

“Advances in catalysis for hydrocarbons”

Results from ZEOCAT-3D, C123, and BIZEOLCAT EU research projects

16^o MARCH 2023
EVENT SUMMARY



Athens, 16 March 2023

At 09:00 AM (Athens' time zone) **María Tripijana Serrano** (from IDENER) introduced the event.

The first speaker was **Fotis Katsaros** (DEMOKRITOS), who showed his presentation entitled "Novel zeolites for methane conversion to aromatics (DMA)" for ZEOCAT-3D Project; then professor Richard Heyn (from SINTEF in remotely way) showed the results and conclusions of the C123 Project.

Ludovic Pinard (CNRS) showed remotely the 3D printing as an innovative strategy to improve catalytic performance in the methane Dehydroaromatization process for ZEOCAT-3D Project; then, **Alejandro Romero Limones** (GHENT UNIVERSITY in remotely way) explained the catalysts and processes for the conversion of methane to CO and ethene related to C123 Project

ADVANCES IN CATALYSIS FOR HYDROCARBONS

An investigation on catalytic performance of SAPO-34@ZSM5 and ZSM-5@SAPO-34 core/shell structures for the conversion of methane to aromatics.

Charitomeni M. Veziri, George Em. Romanos, Aggeliki Papavasiliou, George Theodorakopoulos, **Fotis K. Katsaros**

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C123
Methane oxidative conversion and hydroformylation to propylene
Project overview

Richard H. Heyn (SINTEF), Project coordinator
Joris Thybaut (Univ. Gent), Scientific coordinator

EU project Horizon 2020 GA No. 814557 C123 Methane oxidative conversion and hydroformylation to propylene

Isabel Vicente Valverde (EURECAT) with online participation showed her presentation entitled “Sustainable olefins and aromatics by innovative nanocatalysts” related to BIZEOLCAT Project. She talked about the Membrane reactor and the target molecules. She showed the chemical-physical characterization and she explained the design and development of catalysis useful for three different processes: PDH, BDH and PA reactions. High conversion, selectivity and stability results were obtained. She showed also the synthesis of SOMC single site catalysts and their best performance.



BiZeolCat Nanocatalysts preparation: OPOA

- Organometallic precursors
- Mild conditions (TP)
- Ligand control (SA)
- Tunable catalytic properties
- Control (small) size and shape
- Addition of support

3 bar H₂
THF or Toluene
100°C

Support: No ZSM5, H-ZSM5

Ligand: L¹ (Bidentate ligand)

Reaction: Me3Si-CO2 + Me3Si-CO2 -> Me3Si-CO2 + Me3Si-CO2

Products: PtSn-0.2L@Support, PtSn-0.2L@Support, PtSn-0.2L@Support

In-situ monitoring (GC-TCD)

FUNDACIÓ EURECAT. Alkane dehydrogenation nanocatalyst and process for its preparation. PCT/EP2022/054574, Feb. 2022, EPO. This international patent application PCT extended the reivindications of the European patent application no.: EP21382154-9, Feb. 2021

BiZeolCat

Membrane reactor: Recovery and valorisation of pure hydrogen.

PDH: Propane → Propylene

BDH: Butane → Butadiene

Aromatisation: Methane → BTX

Hybrid Catalyst: Metal catalyst on mesoporous zeolites.

Eurecat: Nanocatalysts

Partners: eurecat, C2P2, TU/e, SINTEF, UNE, Strane, Persorp, Tüprag, CEPSA

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814671

BiZeolCat Nanocatalyst catalytic performance PDH: OPOA

ΔH° = 124 kJ.mol⁻¹

Propane Conversion %

TOS / min

ICP: Sn/Pt 1.04

PRETREATMENT: 550 °C reduction H₂ + purge Ar

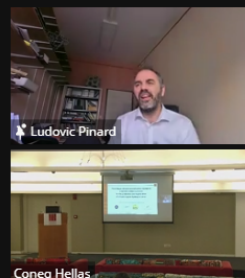
CATALYSIS: 530 °C total flow 25 mL/min P=1 bar 21 Ar / 1 H₂ / 3 C₃H₈ (mL/min).

Oleflex: T= 525-705 °C P= 1 to 3 bar Conv. of 22-70 % Sel. 85% Cycle time: 15-30 min

FUNDACIÓ EURECAT. Alkane dehydrogenation nanocatalyst and process for its preparation. PCT/EP2022/054574, Feb. 2022, EPO. This international patent application PCT extended the reivindications of the European patent application no.: EP21382154-9, Feb. 2021

From biogas dehydroaromatization reaction to a tandem catalysis process for the production and regeneration of a liquid organic hydrogen carrier

L. Pinard, A. Beauque, S. Santiago, N. Bathalha, A. Sasche



BiZeolCat

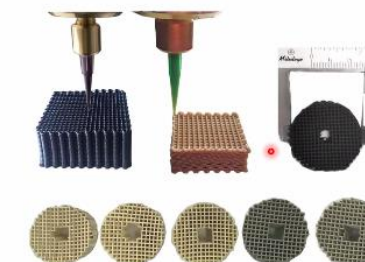


After coffee break, **Alvaro Amieiro** (JOHNSON MATTHEY) explained Catalysts for the gas phase hydroformylation of ethene related to C123 Project.

