17.09.2021

In the process industry, down-stream processes are the most resource and energy consuming industrial operation steps. Moreover, the integration of new processes often requires a large portion of CAPEX and OPEX. To enhance the competitiveness of the European process industry and to contribute to Europe's goal of a clean and liveable environment, a broadly applicable concept for efficient integration of downstream operations in the overall process chain is highly desired.
The MACBETH consortium provides a ***breakthrough technology by combining catalytic synthesis reaction with the corresponding separation units*** *in a single highly efficient* ***C****atalytic* ***M****embrane* ***R****eactor (CMR). With this disruptive technology a* ***reduction of greenhouse gas emissions (GHG)*** *and an* ***increase in resource and energy efficiency*** *of large volume industrial processes can be achieved. The revolutionary new reactor design will guarantee substantially smaller and safer production plants and thus* ***reduce operational and investment costs****.*

MACBETH
Membranes And Catalysts Beyond Economic and Technological Hurdles

Topics

Consortium News

Hereon – New Name no Change

The Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH (HZG) was renamed to Helmholtz-Zentrum Hereon GmbH (Hereon). This change will not affect Hereon´s work and contribution to the MACBETH project, and the HYFO case in particular.

Positive 18-month evaluation

MACBETH has reached its **first milestone** after 18 months in operation. The EU Commission has evaluated the project for the first time - with **positive results**. The goal of MACBETH is to develop technologies that make important large-scale reactions, such as hydro-formylation, significantly more energy efficient.

"The results so far are impressive. All subprojects are on schedule and well on track," says Carmine Marzano, project officer at the European Health and Digital Executive Agency (HaDEA), responsible for all administrative aspects of MACBETH on behalf of the EU Commission.

"With the positive evaluation, we have secured the support of the EU and achieved a very good interim status," says Prof. Dr. Robert Franke, project coordinator for the overall MACBETH project and head of hydroformylation research at Evonik. At the virtual review meeting held in June, all the project partners, the project officer for the EU Commission and the project reviewer came together to get an update of the current status.

Project Information

Project No.:
GA 869896

Call (ID) Identifier:
H2020-NMBP-SPIRE-2019

Topic:
CE-SPIRE-04-2019
Efficient integrated downstream processes (IA)

Project Duration:
54 (+6) months
Nov 2019 – Oct 2024

Project Budget:
20,7 M€

PROJECT PROGRESS

As outlined above, the MACBETH consortium provides a breakthrough technology combining catalytic synthesis reaction with the corresponding separation units in a single highly efficient catalytic membrane reactor (CMR). In the project, this technology is applied to four highly relevant large-scale processes: Hydroformylation (HYFO), hydrogen production (H2), propane dehydrogenation (PDH) and bio catalytical oil cleavage (BOC). In the following, an update on the project progress achieved for each of these four cases is provided.

HYFO - Hydroformylation

Hydroformylation (HYFO) is one of the application cases within MACBETH. In hydroformylation, unsaturated hydrocarbons, or olefins, are converted to aldehydes using synthesis gas, a mixture of hydrogen and carbon monoxide. For the Performance Intermediates business line, aldehydes are intermediates on the way to higher alcohols, organic acids or esters, which are then used, for example, as plasticizers in plastics or as surfactants.

The HYFO subproject is being carried out at the Marl Chemical Park by Evonik with the aim to develop so-called catalytic membrane reactors for industrial use. The reactors are already working at laboratory scale - the aim now is to make them suitable for industrial use and to investigate the economic viability of the approach.

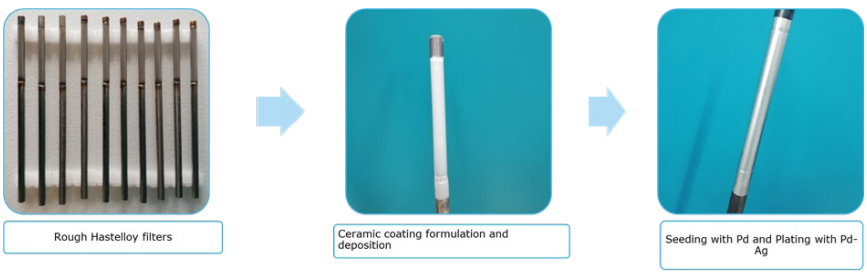
"We now want to make the leap from the laboratory to production," says Prof. Dr. Robert Franke, project coordinator for the overall MACBETH project and head of hydroformylation research at Evonik. "Only when we conduct investigations in the production environment, we can make statements about the suitability of the technology. We need to test whether the process is suitable for larger production volumes and if it will work stably over the long term." By the end of 2022, the plan is to set up a demonstration plant under real, industrial conditions at the so-called Oxo plant at the Marl Chemical Park.

H2 - Hydrogen Production

The Hydrogen line within MACBETH is proceeding very well both in terms of prototypes design and construction and in terms of advancement in the building block development. In particular, two prototypes are being realized. One by TUE (through H2Site) on natural gas reforming and one by ICI on biogas autothermal reforming. Both prototypes are very advanced with detailed engineering proceeding after the HAZOP revision on both of them. The last components have been purchased and the system are being assembled, while waiting for the catalysts and membranes developed in MACBETH.

