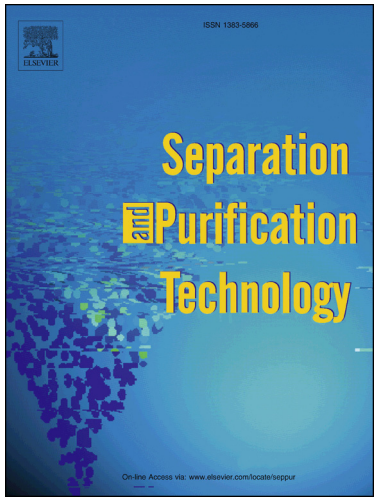

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Demonstration and Optimisation of the Four Dual-Reflux Pressure Swing Adsorption Configurations

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Abstract

The four base configurations of Dual-Reflux Pressure Swing Adsorption (DR PSA) cycles, namely feed to the low (PL) or high (PH) pressure bed, with blowdown and pressurisation using either the heavy (A) or light adsorbate (B), were demonstrated and compared experimentally in terms of their respective performance separating N_2 and CH_4 using activated carbon. Non-isothermal numerical simulations of these four cycles were validated against the experiments and used to help develop a means of optimising DR PSA cycles. While previous theoretical treatments and experimental studies have largely focussed on situations where the heavy product-to-feed ratio, H/F, is near to the ideal value necessary to produce two pure products, we demonstrate how H/F can be used to bias the separation towards either improved stripping or enrichment; this can be of practical importance in physical cycles where perfect separation is not possible. Consequently, H/F can be considered together with bed's capacity ratio, $\mathbb{C}$, and the (heavy) reflux-to-feed ratio R/F as key operational parameters available for optimising cycle performance in terms of product purity, cycle work and productivity when adsorbent selectivity, bed pressure ratio and feed location are fixed. For N_2-CH_4 separations biased towards stripping (larger H/F values), PL-A cycles achieved the best separation performance while PH-B cycles were best for separations biased towards enriching (smaller H/F values). In terms of cycle work per mole of feed treated, for a particular set of experiments with the same light reflux flow (2 SLPM) B configurations required about 15 % less work than A configurations. For these experiments PH cycles required about 25 % less work than the PL cycles because the feed was at a lower pressure than either of the products, which were both delivered at high pressure.