Catalytic condensation of biobased molecules for jet fuel synthesis

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HIGFLY

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HIGFLY

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Outline

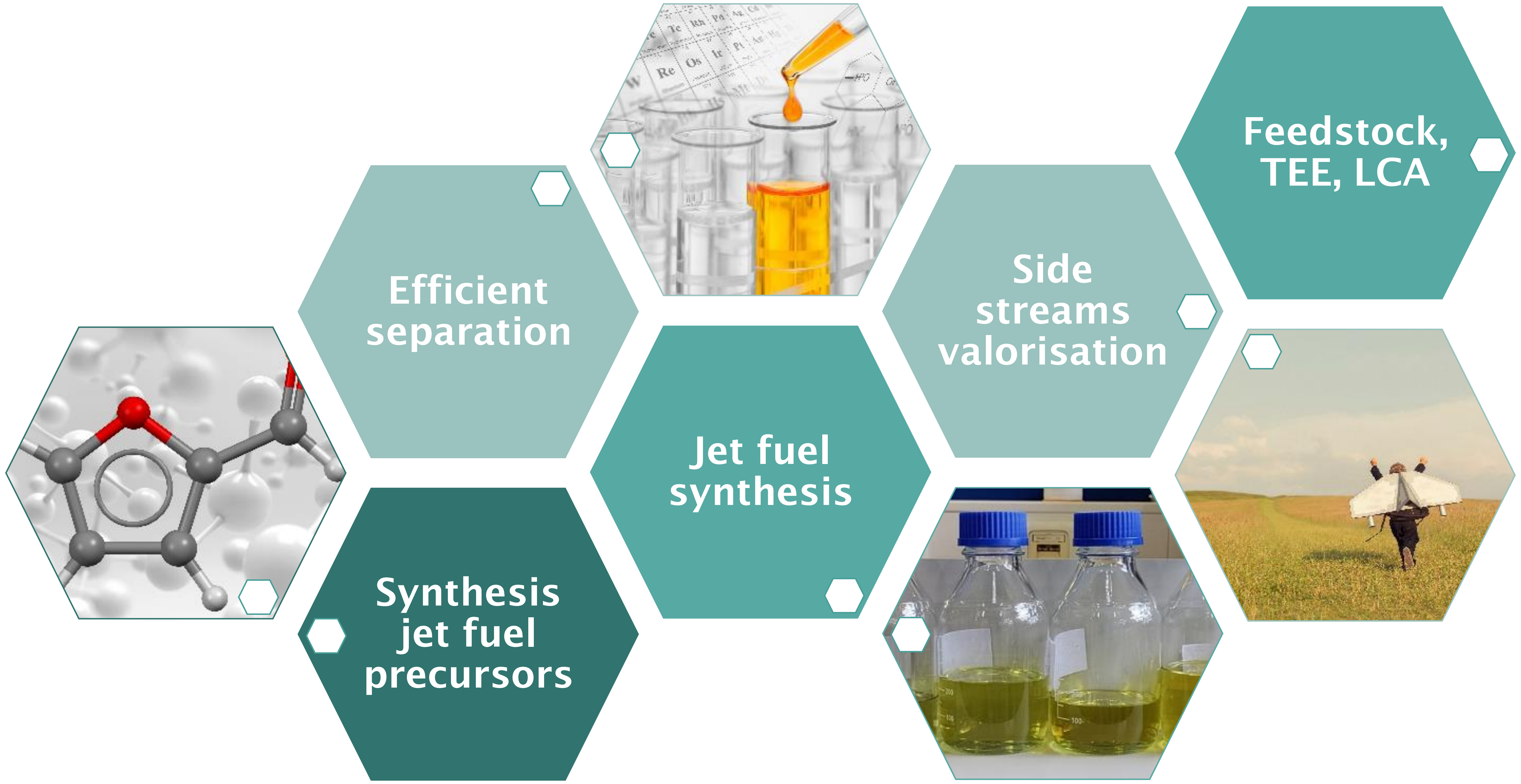
- HIGFLY project & background
- Condensation: Catalyst screening
- Condensation at low temperature: Tests under flow
- Condensation at high temperature: Tests under flow
- Hydrotreatment: Preliminary outlook
- Conclusions

