IEQmax Air Filtration System for Agricultural Environments

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Background & Motivation

- The IEQmax is an air quality monitoring device originally used in clean, medical settings
- IEQmax's goal is to develop an Agricultural Pilot Project
- Improved air quality monitoring will enhance animal welfare, ensure worker safety, and optimize production

Livestock accounts for 14.5% of worldwide **methane** emissions

81% of global **ammonia** emissions are due to agriculture

High PM2.5 and PM10 levels can lead to breathing problems and respiratory irritation

Objective

Design and build an outer enclosure that:

- Protects the IEQmax from large particles and sensor damage
- Simulates ambient external air conditions within the enclosure
- Enables mounting in various agricultural locations

Design Specifications

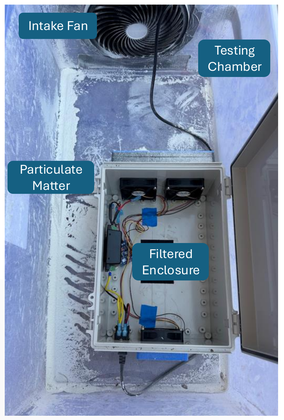
- ✓ Filter particles > 10 microns
- ✓ Maintain 95% data similarity
- ✓ IP51-rated
- ✓ Adaptable external mounting for poles, walls, and shelves
- ✓ Secure internal mounting system
- ✓ Filter maintenance < 5 min to extend lifetime
- ✓ Power with surge protection
- ✓ System weight < 10 lbs.

Large Enclosure → Small Enclosure

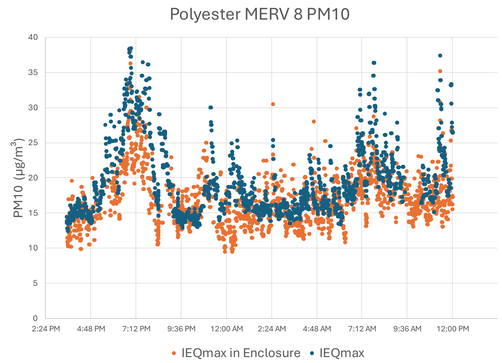
Large Enclosure	Small Enclosure
Oversized enclosure for optimal airflow	Compact and lightweight design for easy installation
Utilizes a large (6"x6") MERV 6 box filter	Integrates filter rolls that come in a variety of ratings
Higher cost and weight	Lower cost and weight

Testing

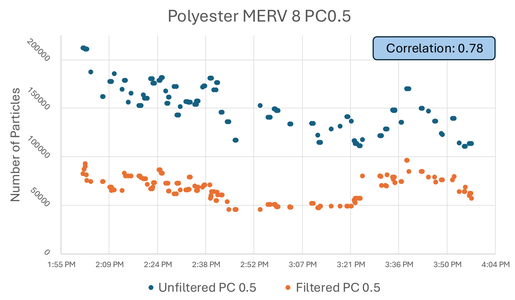
- Ingress Protection (IP51)
- Filter Exchange for Maintenance
- Mounting Ease-of-Use
- Preliminary Particulate Test
  - Testing Setup →

