A Rapid Pressure Swing Adsorption Process for the Improvement of Portable Oxygen Concentrators

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Abstract

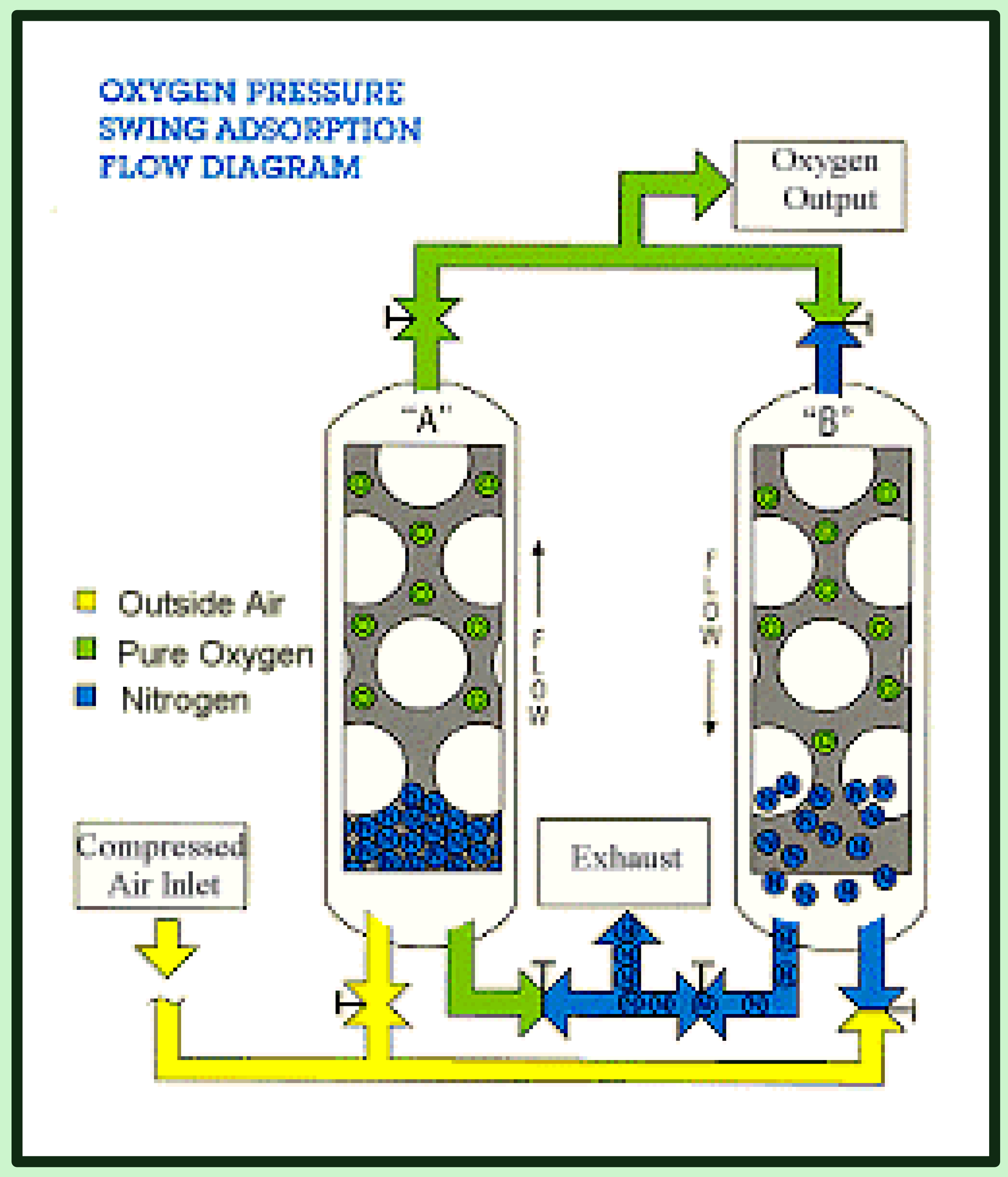
- Oxygen therapy helps enhance the lives of people struggling with Chronic Obstructive Pulmonary Disease (COPD).
- Recent developments in zeolite manufacturing provide a way to improve small scale or rapid PSA processes for portable oxygen concentrator (POC) applications.
- A PSA process was developed to investigate what occurs under rapid cyclic conditions.
- Pressure drop was significant with short cycle times, but the cycle maintained a high recovery and low BSF.

