

**Combined Active, Passive, and Biological Methods for Cleaning Indoor Air
and Reducing Building Energy Consumption**

by

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ABSTRACT

Indoor air quality is maintained by heating, ventilating, and air conditioning equipment that accounts for 30 to 40% of a building's total energy consumption. There are two primary factors that define IAQ: the *condition* of air, and the *quality* of air. The condition of air leads to human *thermal* comfort and is controlled through normalizing temperature, humidity, and air velocity. The quality of air impacts human *health* and is controlled by various filtration methods and the dilution of indoor toxins with outside air. These two IAQ factors are at odds with each other when viewed through the lens of energy efficiency. The former requires large energy investments in thermal conditioning, yet the latter requires the constant replacement of that conditioned air with unconditioned air. If we continue to rely on unconditioned outdoor air as the predominant method of remediating indoor air quality, then there is a definitive limit to how low building energy consumption can go in terms of HVAC. In order to achieve significantly lower energy use than current technology affords, the relationship between the condition of the air, and the quality of the air has to be reconfigured.

Passive, active, and biological methods for air quality control have been in use for centuries. A comprehensive remediation system that combines these three methods and significantly reduces dependence on outdoor air would provide fresh indoor air through morphologically driven separation of particulates, living microbial remediation of toxins, preventative material properties, and localized thermal conditioning. The comprehensive remediation system must address the vast scalar differences, from the smallest gases to the largest particulates, of airborne pollutants. The successful system would first prevent the growth of unwanted biological contaminants, while also separating, sequestering and digesting unwanted volatile organic compounds and other gasses such as carbon dioxide and carbon monoxide. A comprehensive system for both the condition and quality of indoor air can bring these two factors into symbiosis and allow for comfort, health, and energy efficiency to simultaneously exist in buildings.