Cost for Energy US$	1600	1000
Cost for Filter US$	550	750
Total Cost (Filter +Energy) US$	2150	1750

Table 2
Filter Class M5

	STANDARD CONCEPT	**OPTIMISED CONCEPT**
	4-POCKET FILTER	**6-POCKET FILTER**
Number of Filters	10	10
Initial Pressure Drop Pa	51	40
Final Pressure Drop Pa (after 12 months)	118	58
Cost for Energy US$	890	510
Cost for Filter US$	340	500
Total Cost (Filter +Energy) US$	1230	1020

Conclusions
Filter class counts

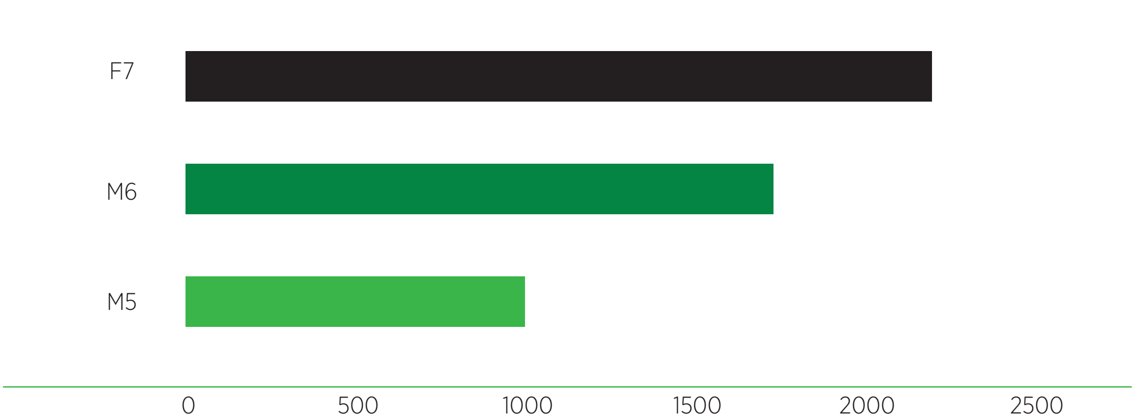
The program has been in use in our sales force for a period of one and half year. Our experiences this is that optimising the filter banks often results in substantial reduction of the filter cost.

One example is Landvetter Airport. Landvetter has expanded the building surface during the last years. To get enough supply air to the new building area, the revolutions on the fans were increased, but the filter surface was not. When we did calculations on the system we found that by increasing the filter surface by 50 % the filter cost could be reduced by 40 %.

We found that the program could also result in big savings when the optimised bank turned out to be smaller than the original one. In order to save money, they have closed many operation theatres at Borås Hospital. To those areas the supply air has been minimized. We did a calculation on a filter bank with 80 filters. The program found that the optimum number of filters was 16.

Another important output from the program is highlighting the cost for different filter classes.

Cost for Different Filter Classes
US$



The evidence shows that the cost for operating F7 filters is 2.2 times higher than running a filter of class M5.

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