TEAM F09

Hospital Oxygen Supply System Using Hollow Fiber Membrane Integrated With Pressure Swing Adsorption (PSA)Unit

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CHE

ICS 3 ISE

PROBLEM STATEMENT

To address the risk of oxygen shortages in hospitals, this project designs a reliable hybrid membrane-PSA system that ensures continuous, high-purity oxygen supply under varying demand conditions.

Uniqueness & Novelty

A hybrid membrane–PSA system is used instead of conventional PSA-only systems. The membrane increases oxygen from **21% to ~31%**, reducing PSA size and improving efficiency, while maintaining reliable and scalable oxygen production.

Constraints & Specifications

Constraints

- Store operating/alarm data ≥6 months
- Testing per ISO 13485 & ISO 14971 standards
- O_2 purity 93–99 mol%; production 40–60 m^3/h
- Energy consumption ≤ 0.8 kWh/Nm^3 O_2
- Membrane stage cut 0.1–0.4

Specifications

- System availability ≥ 99%
- Pressures 4–6 bar; temperatures 20–35 °C
- Alarm to abnormal conditions within 1–2 s
- SPC control charts; purity within ±1% control limits
- Backup storage covers 6–12 h
- Alarms: purity <93%, supply <85–95%, storage <15–25%
- Color-coded alarms & trend graphs
- Dashboard shows purity, flow, pressure, storage
- Membrane pre-enrichment raises O_2 mole fraction from 0.21
- Air compressor delivers 4–6 bar for membrane separation

Integrated Specifications

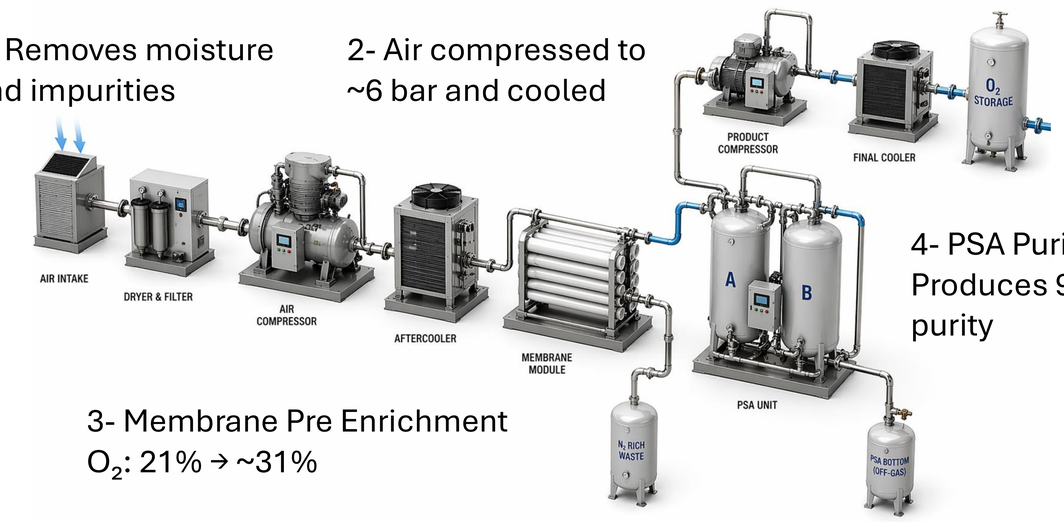
- Scale from clinic to hospital; purity 93–99 mol%, coverage ≥95%
- Cover ≥95–100% demand; energy ≤0.8 kWh/Nm^3
- Dashboard integrates demand forecasts with real-time data; auto-alerts

Hybrid Membrane–PSA Oxygen Generation Process

System Process Flow

1- Removes moisture and impurities

2- Air compressed to ~6 bar and cooled

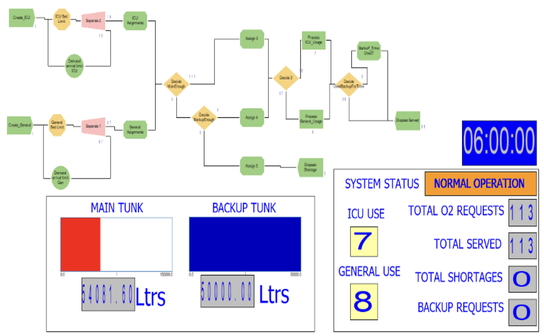


3- Membrane Pre Enrichment
O_2: 21% → ~31%

4- PSA Purification Produces 95.5% O_2 purity

Simulation

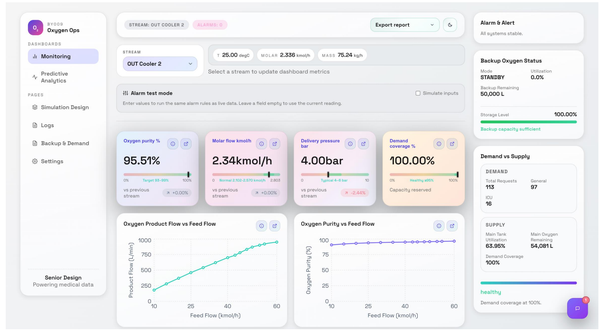
Normal & Peak Scenarios



Backup Storage Availability

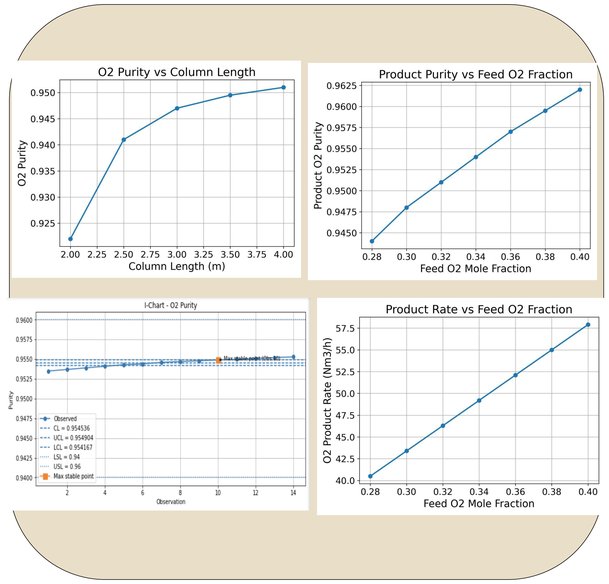
Smart Monitoring Dashboard

Monitoring Dashboard Alarm System



Predictive Analysis AI Assistant

Validation and Verification



CONCLUSION

The project delivers an integrated hybrid membrane-PSA oxygen system with simulation, optimization, and monitoring to ensure stable performance and meet demand, with strong scalability for real-world use.