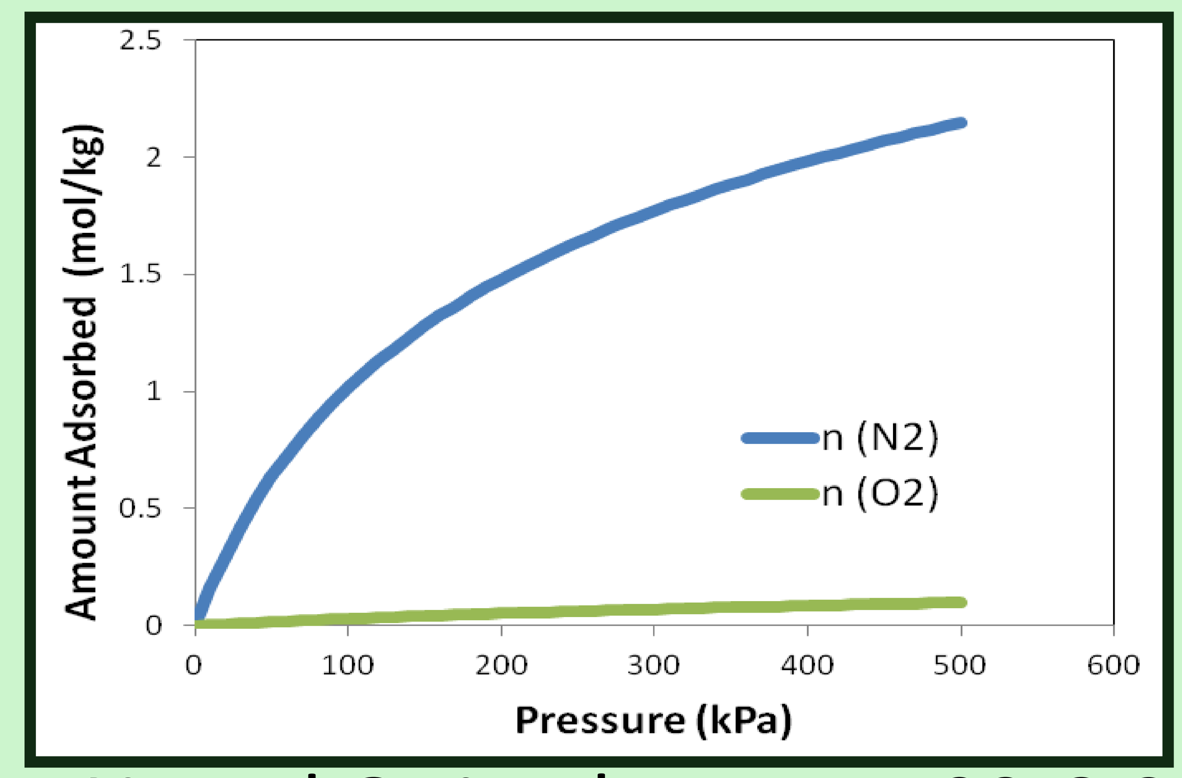
Portable Oxygen Concentrators

Process Description

Column Details	
Length	19.6 cm
Diameter	0.883 cm
Particle Diameter	~ 0.5 mm (Li-X zeolite)

Cycle Details	
Type	• 2 column PVSA • Skarstrom with equalization step
Adsorption Pressure	~ 193 kPa
Desorption Pressure	Varied to achieve pressure ratios of 2.5, 3.5, and 4.5.





N_2 and O_2 Isotherms at 23.6 C

Objectives

- Investigate how fast a PSA process can efficiently and productively be operated.
- Determine the effect of column pressure drop on process performance.
- Determine if a minimum BSF exists for the process.