*See HIGFLY presentation:
3BO.3.2 Integrated biorefineries

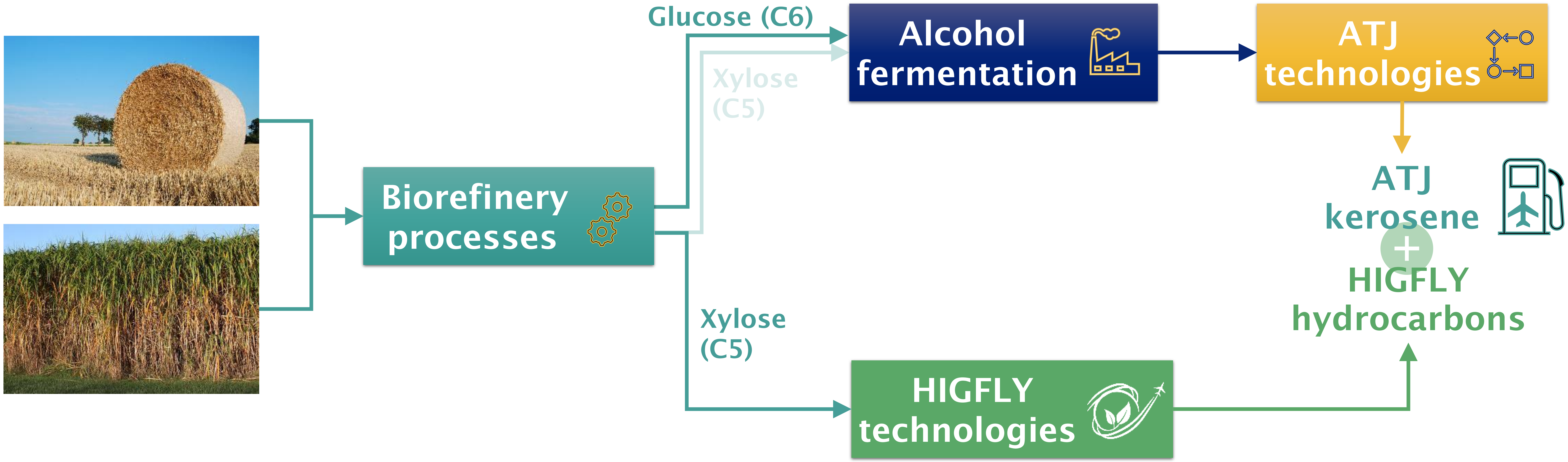
HIGFLY: HiGee to Furanic-based Jet fuel Technology

HIGFLY aims to develop the **next generation of technologies** for the production of sustainable aviation fuel from abundant **second generation feedstocks.**

- LC-SC3-RES-1-2019-2020 - Developing the next generation of renewable energy technologies
- TRL 3-4
- Duration: 48 months
- 9 partners, 4 countries
- Coordinator: TU/e
- 10.3030/101006618



Background


Glucose (C6)
Xylose (C5)
Alcohol fermentation
ATJ technologies
ATJ kerosene
+
HIGFLY hydrocarbons
Biorefinery processes
Xylose (C5)
HIGFLY technologies

