Building-Integrated Active Phytoremediation Systems

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ABSTRACT

Contemporary construction materials and building types are complicit in the degradation of indoor air quality (IAQ) and have become principal contributors to health problems in developed countries. Compounding this is the poor, and in many cases severely deteriorating air quality within global metropolitan areas which is an important determinant of population health and well-being. The purpose of this thesis is to develop and research the potential of a 'Bio-Mechanical Hybrid' Heating Ventilating Air Conditioning (HVAC) building system to improve indoor air quality while decreasing both the energy consumption and exposure to external air pollution that is associated with external air intake systems. Transferring hydroponic / phytoremediation technologies developed by Bill C. Wolverton for closed loop systems (habitable space environments). The research focuses on the transfer of phytofiltration and remediation techniques using biological matter to 'scrub' toxins from the air by integrating select hydroponic supported plant materials into HVAC building systems. The methodological argument of this thesis engages interdisciplinary study to develop an integrated system design that brings together emerging technology in architecture, mechanical engineering and biology, in a Building-Integrated Active Phytoremediation System. Finally, this research demonstrates how the integration of hydroponic phytofiltration technology with conventional HVAC systems has potential to further increase the conventional air cleaning capacity of common plant leaves 200 times by exposing the airstream to the plant root matrix, thereby having the secondary potential effect of dramatically decreasing the energy consumption profile of buildings. By integrally cleaning airborne contaminants associated with poor indoor air quality, this system has the potential to decrease or even eliminate fresh air requirements required by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and with that the potential to both realize substantial energy savings in climate types with high heating and/or cooling loads and to reduce or eliminate the need to intake, treat and circulate poor quality air in heavily polluted urban areas.

Keywords: Indoor Plants, Indoor Air Quality (IAQ), Phytoremediation, Hydroponics, Energy, HVAC Systems, Sick Building Syndrome (SBS).