Sizing of Nedlaw Indoor Air Biofilters

A Technical Note by Dr. Alan Darlington

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System Description
The biofilters appear as vertical hydroponic green walls containing a wide range plants specifically selected for each site. However, the plant wall is actually an integrated part of the handling system for the building.

Air is actively forced through the wall of plants and highly specialized biological components actively degrade pollutants such formaldehyde and benzene in the air into their benign constituents of water and carbon dioxide. The clean air is then distributed throughout the building.

Background to Sizing Issue
One of the most frequent question we receive is "How big should the wall be?"

Sizing of Wall
There at least three ways to calculate the size of the wall for a particular application. The first, the quickest and simplest is a simple 1:100 ratio for the size of the biofilter to the area of floor space being treated by the biofilter. A 200 m^2 space would require 2 m^2 biofilter.

The second is the size based upon the number of people to occupy the area being treated by the biofilter. Typically the one square metre of biofilter will provide enough virtual outside air for 5 people. In other words a space holding 10 occupants would require 2 m^2 of biofilter.

Both these methods assume air fluxes of approximately 50 litres per second through each square metre of biofilter (air flux of 0.05 m/s or roughly 10 cfm per square foot) and 60% removal efficiency by the filter.

These two methods are approximately the same since most commercial spaces use a 20 m^2 of floor space per person occupancy density.

The final method of sizing is to use the mechanical requirement of the space for clean air to dictate the size of the system. Here the mechanical consultant supplies us with an amount of makeup air required to meet their needs. We then calculate the number of square metres of biofilter and air flux required to meet the mechanicals needs.

Size and performance of wall as a biofilter

The quantity and quality of the biofiltered air dictates the impact of the wall on the overall indoor air quality. For any given size of biofilter, the quantity of air generated is governed by the flux (rate of flow) of air through it. This is the basis of a research paper published by Darlington and co-researchers on flux, temperature and performance of the system

There is a balancing between the flux and quality of air generated. Basically, the longer the contact time between the 'dirty' air being drawn through wall and the wall itself, the more of the contaminants can be removed.

The quantity and quality of the biofiltered air dictates the impact of the wall on the overall indoor air quality.

For a given wall size, drawing the air through slower (lower flux) means we get a smaller volume of air but it is of higher quality. Increasing the size of the wall means that this decrease in volume of treated air can be compensated for.

The modeling of flow rate and performance is complicated by the lack of linearity between removal rates and air flow, in other words doubling the flow rate does not cut the percent removed per pass in half. It is less than half. This means the absolute amount of contaminant removed over time increases with higher fluxes.

But the relative quality of the exhausted air diminishes. Aside: the increasing absolute removal with flux has limits, the removal capacity of the system will saturate with air speed (typically between 0.15 and 0.20 m^3_{air} per $m^2_{biofilter}$ per second).

With commercial applications, we have typically targeted fluxes of 0.05 to 0.07 m^3_{air} per $m^2_{biofilter}$ per second. Recent studies suggest that this number can be increased to 0.1 m^3_{air} per $m^2_{biofilter}$ per second. If the system is using onboard fans, then special concern has to be made for the noise made by the fans. In this case we tend to under size the amount of air being treated by the biofilter.

Obviously factors such as aesthetics, design and capital and operating factors should also be taken into account but generally for a given amount of air required, a smaller wall means higher air velocities and therefore less contaminant removed.