To make sure that the prototypes run for at least 8000 hr. new catalysts are being developed by JM. These catalysts need to be very active as temperatures in the two reactors are much lower than standard reforming reactors and need to be resistant to fluidization. The formulation has been identified and scaleup of the production is planned. In parallel TECNALIA has produced all membranes for the biogas prototype and these are ready to be integrated in the prototype by ICI. For the natural gas prototype the research is still ongoing to identify the best way to produce metallic supported membranes. TUE has already identified a suitable production route so that very selective membranes can be produced starting from relatively cheap supports (see figure below). Together with TECNALIA, TUE is busy identifying a sustainable process for further scaling up this production.

In the meantime, modelling of the reactors is being carried out by POLIMI/UNIBS/TUE and scaleup simulations of the system for very large-scale plants is being performed by KT.

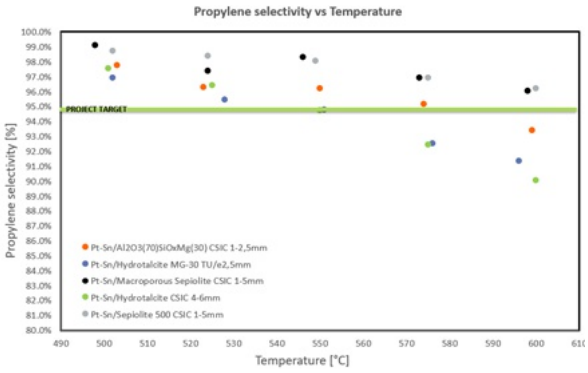


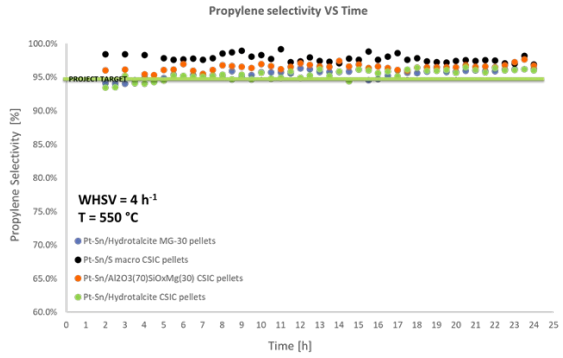
PDH - Propane Dehydrogenation

The PDH case has recently achieved an important milestone of the project: the completion of Basic Design of the pilot unit to be installed and tested at ENGIE site in France. This important achievement allows to continue with the definition of the detailed engineering of the pilot equipment and instrumentation and the subsequent procurement of materials by ICI. The design of the pilot unit lays its foundations on the results of the development of the building blocks that has incessantly continued over these first two years of the MACBETH project. In particular, the double skin membranes and the catalyst, developed and tested by TECNALIA/TUE and UNISA respectively and under scale up for industrial application by TUPRAS, play a primary role for the success of the novel PDH technology, based on the adoption of an integrated membrane reactor.

Parallel to the modelling (POLIMI/UNIBS) and design activities (KT), the Business Plan and Exploitation activities are underway; in this second year of the project, these activities were mainly focused on the Value Chain Stakeholder's analysis (PNO), now almost completed, and on the market analysis with the aim of identifying a potential entry market for the novel PDH technology and establish the basis for the future exploitation strategy.

In the meantime, the activities for the LCA were also started with the collection of general information on the benchmark process and on the novel PDH process to outline the framework for data collection and the impact assessment methodology.





BOC - Bio Catalytical Oil Cleavage

The Biocatalytic Oil Cleavage (BOC) case aims to enrich valuable omega-3-fatty acids in fish oil utilizing enzymes as selective catalysts followed by a membrane separation process. In the last weeks, the BOC case made some crucial steps forward. The transition from small scale batch experiments to a continuous flow process with lab-scale equipment was successfully achieved at the facilities of Microinnova. At the moment, optimization of critical reaction parameters are under investigation in the laboratories of Enzymicals and ChiralVision. Also, a potential candidate for the membrane separation unit was identified by the VITO institute and experiments aiming to improve its performance are in progress.

The plan is to have the pilot plant up and running for the first trials in early 2023. For long term stability tests, the plant will be relocated from Enzymicals in Germany to Solutex in Spain. To achieve the local flexibility of the system, a containerized set up of the pilot plant is foreseen.