Design and Evaluation of PSA Processes

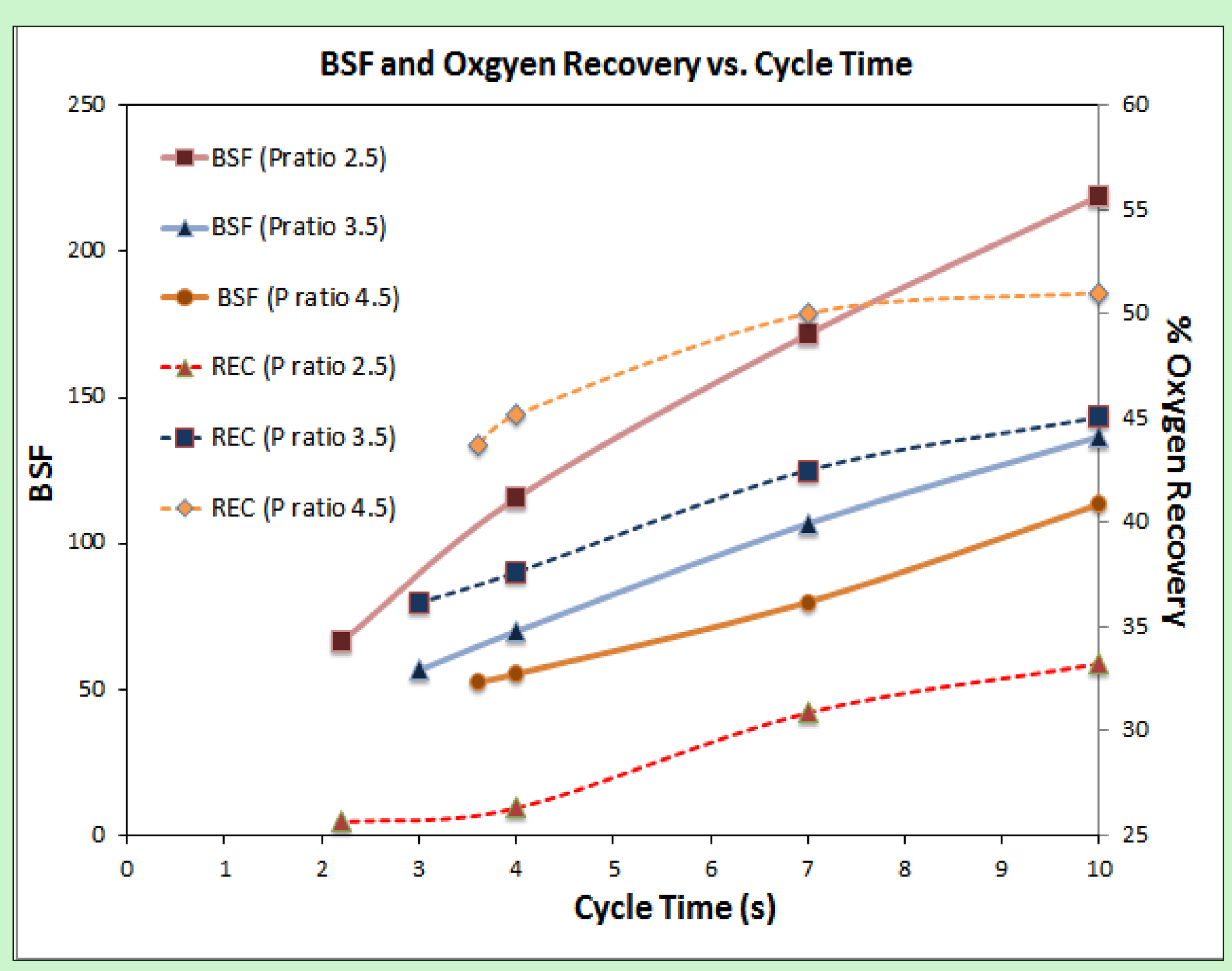
Cycle Design Parameters

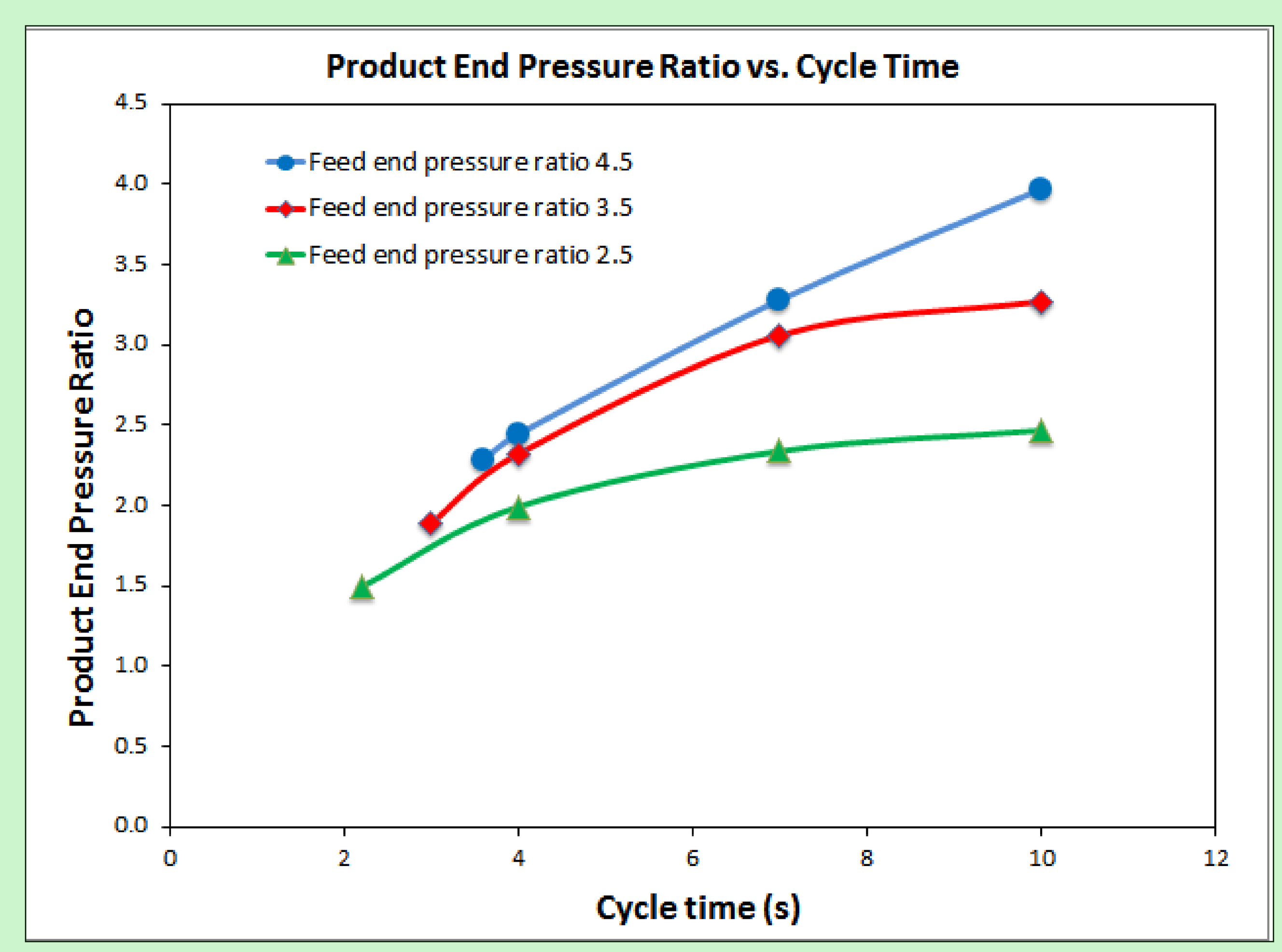
- 96% O_2 Product (argon-free air supply)
- $$\text{Pressure Ratio} = \frac{P\ \text{High (Feed End)}}{P\ \text{Low (Feed End)}}$$
- $$\text{Purge/Feed Ratio} = \frac{\text{moles } O_2 \text{ purge step}}{\text{moles } O_2 \text{ feed step}}$$

