Sustainable Process Engineering-SPI

Inorganic Membranes and Membrane Reactors

EINDHOVEN UNIVERSITY OF TECHNOLOGY

Techno-economic feasibility of light alkanes dehydrogenation in novel membrane reactors

Camilla Brencio, Jose A. Medrano Jimenez, Fausto Gallucci

Introduction

The availability and low cost of shale gas has boosted its use as raw material to produce high value-added compounds. Propane and butane are the main shale gas compounds and can be efficiently converted into light olefins (propylene, butadiene; direct dehydrogenation of light alkanes is emerging as a promising alternative to traditional steam cracking, being on-purpose technologies for the synthesis of these value-added compounds.

Project summary

Direct dehydrogenation reactions are highly endothermic, requiring high operating temperatures (550-600 °C) and low pressures (0.5-2 bar) to reach quite high conversion; at these severe conditions, cracking side reactions are favored, leading to coke formation and consequent catalyst deactivation. The choice of reactor design and heat management plays a very important role in the success of those catalytic processes: fixed bed and fluidized bed reactors with inter stage heating and/or continuous catalyst regeneration are typically used at industrial scale.

Improved performance (on energy/carbon bases) and competitive costs compared to existing industrial processes could be reached with the integration of a H_2-selective membrane in the reactor, improving conversion at mild operating conditions and lowering coke formation.

Detailed process flowsheet of benchmark technologies will be developed in Aspen Plus in order to identify requirements on catalysts and reactors to improve the reliability and robustness of production systems and lower the capital and operational costs.

Membrane reactors will be integrated in the process in order to enhance the performance by a continuous removal of H_2 from the catalytic bed and a techno-economic analysis will be performed in order to identify the potential of this novel process scheme with respect to the state-of-art.

Project goals

- Development of detailed flowsheet in Aspen Plus for conventional and novel process;
- Thecno-economic comparison of traditional and novel PDH technologies.

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CHEMICAL ENGINEERING AND CHEMISTRY

Sustainable Process Engineering-SIR

Inorganic Membranes and Membrane Reactors

EINDHOVEN UNIVERSITY OF TECHNOLOGY

Experimental investigation of novel Pd membranes in propane dehydrogenation processes

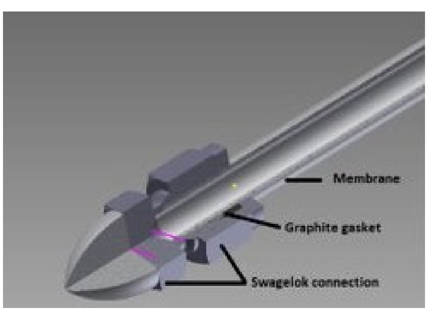
Camilla Brencio, Jose A. Medrano Jimenez, Fausto Gallucci

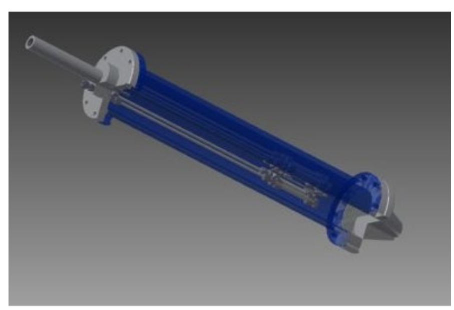
Introduction

Direct dehydrogenation of propane into propylene is an interesting strategy already commercialized and used worldwide. This technology suffers from several common limitations, including thermodynamic restrictions on conversion, which imply high temperatures to obtain reasonable conversion, and coke formation due to high operating temperatures. Successful implementation of novel Pd-based membranes has the potential of overcoming these technological issues.

Project summary

Novel Pd-based membranes, patented by TU/e, will be tested for the selective removal of H_2 in propane dehydrogenation processes. The peculiarity of those membranes is represented by a protective layer on their surface, which can reduce the interaction with undesired products formed during the reaction process, resulting in highly resistant membranes. The membranes will be integrated in fluidized bed reactors to investigate the effects of selective H_2 removal on the performance of the propane dehydrogenation processes; continuous removal of hydrogen will increase propane conversion for a given temperature and this in turn will allow operation at lower temperatures, therefore reducing the coke formation and side reactions.





Project goals

- Analysis of membrane protection to reduce coke formation;
- Investigation of operating conditions on the performance of the membranes;
- Integration in fluidized bed membrane reactors.

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