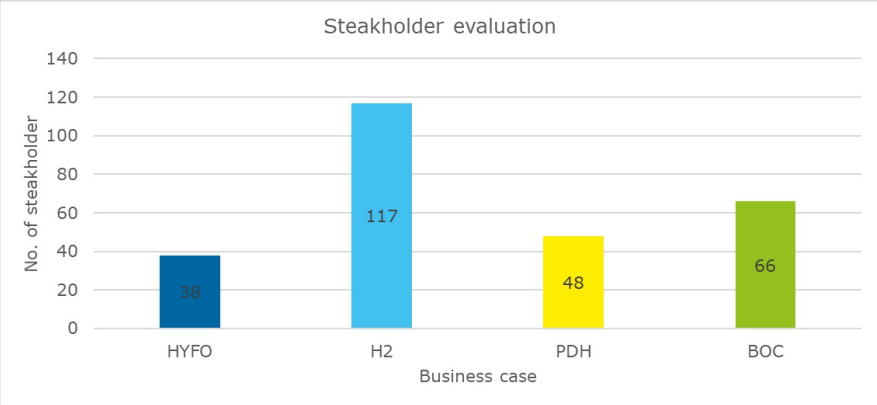
Stakeholder Analysis and Exploitation

A Stakeholders Analysis was performed by Ciaotech, in collaboration with the four Business Case leaders and the whole MACBETH consortium, with the aim of mapping the relevant stakeholders in all four business cases. This map allows for a deeper understanding of who's who in the market, and permits to assess each stakeholder's position towards the project results in order to set up custom-tailored engagement and exploitation strategies, to maximise impact.

The Stakeholders' Analysis consists of a thorough mapping of the relevant stakeholders for MACBETH, according to their investment capacity as a function of their R&D expertise on the MACBETH processes. Recently funded EU-projects were assessed to i) establish links and develop synergies for mutual benefit and maximization of EU-funding results; and ii) map relevant stakeholders with an active role in the European innovation ecosystem as privileged interlocutors for the MACBETH results. Patents were assessed to define the stakeholder's investment capacities, including their patenting strategies in technologies close to those developed in MACBETH, in order to finetune their positioning. A total of almost 270 organisations, ranging from universities to large companies, research centres or SMEs were identified for the whole MACBETH project.

For each case, the stakeholders were mapped according to their potential interest towards the MACBETH results, taking into account their R&D positioning and investment capacity, respectively assessed by their national and EU project participation, and patenting strategy in similar or complementary technologies.

This analysis sets the ground for market analysis and exploitation strategy for each MACBETH result. It will permit a custom-tailored valorisation of each result, in order to maximise impact, thanks to a deeper understanding of the ecosystem, its players, and the overall market challenges and opportunities.



EVENTS

Consortium Meeting April 2021

The Virtual MACBETH Consortium Meeting was held from 28th to 30th of April 2021 to discuss the outcomes and results of the recent progress. All partners contributed to this great meeting and put a lot of efforts to bring MACBETHs breakthrough catalytic membrane reactor technology forward despite difficult working conditions due to the pandemic.

In case-wise workshops, recent results & technological progress were discussed and presented in plenary sessions to the consortium to profit from the experiences of all partners. Additionally, communication, dissemination, and exploitation activities were coordinated for the next project period. For socializing, virtual fireplace discussions in the evening of day 1 enabled a get-together of project members. However, all project members are looking forward to the next "offline" project meeting.

Review Meeting June 2021

In June 2021 the project process of MACBETH was reviewed by the EU Commission with positive results. The first milestone was reached after 18 months in operation and the results so far were reviewed as positive and the project is on the right track.

Announcement ECCE/ECAB

MACBETH is proud to invite you to the 13th European Congress of Chemical Engineering (ECCE) and the 6th European Congress of Applied Biotechnology (ECAB) which will take place from September 20-23, 2021 as virtual event.

MACBETH is host of the two Sessions "MACBETH Membranes And Catalysts Beyond Economic and Technological Hurdles 1 & 2" under the topic Engineering Processes &

Products scheduled on Tuesday, 21st of September starting at 11:00 a.m. and 2:45 p.m.

In the Keynote Lecture "MACBETH – A revolution in catalytic reaction technology", we will highlight MACBETHs breakthrough CMR technology and its potential to improve chemical processes for a sustainable and resource efficient process industry in future. Moreover, several talks and posters will present recent results of all MACBETH cases.

Announcement Consortium Meeting

The next Virtual MACBETH Consortium Meeting will be scheduled from 27th to 29th of October 2021. The MACBETH Consortium will share and discuss the outcomes and results of the recent project progress in a three days meeting to stipulate the roadmap for the next project period.

Announcement Webinar

The integration of reaction and separation in Membrane Reactors allows to improve efficiency and costs of different industrially relevant reaction systems. The MACBETH project is working towards demonstration of membrane reactors in industrial conditions. Five prototypes will be tested at TRL7 in MACBETH for four different reaction systems.

In our webinar "Membrane Reactors: One step forward towards industrial implementation" the status of membrane reactors for the different reaction systems with emphasis on scale-up challenges of new reactors will be reported. For more information, please check out our website www.macbeth-project.eu.

Meet MACBETH

Are you interested to meet our partners and learn more about the project?

Upcoming Events:

September 19-23, 2021
International Conference on Hydrogen Production (ICH2P)
www.ich2p-2021.org

September 20-23, 2021
13th European Congress of Chemical Engineering and 6th European Congress of Applied Biotechnology (ECCE/ECAB)
www.ecce-ecab2021.eu

October 27-29, 2021
5th Consortium Meeting

www.macbeth-project.eu | macbeth.h2020@gmail.com
www.twitter.com/MACBETH_H2020 | www.linkedin.com/company/macbeth-h2020

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