



Problem statement:

Developing an energy-efficient, automated system that safely enriches room oxygen levels while maintaining an oxygen-air ratio below 27% is a key challenge.

Constraints

- Space Limitation:** Fits within rooms ≤ 100 cubic meters.
- Safety:** Oxygen-air ratio $\leq 27\%$
- Ventilation Structures:** System depends on building ventilation configuration.
- Compatibility:** System components must be compatible.

Target Specifications

Cleanliness of Feed Air: Free from contaminants or dust	Operational Volume ≤ 100 cubic meters
Vacuum Pump Pressure: -0.75 barg	Membrane Oxygen Purity $29\% \pm 0.5\%$
Membrane Product Flowrate: 300 ± 100 L/min	Smoke Detector Response < 1 second
Blower Flowrate: 1666 L/min	System Lifetime ≥ 5 years
Energy Consumption: 3 kW	Membrane Size: $530 \times 220 \times 580$ mm
Air Permeability: 166.6 L/min	Membrane Weight ≤ 13.2 kg

Project Impact

- Welfare:** Enhances well-being and productivity with improved air quality.
- Environmental:** Minimizes power consumption and transport emissions.
- Economic:** Reduces both capital and operational expenses compared to traditional oxygen concentrators and cylinders.

Essential Parts

Membrane

Manufacturer: Gouchu
Technology
Model: P02801020
Operating pressure: $0-80$ kpa
Air Intake: Clean Air
Oxygen Purity $29.5\% \pm 1\%$



Vacuum Pump

Manufacturer: Tidrop
Model: RS-1
Vacuum: 5 Pa
Free air displacement: 2.5 CFM



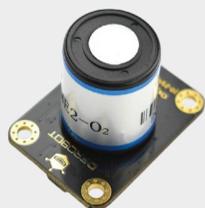
Air Blower

Brand: Zartsen
Model: R1-100
Power: 35 W
Speed: 2600 L/min



Oxygen Sensor

Manufacturer: DFROBOT
Model: SEN0322
O₂ concentration: $<30\%$
Dimension: $37 \times 27 \times 24.5$ mm
Weight: 0.037 kg

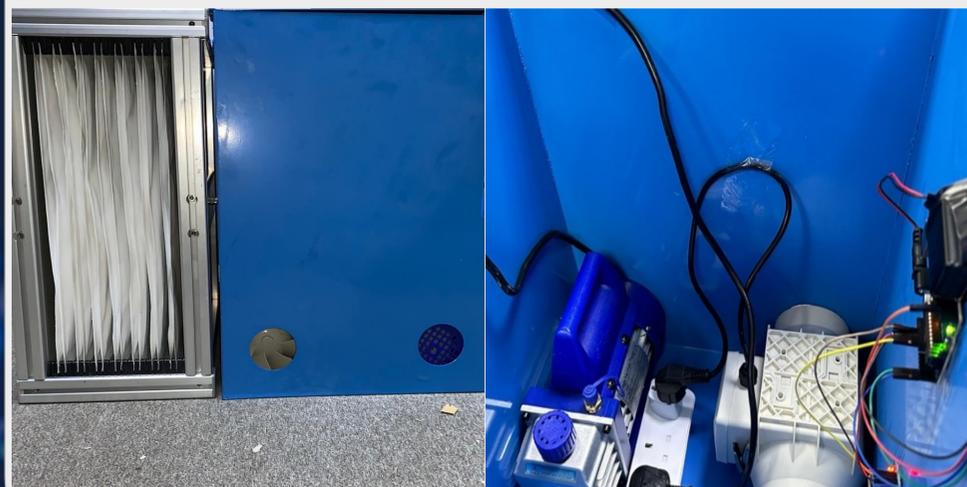


Arduino

Manufacturer: Arduino
Model: UNO
Software : Arduino IDE 2.3.3
Analog ports: 6
Digital ports: 14
Clockspeed: 16 MHz
Flash memory: 32 KB



