### Clinical Need

**Hypoxemia**
- Respiratory diseases like chronic obstructive pulmonary disorder and pneumonia lead to hypoxemia
- Low blood-oxygen saturation
- 1/3 of hospital visits and 20-30% adults affected

**Oxygen Supply**
- Oxygen- one of the essential medicines by World Health Organization (WHO)
- Highly effective in treating hypoxemia
- Not widely available in low resource settings

### Design Accomplishments

#### Oxygen Tanks
- Designed to transport oxygen
- Used for emergency situations

#### Oxygen Pipeline System
- Designed to supply oxygen to patients
- Requires steady voltage supply

#### Oxygen Concentrators
- Designed to concentrate oxygen
- Difficult to transport

### Solution Profile

**Existing solutions and their shortcomings Include:**
- Oxygen Tanks: Difficult to transport
- Oxygen Pipeline System: Very expensive
- Oxygen Concentrators: Expensive

**Needs Statement**
- An affordable, safe, and effective oxygen concentrator capable of handling power supply issues

**Pressure Swing Adsorption**
- Designed a dual bed setup that would allow for continuous oxygen concentration via selective adsorption of nitrogen
- Physically implemented design (pressure vessels with zeolite, fittings, tubing, solenoid valves) and incorporated an Arduino controller and associated electronics to switch air flow between the two beds
- Performed calculations to determine mass balance, bed size, nitrogen adsorption, optimal pressure and flow rate
- Tested design using prototype
- Troubleshooted design and systematically tried to identify root cause for low oxygen concentration

**Assumptions for local equilibrium model for pressure swing absorption**
- No flow maldistribution or dead volume
- No concentration gradients within zeolite particles or film surrounding particles
- Isothermal plug flow with constant velocity
- sterility plug flow with constant velocity

**Voltage Stabilizer**
- Designed a voltage stabilizing circuit that can interpret magnitude and direction of voltage fluctuations
- Simulated the circuit in LTSpice to prove that it can adequately handle voltage disturbances
- Research fabrication methods and created list of components needed to actually make the device

**Voltage input and outputs for Fig 2:**
- V(in) through V(out) are inputs, ranging from 160V to 280V
- V(in) through V(out) are corresponding outputs, with the range limited to between 220V to 240V

**Fig 1: Diagram of the voltage stabilizer**

**Fig 2: Voltage inputs and outputs for the voltage stabilizer simulated in LTSpice**

**Fig 3: Experimental setup used to test its oxygen concentrating efficacy**

**Fig 4: Local equilibrium model for pressure swing absorption**

**Fig 5: Rendering of the exterior design**

**Fig 6: Rendering of the interior layout of the device**

### Market Analysis and Cost

**An Affordable, Safe and Effective Oxygen Concentrator for Use in Low-Resource Settings**

**An at-home oxygen concentrator is sold for $735 on average. In addition to being expensive, the existing models are unable to handle fluctuating voltage input and performing maintenance on the devices is difficult.**

EverAir is expected to be manufactured and assembled locally in Nepal within a university lab environment. Off-the-shelf components will be procured from India and China. The cost of a unit produced is expected to be $328. It is designed for the local environment and requires minimum maintenance.

**Cost Per Oxygen Concentrator**

- Market Average: $735
- EverAir: $328

### Future Work

**To address the lack of an affordable oxygen concentrator capable of dealing with the voltage fluctuations typical in Nepal, the team has designed and tested an oxygen concentrating subsystem and a voltage stabilizer, as well as developed an overall design for an easy-to-use oxygen concentrator:**

- Key innovation is the voltage stabilizer
- Detects voltage differences above and below standard input voltage range and uses voltage transformers to maintain it within the acceptable range
- Also takes into account the functionality of the oxygen concentrating subsystem, voltage stabilizer, and exterior design

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### References