TWO-COLUMN RELAY SIMULATED MOVING-BED FOR GAS-PHASE SEPARATIONS

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A new two-column, relay, simulated moving bed process (2-column R-SMB) for gas-phase separations has been designed and implemented experimentally in this work. R-SMB differs from classical SMB processes by avoiding the partial withdrawal of products, since the outlet streams are handled in a relay mode. The outlet streams are either fully collected as product/waste or completely recycled to another column.
In this work, the relay concept is applied for the first time in 2-column SMB processes and gas-phase separations. The process is designed and optimized through model-based computational simulation and the results obtained are validated experimentally. For the purpose, a new experimental lab-scale unit was designed and assembled.

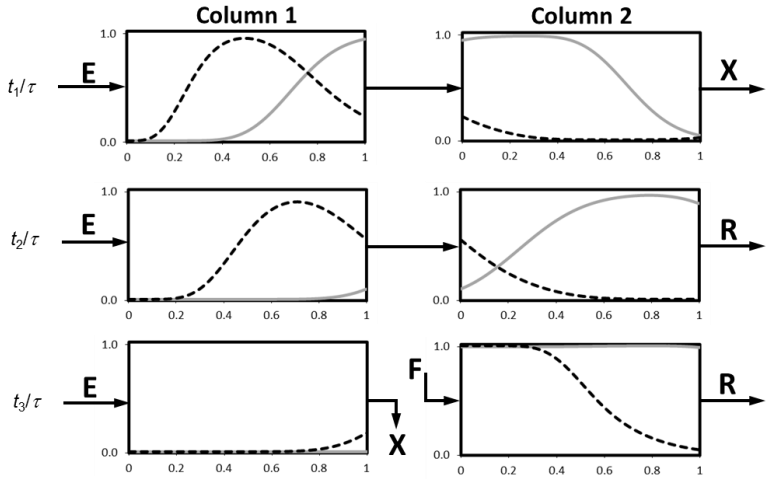

Figure 1 – Simulated CSS gas phase mole-fraction internal profiles at the end of each sub-step of an half-cycle of the optimized 2-Column R-SMB scheme. The CH_4 and CO_2 internal concentrations are represented by the solid grey line and the dashed black line, respectively. Symbols F, E, X, R, respectively denote, feed, eluent, extract, and raffinate.

In this study, the simplest case of a binary gas-phase separation of an isothermal trace system was studied. For the purpose, the separation of carbon dioxide/methane mixtures using nitrogen as carrier gas was evaluated as a proof-of-concept.

The 2-column R-SMB scheme designed allowed obtaining 99% purity (eluent free basis) in both extract and raffinate products. Figure 1 presents the simulated internal profiles, in cyclic steady state (CSS) conditions, at the end of each sub-step of an optimized half-cycle. Furthermore, the process performance is compared with classical four-zone SMB and asynchronous port switching schemes, showing that at low-feed throughput the process performances are coincident.