Pura Aer 2: Dual-Stage, Energy-Efficient, Modular Air Purifier System, Inspired by Porifera To Improve Air Quality

Prawira, Jordan (School: Mountain House High School)

Air pollution, especially PM 2.5, affects the health of millions of people globally, causing premature death. Outdoor air pollutants can leak indoors, leading to pollution concentrations 2-5x higher. The project goal is to develop a low-cost, energy-efficient air purifier system inspired by sponges, phylum Porifera, passive filter feeders. Pura Aer 2 (PA2) was developed in 5 phases and consists of 3 main parts (purifier structure, Air Mesh, Air Tunnel), implementing the sponge's canal systems and hyperbolic shape. Control was the original PA using face masks as filters. PA2 as a dual-stage filtration system outperforms control in filter performance, reaching Good Air Quality from hazardous levels in 20 minutes, removing 94% more pollutants in 15 minutes with energy efficiency 160% higher than control. PA2 generates airflow higher than the ASHRAE indoor ventilation standard (0.35 ACPH) using 5W of power and does not require consumable filters. Air Mesh captures particles using a variable mesh pattern and mechanical sieving. Air Tunnel provides high-efficiency and clog-resistant filtration, implementing the Coanda Effect and inertia to separate particles. Solidworks flow simulation (air and particle flow) supported test results, high-speed air increases particle gas separation. System optimization modularizes the design and reduces cost to $48.47. Dual-Stage filtration removes the most pollutants, as Air Tunnel filters the majority of particles and reduces clogs, while Air Mesh captures any leaked particles as a secondary filter. Air Tunnel's hyperbolic shape maintains high airflow, improving filter performance. Modular design (nesting and stackable) makes PA2 more functional and portable. PA2 improves air quality and reduces air pollution-caused health risks.

Awards Won:
Third Award of $1,000
Office of Naval Research on behalf of the United States Navy and Marine Corps: The Chief of Naval Research Scholarship Award of $15,000
Arizona State University: Arizona State University ISEF Scholarship (valued at up to $52,000 each)