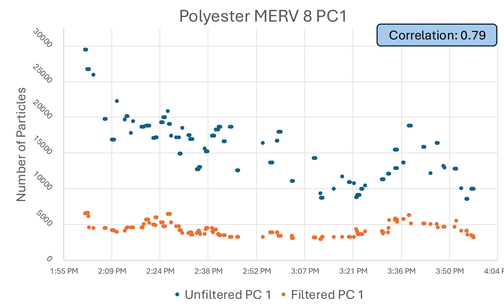


IEQmax Control Similarity Testing



Correlation Coefficients		
PC 0.5	**PC 1**	**PC 5**
0.78	0.79	0.26



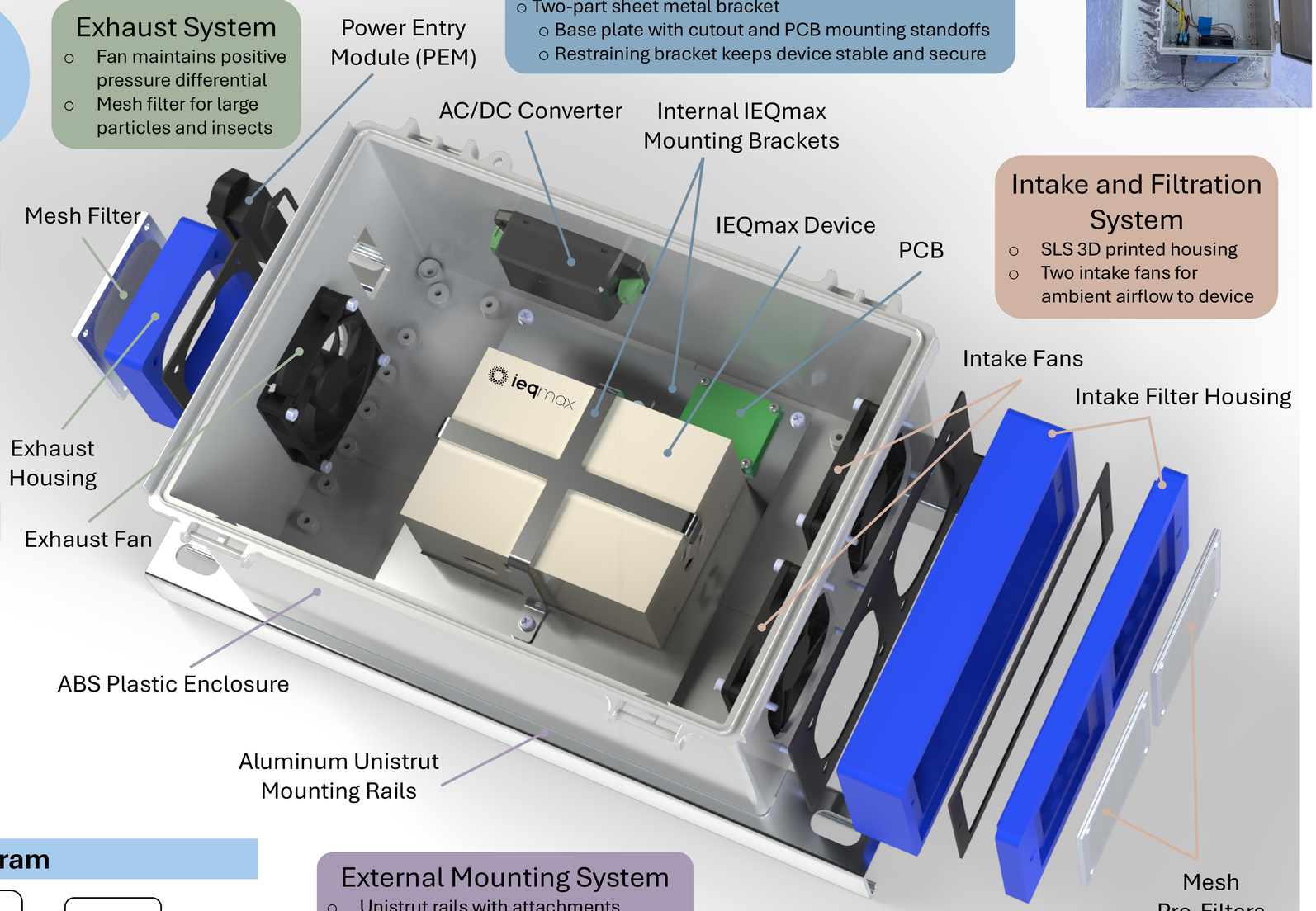


Exhaust System

- Fan maintains positive pressure differential
- Mesh filter for large particles and insects

Internal Mounting and Electronics

- Two-part sheet metal bracket
  - Base plate with cutout and PCB mounting standoffs
  - Restraining bracket keeps device stable and secure



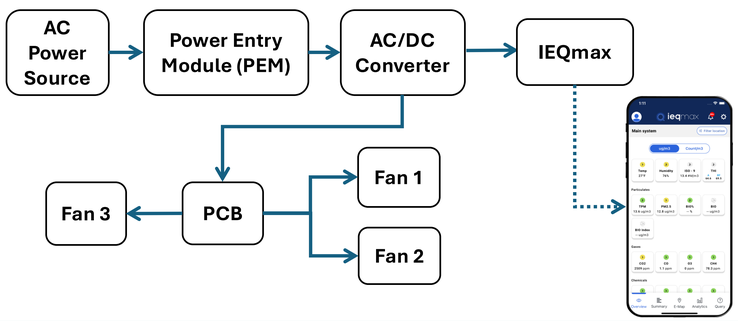
Intake and Filtration System

- SLS 3D printed housing
- Two intake fans for ambient airflow to device

External Mounting System

- Unistrut rails with attachments
- Variety of mounting options

Wiring Diagram



Challenges

Testing Challenges

- Calibration of sensors & accuracy
- EPA facility sampling frequency

General Challenges

- Nature of a pilot project
- Iteration of key components

Impact

"The output of this project enables IEQmax to sell our solution into new more complex markets, including agriculture where real-time monitoring can have a significant impact on improving worker and animal welfare and optimizing resource management."

- Melissa Edison Barnes (President, IEQmax)

Future Work

- Higher IP rating for outdoor applications
- Enable compatibility with renewable energy sources
- Integrate fan control into PCB design
- Perform extended field testing to better determine lifetime

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