Four presentations about ZEOCAT-3D Project followed Dr. Amieiro's presentation: **Carmen Garijo** (LUREDERRA) explained the design and production of very specific nanocatalysts by FSP technology; **Leon R.S. Rosseau** (TU/e EINDHOVEN) showed his presentation entitled "Catalyst 3D printing for intensified chemical reactors, the heat transfer – pressure drop trade-off"; **Riccardo Togni** (DCS) talked about 3D-1D model for the simulation of chemical reactors and, after lunch, **Grigoris Pantoleonos** (CERTH) reported the presentation entitled "Biogas upgrading using a gas-liquid contact membrane process".

3D printing of catalysts

- Currently still fairly complex and relatively expensive
- Printed catalyst needs to possess
 - Catalytic properties
 - Porosity
 - Intended dimensions
 - Mechanical stability



Middelkoop, V. et al. Chem. Eng. J., 2019, 357, pp 309-319.

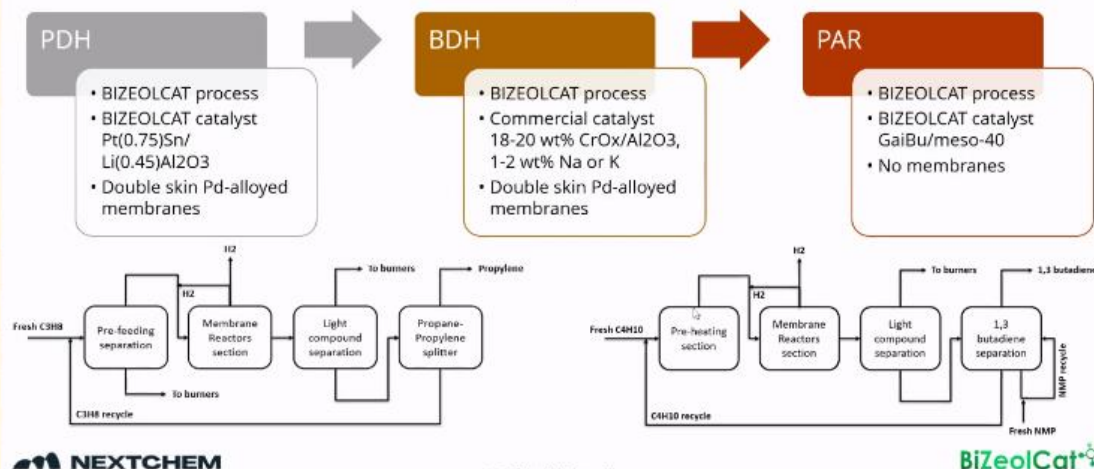


Then, **Vittoria Cosentino** (NEXTCHEM) talked about techno-economic assessment of BIZEOLCAT new propane and butane dehydrogenation and propane aromatization. In particular, after an introduction, she gave an overview on Process technologies and benchmark of PDH, BDH and PAr. The analysis of main parameters on COP (Cost of Production) were showed: feed cost, CAPEX, Catalyst cost, Membrane cost and life.

Stai visualizzando lo schermo di Vittoria Cosentino, REC Visualizza opzioni

Process technologies overview

Innovative processes



NEXTCHEM

Confidential Information

BiZeolCat

Stai visualizzando lo schermo di Mohamed Mahmoud, REC Visualizza opzioni

Conceptual process design, techno-economic and environmental assessment of C123 modular processes

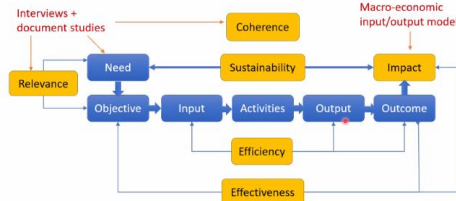
Mohamed Mahmoud & Jordy Motte

EU-project Horizon 2020 GA No. 814557 C123 Methane oxidative conversion and hydroformylation to propylene

The last presentation about C123 Project was made by **Mohamed Mahmoud** (PDC) and Jordy Motte (GHENT UNIVERSITY), who talked about TEA and LCA of the C123 process.



