A Theoretical and Experimental Study of a Two Step Pulsed Pressure Swing Adsorption Based Oxygen Concentrator
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Abstract:
A two step single bed pulsed pressure swing adsorption process has been simulated to access the extent to which an oxygen concentrator size might be miniaturized to the personal medical applications for active chronic obstructive pulmonary disease (COPD) patients. The process consists of a single bed packed with adsorbent particles which is pressurized and depressurized at the feed end. An enriched oxygen product is withdrawn at ambient pressure at the product end when the bed is pressurized at the feed end. The product end is remaining closed during the depressurization step. A mathematical model was developed for the PPSA process and the model equations were solved using COMSOL Multiphysics software. The effect on the process performance of the adsorption time, desorption time, bed length, particle diameter and pressure drop were investigated. An interesting novel result is that there is an optimum combination of adsorption and desorption time that maximizes the oxygen product purity for a chosen bed length, particle size and pressure drop. A principle conclusion from the simulation study is the extent of miniaturization of oxygen concentrator is possible within an operating window where the oxygen product purity is > 90% using commercially available 5A zeolite and Silver exchanged Lithium substituted 13X zeolite, however, the extent of miniaturization is limited by the maximum cycling frequency that can practically achievable. A general graphical design methodology has been proposed based on simulation results. By identifying the domain of

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interest from the simulation study, an experimental setup has been designed to demonstrate the extent of miniaturization of oxygen concentrator that can be possible using PPSA technology and to validate the proposed design methodology. Progress made till the time of the symposium will be presented.

**Keywords:** Portable Oxygen Concentrator, COPD, Rapid Cycling, Air Separation, 5A zeolite, 13X zeolite.