

## **Immobilized homogeneous catalysts in a membrane reactor – continuous hydroformylation test case**

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Process intensification is a cornerstone to achieve a significant reduction in energy consumption and CO<sub>2</sub> emissions in the chemical industry. We present a monolithic membrane reactor combining a homogeneous catalytic gas-phase hydroformylation of 1-butylene with an in-situ product removal via a membrane. Immobilization of the homogeneous Rh-biphephos complex on a mesoporous SiC monolith is based on the supported ionic liquid phase (SILP) concept with 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide [C<sub>2</sub>C<sub>1</sub>Im][NTf<sub>2</sub>]. The resulting monolith is active and selective, but the accumulation of aldehydes and high boilers in the liquid leads to slow catalyst deactivation. This accumulation is suppressed when only bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate is used as the solvent phase. With this solvent, only marginal aldehyde accumulation and aldol formation are observed. A PDMS membrane coating increases the aldehyde-alkene ratio in the permeate compared to the retentate by an enrichment factor of 2.2, which simplifies further downstream processing. The monolithic membrane reactor with immobilized SLP catalyst presents a scalable, versatile platform to achieve process intensification for diverse syngas reactions.