UNIVERSITY OF TECHNOLOGY SYDNEY

UTS:SCIENCE

DEVELOPMENT AND AUGMENTATION THE JUNGLEFY BREATHING WALL

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EXECUTIVE SUMMARY

Our current work has established that the existing Breathing wall system used inside buildings has the capacity for indoor air purification or biofiltration, with the retention of suspended particles (and removal of VOCs. This project aimed to optimise the constituents of a botanical biofilter system for the maximisation of bioremediation properties. The work presented here identified the most efficient plant species for air pollutant removal within the existing system. Further, investigations identified substrate characteristics for enhanced air quality biofiltration in indoor environments, with an assessment of the capability of the modified system to ameliorate the major forms of air pollution.

Whilst it is known that the plant growth substrate in active biofilters can act as a filter medium, it was previously not known whether the plant component of these systems played a function in PM filtration. Despite differences in single pass removal efficiency across treatments, green walls containing all species of plants effectively reduced PM across all tested fractions, and thus would contribute to improved air quality if used *in situ*. Fern species recorded the highest removal efficiencies across all measured particle sizes (*Nephrolepis exaltata bostoniensis* SPRE for $PM_{5\text{-}10}$ = 92.46%). An assessment of plant morphological data suggested that the root structure of the plants strongly influenced removal efficiency, the likely mechanism for which is the roots creating a filter themselves, and/or root induced substrate alteration. These findings demonstrate the potential to enhance active botanical biofiltration technology with appropriate plant species selection, with the percentage of PM filtered from a polluted air stream higher than that of many common HVAC filter media.

An investigation was also made of the filtration capacity of multiple substrate types, and the addition of a material (material X) with known VOC absorbent properties. This was achieved by assessing their ability to remove PM, benzene, ethyl acetate and ambient total VOCs. The system's capacity to filter out VOCs was increased from 34.5% to 60.24%, nearly doubling its efficiency. This improvement marks a major step forward in air cleaning technology, as most existing filters simply remove suspended particles and cannot filter out VOCs.

Whilst the system is currently somewhat less efficient than a conventional HVAC filter, the system shows potential, and further developments that improve its efficiency to match those demonstrated by current air filtration methodologies should be possible. Additionally, the system's ability to remove VOCs and PMs and modulate temperature and humidity make the device superior to most non-biological systems as general air quality maintenance devices. Nonetheless, further controlled laboratory experiments are needed to investigate the long term performance of the system, and to better describe the simultaneous removal of PMs and VOCs. These investigations will provide empirical data on which to develop a simulation model that can be used to optimize the system's design, as well as to advance the implementation of the device.

Recently, an emphasis on the acoustic benefits of Vertical Greenery Systems has led to an increase in their implementation. An investigation was made into the acoustic applications of these systems and the influence of the density of the soil substrate and plant matter on the audio

absorption coefficient. Additionally, the shape of foliage and the ratio between rigid and non-rigid plant matter will was incorporated into the experimental design to determine if these factors have the greatest effect on the scattering coefficient. Results from studies performed in the previously mentioned literature indicate that the characteristics of vertical greenery systems that most affect absorption are the density of the plant matter, and the composition of the substrate at higher and lower frequencies respectively. Little research has been done into the relationship between the specific physical characteristics of the plants themselves and acoustic performance, which requires further investigation.