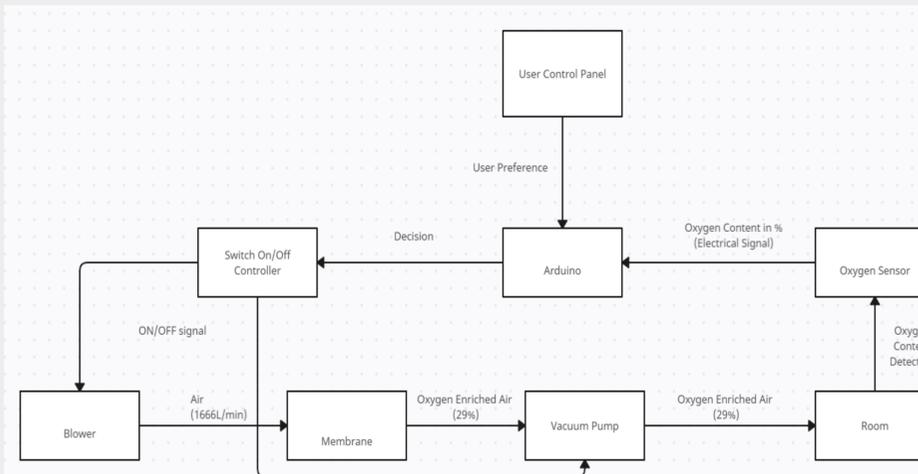
Final Assembly



Conclusion

The innovative O₂ booster system, utilizing air separation membrane technology, represents a breakthrough solution for addressing respiratory health concerns in diverse environments. It provides sustainable, energy-efficient oxygen enrichment, overcoming logistical and safety challenges of traditional methods. With high customization and a robust lifespan, it offers real-time, on-demand oxygen supplementation tailored to specific user needs. While some performance variations were observed in the prototype, ongoing optimization efforts aim to restore full capacity and enhance respiratory health through continuous, proactive oxygen enrichment.

Block Flow Diagram

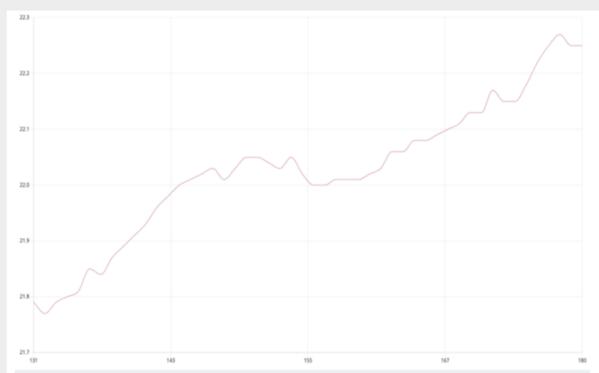


Acknowledgment

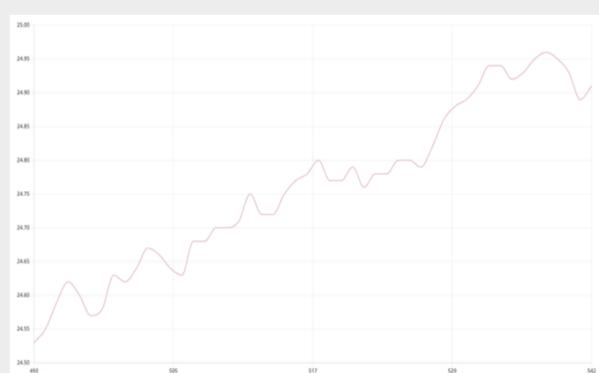
We would like to express our heartfelt gratitude to the design team, which was coached by Dr. Bo Liu, and to KFUPM for their invaluable contributions towards the Spinning Drone project.

Testing and Validations

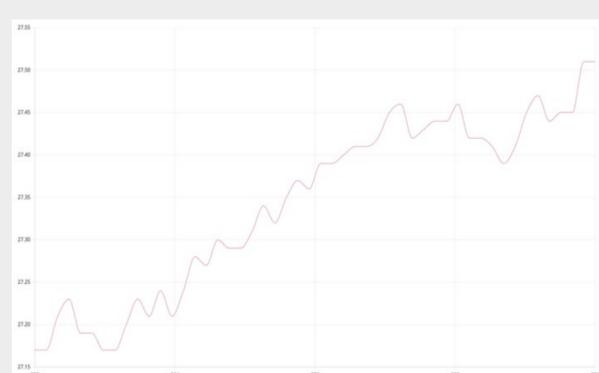
Oxygen reading after 3 minutes



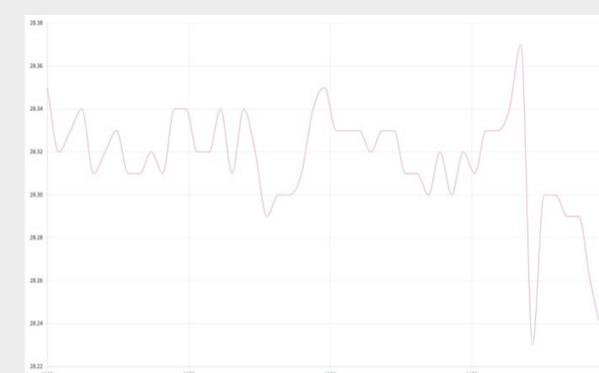
Oxygen reading after 9 minutes



Oxygen reading after 15 minutes



Oxygen reading after 20 minutes



Key Takeaways

- Product Flow Rate:** Fell within the specified range.
- Oxygen Purity:** Measured 0.3% lower than specified, reducing operational capacity by 12.7 cubic meters.
- Optimization Focus:** Improve flow between mechanical components to enhance oxygen purity and restore capacity.