UNIVERSITY OF TECHNOLOGY SYDNEY

UTS:SCIENCE

DEVELOPING THE JUNGLEFY BREATHING WALL FOR ENHANCED INDOOR AIR QUALITY REMEDIATION

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KEY RESEARCH HIGHLIGHTS

The Junglefy Breathing Wall system has been shown to be capable of removing several key air pollutants from indoor air. However, to develop the system to achieve maximal air pollutant mitigation, several critical operational variables required characterisation. These included system operational water loss, pressure drop, air distribution and the system's effect on ambient temperature and relative humidity.

As an initial assessment of system particulate matter removal, clean air delivery rates were calculated utilising single pass removal efficiencies. The system produced 25.86–28.70 m^3/h of clean air per module, depending on particle size and airflow rate. A typical Breathing Wall of 10 m^2, utilising 40 modules would thus produce up to 1034.4–1178 m^3/h of particle-free air.

Tests were conducted to identify the most appropriate plant species for survival in high pollution environments. All of the plant species tested, which are currently used in commercial applications of the Breathing Wall, recorded moderate air pollutant tolerance, and thus the system using the current plant species could possibly be used in industrial applications. Pollutant effect on the air filled porosity of the substrate was negligible, even under extremely high pollutant loads.

Air quality tests were conducted at the Lend Lease Head Office, and the efficiency of the first Breathing Wall installation was monitored. The Breathing Wall is successfully reducing ambient particulate matter and carbon dioxide relative to outdoors and other areas throughout the building. Additionally, air pollutants including carbon monoxide, volatile organic compounds and sulphur dioxide were below the detection limit of the equipment being used, indicating excellent indoor environmental quality. The results indicate that the Breathing Wall is working as intended.

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EXECUTIVE SUMMARY

Recent advances in green wall technology have led to the development of activated systems that move air through the plant substrate to increase the rate at which they can modulate the interior atmospheric environment. These systems have enhanced pollutant removal capabilities, and may also be capable of stabilising the temperature and humidity of the indoor environment. Development of this technology is moving towards the integration of activated plant walls within building air conditioning and ventilation systems. A leading active green-wall system is the 'Breathing Wall', developed through a collaboration between Junglefy Pty Ltd (Sydney, Australia) and the Plants and Environmental Quality Research Group at the University of Technology Sydney.

The work presented here describes studies conducted to evaluate several operational characteristics essential for determining the functionality of the Breathing Wall, as well as experiments to systematically characterise the effectiveness of the device in removing particulate matter from air. In doing so, the air flow rate and distribution, as well as the pressure differential across the Breathing Wall module were characterised, the moisture loss potential of the system was determined, as has the Breathing Wall's effluent air temperature and humidity. Subsequently, the single-pass removal efficiency, or the fraction of particulate matter in contaminated air removed by the Breathing Wall, was defined, and used to calculate the clean air delivery rate to allow direct comparison to contemporary mechanical filtration systems. Whilst the removal efficiency detected was lower than conventional in-room air filters, development of the device has the potential to improve the system.

Further work was conducted to evaluate the use of the system in highly polluted environments, measuring the resilience of the botanical components, in addition to changes to the air filled porosity of the substrate, an important characteristic of the system which may constrain its long-term efficiency. All species tolerated exposure to 5 weeks of concentrated hydrocarbon emissions reasonably well, with visible, but limited pathological effects. Surprisingly, the effect of very high

particulate pollutant loads on the on air filled porosity of the substrate was minimal. Thus it is likely that the botanical component of the system will be the limiting system variable dictating the long term viability of the system in highly polluted environments, rather than the interaction between the filtered particles and the system filter matrix.

Finally, we describe a case study involving field sampling of the first installation of the Breathing Wall within a commercial environment. Both particulate matter and carbon dioxide levels were lower at the area surrounding the Breathing Wall relative to other areas throughout the building. Other air pollutants including carbon monoxide, volatile organic compounds and sulphur dioxide were below the detection limit of the equipment being used. Overall, the results indicate that the Breathing Wall is working as intended by effectively removing indoor air pollution.

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