Methodology: The OECD/DAC evaluation criteria



The European Neighbourhood Policy countries

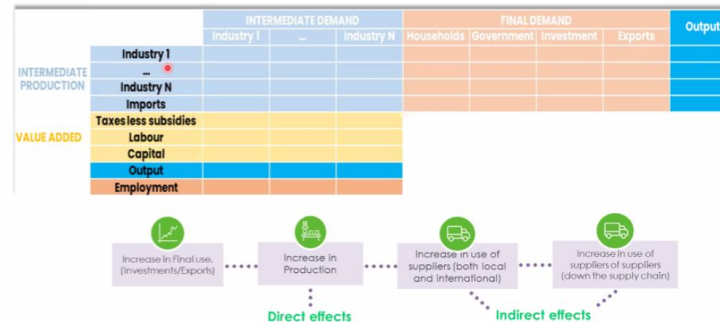
The European Neighbourhood Policy (ENP) is meant to foster collaboration between the EU and its immediate neighbours.

The countries are split in two regions:

- Eastern partnership programme (green)
- Mediterranean partnership programme (orange)



Input/Output analysis



Trond Halvorsen (SINTEF) entitled “Expected socio-economic impacts of the BIZEOLCAT project on European Neighbourhood Policy countries”, Trond Halvorsen explained the objectives of this project's WP. In particular, was expected the definition of the social character of the technology taking into account precepts of sustainable development and the impact to be delivered into the social context and communities.

To do this, the job was divided into three parts: a baseline study characterizing the current situation, the estimation of the potential impact of BIZEOLCAT processes and the development of guidelines for establishing viable operation in ENP Countries. He showed also the distribution of ripple effects in Tunisia and Morocco, the expected impacts from a new PDH route in Spain, the economic value added (as CAPEX and OPEX) and the expected increase in employment and job creation.

The last presentation, entitled “Scaling innovative BIZEOLCAT catalysts and reaction tests to reach TRL 5” was showed by **Dr. Cem Açıksarı** and **Dr. Serdar Çelebi**. First of all, the main objectives and their roles in BIZEOLCAT Project were explained: in particular, the design and processing of innovative catalysts methodologies and novel reactor and the demonstration improvement in front of existing industrial processes.

TÜPRAS was involved in Task 4.4, in which the Company extrudes powder supports that were defined in the development stage of the project and shaped them as a pellet form, in order to fabricate the final catalysts for pilot scale unit testing of PDH, BDH and PA reactions, and Task 4.5, in which TÜPRAS performed the industrial-environment pilot-scale fixed-bed reactor tests for PDH, BDH and PA reactions.

The PDH, BDH and PA catalysts scale-up has been completed in collaboration with the technology developers.

At the end of this presentation, **George Kotsikos** did his final greetings.



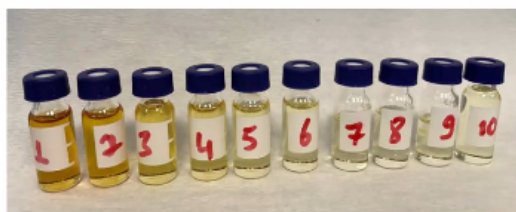
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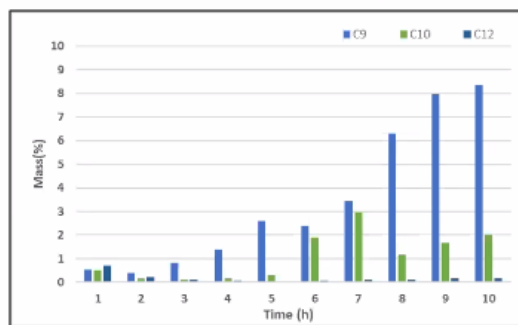
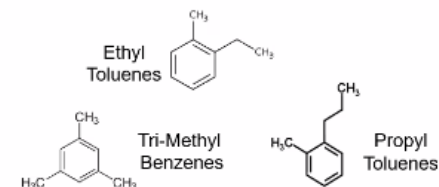
ZEOLCAT-3D

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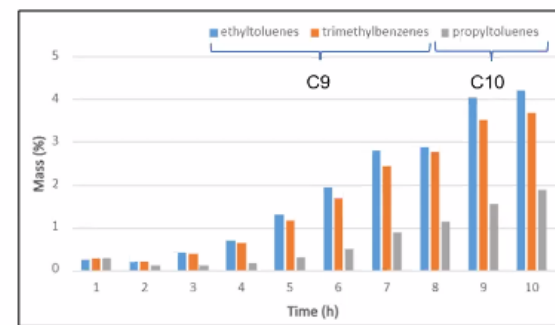
T 4.5 – PA Reaction Performance at Pilot Scale



- Ethyl Toluene (1,3 methylethyl benzenes) and trimethyl benzenes are dominant in C9.
- Propyl Toluene specifically 1,2 methyl-isopropyl benzene is dominant in C10.



PIONA Reformulyzer Result (Group Analyses)



DHA (detailed hydrocarbon analyses)



For any further information contact the project coordinator at:

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BiZeolCat 

