New adaptable catalytic reactor methodologies for Process Intensification

- SPIRE-05-2015 (Sustainable Process Industries)
- Start/end date: 15/09/2015 - 14/09/2019
- Partners:
Project Case Study

1. The EU/ SPIRE needs
SPIRE Roadmap (Key Action 2.4: More efficient systems and equipment) → New ways of targeting energy input via electrochemical ……. → new concepts for industrial electrochemical processes

2. The Project Solution
New adaptable tandem electrocatalytic reactor (TER) and related electrodes for a specific relevant industrial innovation case: the synthesis of PEF (PolyEthylene Furanoate), a next-generation 100%-renewable plastic

3. Value to Customers
- Process intensification,
- Elimination of use of oxidants/reducents,
- Energy saving

4. How will this happen?
TERRA concept based on the development of a Tandem Electrocatalytic Reactor (TER) for the simultaneous oxidation of HFM to FDCA and the hydrogenolysis of alcohols derived from sugars hydrogenation (not converted to HMF) to MEG..
What are the **key expected sustainability impacts** of Project TERRA?

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<th>Performance targets</th>
<th>Relevant performance indicators</th>
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| Develop a cost effective technology for the combined production of FDCA and MEG in a tandem electrocatalytic reactor | - **Energy intensity**: reduction ≥ 25% in process energy intensity with respect to actual**
- **Emissions**: reduction ≥ 20% in emissions with respect to actual**
- **Productivity**: increase ≥ 35% productivity (per reactor vol.) with respect to actual** |
| Improve 3D-type electrodes with supported electrocatalyst                           | - **Productivity**: >50% with respect to conventional-type of electrodes at equal current density values referred to the geometrical electrode surface |

* actual Avantium process of FDCA synthesis: 1000 €/ton; actual MEG production cost: 1200 €/ton

** a 50.000 t/y plant is under development with conventional (not electrocatalytic) technology
What **outputs or learning** from Project TERRA could have value for other SPIRE projects here?

- New electrocatalytic reactors/electrodes to **reduce the number of steps and unit operations** in industrial processes → **process and energy intensification**, **use renewable energy to drive chemical processes**, **distributed production**
- Improving the **efficiency in the use of resources**, and **reducing the impact on the environment**
  - **Energy intensity**: reduction ≥ 25% in process energy intensity with respect to actual
  - **Emissions**: reduction ≥ 20% in emissions with respect to actual
- Enable **flexible and decentralised production** at high process performance
Electrochemical reactor
(160°C; <30 bar)

OH-
(HMF, aq, NaOH)
(Xylose, aq, NaOH)

FDCA
EG, PG
e-
(<1 V)

Ti backbone
High S.S.A.
conductive
support
Ni, Co, ...
clusters

C backbone
High S.S.A.
conductive
support
Ni, Co, ...
clusters

Membrane
3D cathode
3D anode

c.

Process and energy intensification with electrocatalytic novel processes
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