OxyGen: A Low-Cost Oxygen Concentrator for Low-Resource Settings

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CLINICAL NEED

Hypoxemia: Inadequate supply of blood oxygen, can lead to brain & organ damage1,2
- Nepal: 20-30% of adults affected, accounts for 1/3 of hospital visits3

Hypoxemia in Low-Resource Settings
- Lack of oxygen supply for treatment
  - Piped Systems
    - Expensive to implement and maintain4
  - Oxygen Cylinders
    - Difficult to transport4
  - Oxygen Concentrators
    - Ideal WHO price: $450; Devilbiss 525 series: $5852

PROPOSED SOLUTION

Needs Statement: Construct a durable and portable oxygen concentrator that provides oxygen at 85% purity.

Goals
- >85% oxygen purity
- >10 L/min output
- <20 pounds, portable

Implementation
- 2 cylinder Pressure Swing Adsorption (PSA)

MARKET ANALYSIS & DEVICE COST

- Estimated market for oxygen concentrators in Nepal: ~8 million patients
  - Based on the incidence of hypoxemia for adults in Nepal

RESULTS

Table 1: Oxygen Purity vs. Time

| Time (s) | DePressurization
<table>
<thead>
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<tbody>
<tr>
<td>0</td>
<td>35%</td>
</tr>
<tr>
<td>40 psi</td>
<td></td>
</tr>
<tr>
<td>50 psi Trial 1</td>
<td></td>
</tr>
<tr>
<td>50 psi Trial 2</td>
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<tr>
<td>50 psi Trial 3</td>
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Single-Bed System Testing

figure 1: maximum oxygen purity achieved (left)
figure 2b: fully wired dual-bed system with PSA (right)

CONCLUSIONS

- Identified LiX zeolite to be best option for nitrogen adsorption
- Designed circuit for controlling solenoid valves
- Progressed from single-bed purification system to dual-bed system with pressure swing
- Achieved 32.5% purity oxygen with dual-bed pressure swing system
- Optimal cycle time: 8 seconds
- Optimal starting pressure: 50 psi

FUTURE WORKS

Next Priority
- Increase purity of oxygen output to >85%
- Use air filter to purify input air

Long-term
- Increase volumetric flow output of oxygen to accommodate multiple patients
- Develop portable casing

ACKNOWLEDGEMENTS

The OxyGen BME Design team would like to thank Dr. Conrad Zapanta for his guidance and mentorship with this project, along with course TA Angela Lai for her continuous assistance. We would also like to thank the Undergraduate Resource Office for funding this research. Additionally, we would like to thank Emily Reichert and Professor Vishwa Shrivastava for providing context about resources in Nepal, and Matt Cline and Tim Alpert for assisting with lab work, all of which helped bring this project to fruition.

REFERENCES


Parts

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<thead>
<tr>
<th>Parts</th>
<th>Price</th>
<th>Quantity</th>
<th>Total Price</th>
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<tbody>
<tr>
<td>Solenoid Valve</td>
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<td>6</td>
<td>$125.28</td>
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<tr>
<td>Polyethylene Tubing</td>
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<td>$2.50</td>
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<td>Compressor</td>
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<tr>
<td>Arduino Uno/Logic Board</td>
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<td>$30.00</td>
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<td>Zeolite</td>
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<td>Total Cost</td>
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