

TECHNOLOGY OFFER: PERMSMBR

OVERVIEW

Description: Process , Pilot , Product , R&D knowledge , Other

Benefit summary: The PermSMBR results in a more compact, safer and efficient production process for the sustainable synthesis of oxygenated compounds.

Development summary: The Technology Readiness Level is 3 - the PermSMBR was theoretically assessed using mathematical models based on experimental results. The PermSMBR consists in the integration of membranes with the Simulated Moving Bed Reactor (SMBR). The SMBR and pervaporation are technologies which are (separately) proven.

IP Summary: The technology is supported by 104496 PT Patent, 10724137.4 EU Patent and 13/263,828 US Patent.

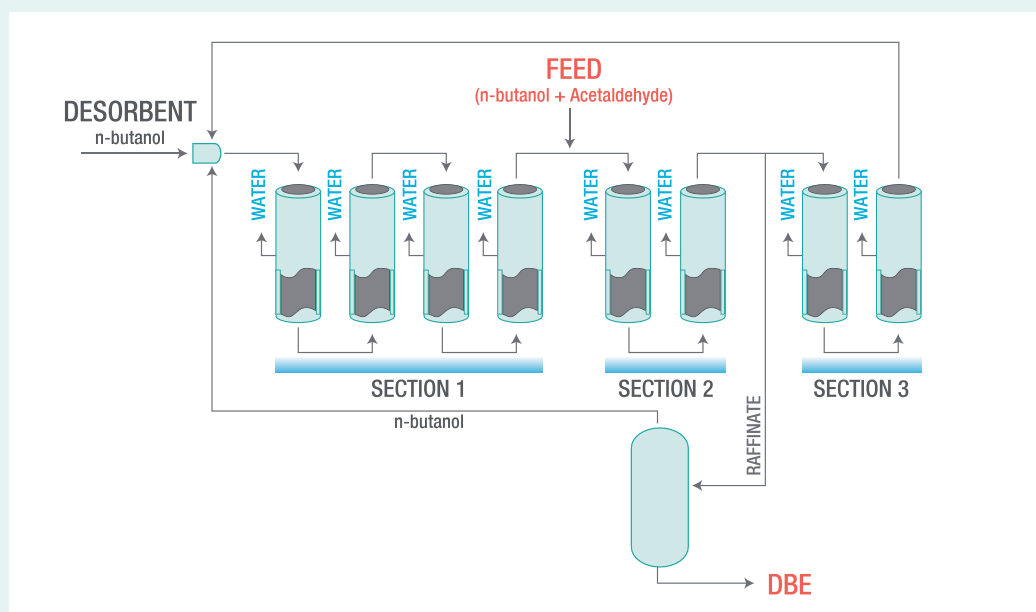


Fig. 1 - PermSMBR process scheme 1, 1,1-dibutoxyethane (DBE) production.

Novelty

- **Technology Benefit description:** The PermSMBR consists in a reactor integrated with two different separation techniques: chromatography with membranes, into a single device. This technology, when applied to the production of compounds involving equilibrium limited reactions, leads to complete reactants conversion, high productivity, and significant reduction of solvent consumption and, consequently, lower downstreaming costs associated to the separation units. It is a very promising technology for the synthesis of oxygenated compounds as esters, acetals and ethers, used as biofuels, solvents, and flavours, among others.
- **Technology differentiation versus competition (and Uniqueness):** The disadvantages in the use of reactive distillation (RD) for systems that exhibit azeotropes formation and/or other volatility restrictions regarding the boiling points of the reactants and/or products are overcome using the PermSMBR, since the separation is performed by adsorption and selective membranes. The SMBR major limitation is the high solvent consumption which is significantly reduced when using the PermSMBR technology.

Development

- **Technology Readiness Level (Scale):** TRL 1 ; 2 ; 3 ; 4 ; 5 ; 6 ; 7 ; 8 ; 9
- **Development Status summary:** The PermSMBR equipment was theoretically evaluated for the production of acetals (diethyl and dibutyl acetals) and ethyl lactate ester using mathematical models that strongly rely on experimental data. In practice, the PermSMBR results of the combination of membranes within the columns of the SMBR. The SMBR technology was experimentally validated and the pervaporation data were measured using a pervaporation membrane lab-scale prototype. The physical PermSMBR unit does not exist yet.

Instrument: Large Scale Collaborative Project
Thematic Priority: FP7-ENERGY.2009.3.3.1

Grant Agreement: 241718

Intellectual Property

Patent Application / Granted				
Priority Patent Number	Title	Countries	Status	Priority date
PT104496	Reactor de membranas adsorptivo de leito móvel simulado, novo processo híbrido de separação e respectivas utilizações	Portugal	Granted	08-04-2009
USA 13/263,828	Simulated moving bed membrane reactor, new hybrid separation process and uses thereof	USA	Pending	08-04-2009
EP 10724137.4	Simulated moving bed membrane reactor, new hybrid separation process and uses thereof	Europe	Pending	08-04-2009

Provider

- **Technology provided by:** University of Porto (LSRE - Laboratory Separation and Reaction Engineering).
- **Related Expertise:** kinetic, adsorption and permeation studies; chromatographic and membrane reactors process development and implementation.

Partner	Academic/Industry	Research / Pilot / Demonstration / Other
UPorto	Academic	Research

Technical Details

The PermSMBR is a hybrid technology that combines the SMBR with membranes. The SMBR is implemented in the well-known SMB equipment (US Patent 2 985 589), where the columns are packed with a solid catalyst with adsorptive properties or with a mixture of solid catalyst and adsorbent particles. The standard SMBR configuration comprises two inlet streams (feed and desorbent) and two outlet streams (extract and raffinate) and the counter-current solid movement is simulated by a synchronous shift of these streams by one column in the direction of the fluid, at regular time intervals called the switching time. If the feed comprises two reactants (A and B), in which, for instance A, is used as desorbent, and A and B react to give two products, C and D, the latter being more adsorbed than the former, then a mixture of D and A is obtained in the extract and a mixture of C and A in the raffinate. This is the SMBR principle of operation which is similar to the one of the PermSMBR. However, in the PermSMBR, each column contains a set of tubular membranes that are permeable to one of the reaction products - integrated PermSMBR or each SMBR column is followed by a membrane module - coupled PermSMBR. Depending on the configuration, the solid or the mixture of solids are packed in the membranes (integrated PermSMBR) or in the columns (coupled PermSMBR). Besides, another stream is collected: the permeate stream that is rich in the product for which the membranes are selective and combines all the flows removed through the membranes.

Licensing

- **Collaboration type sought:** Collaboration for technology development, Licensing, Transfer of IP.
- **Support provided:** PermSMBR lab-scale design, construction and technology demonstration.

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