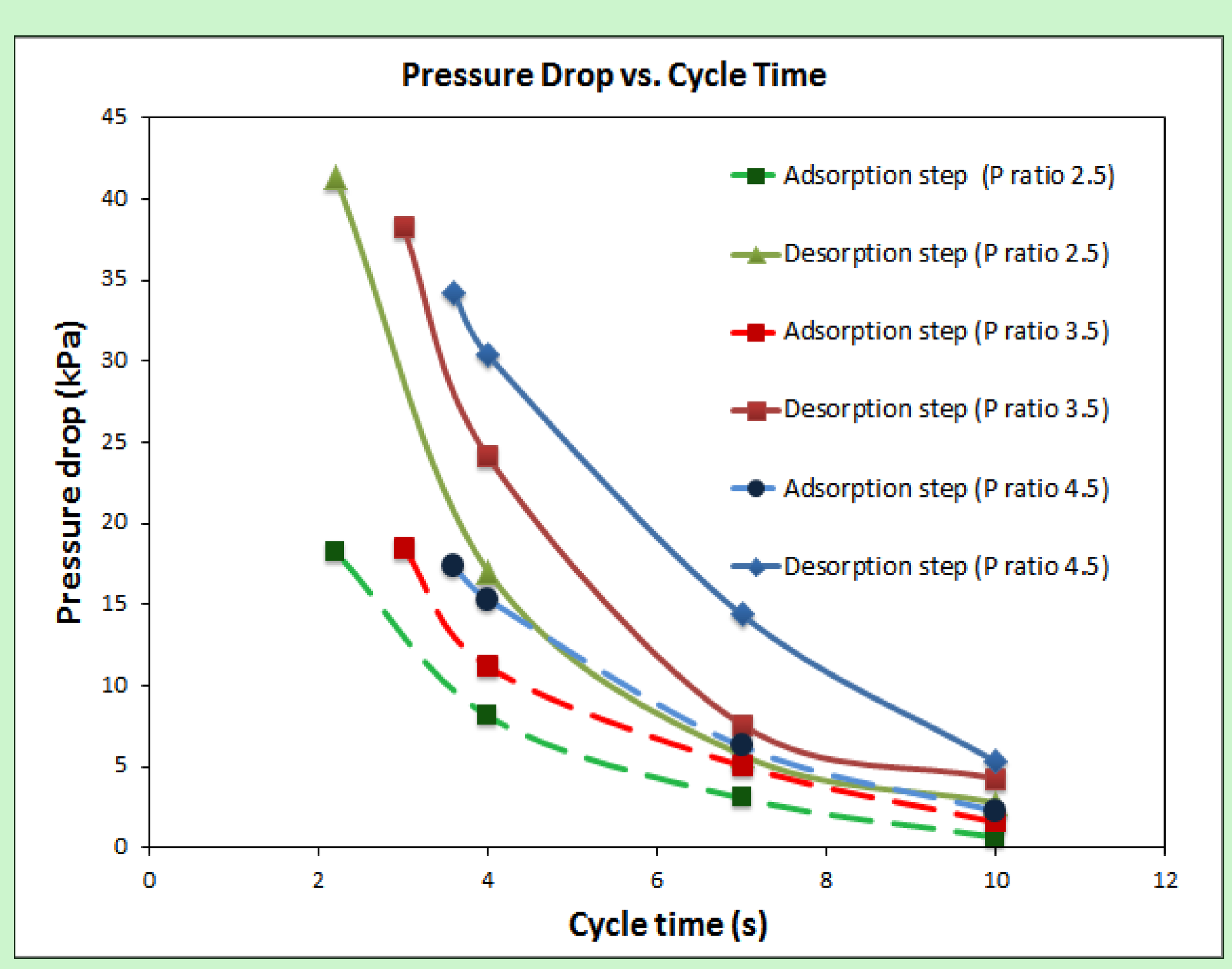
Cycle Evaluation

- $$BSF = \frac{\text{adsorbent mass (lbs.)}}{O_2 \text{ Production } \left(\frac{\text{tons}}{\text{day}}\right)}$$
- $$\text{Recovery} = \frac{\text{moles } O_2\ (\text{product})}{\text{moles } O_2\ (\text{feed})}$$

Results







Summary

- Oxygen recovery remains strong as the cycle time is reduced with the experiments performed.
- BSF declines with decreasing cycle time within the limits of the experimental system.
- Pressure ratio at the product end differs significantly from the feed end at low cycle times.
- Pressure drop in the system while significant , does not cause an increase in BSF.

Future Work

- Utilize a skarstom cycle with no equalization to determine if the same performance trends appear.
- Improve the process to allow for faster cycles.