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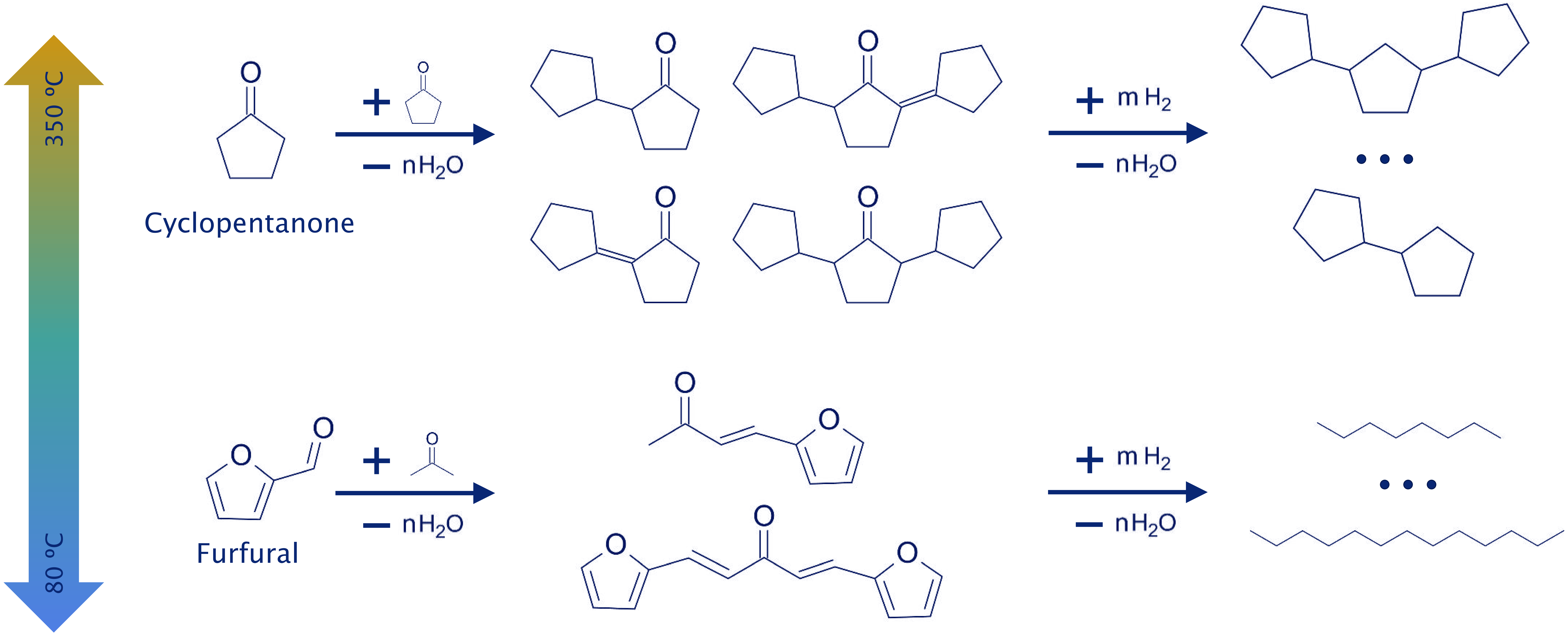
Jet fuel production routes



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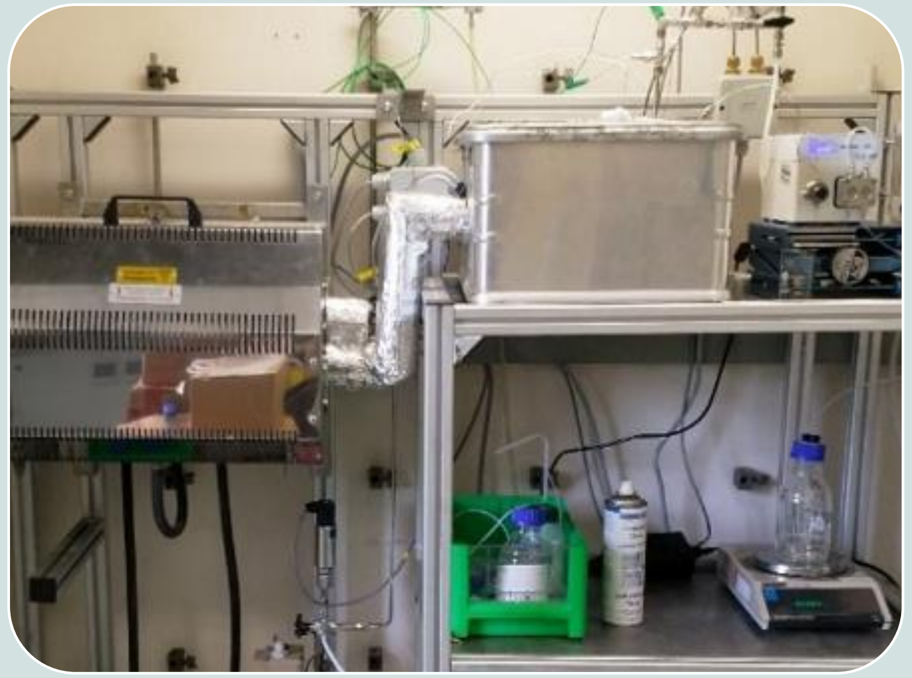
Methodology

Catalyst selection & formation

- ✓ Screening (mL-scale) base & HDO catalysts
- ✓ Selection of most active powders
- ✓ Catalyst characterisation
- ✓ Forming trials via pelletisation/extrusion

Continuous flow testing



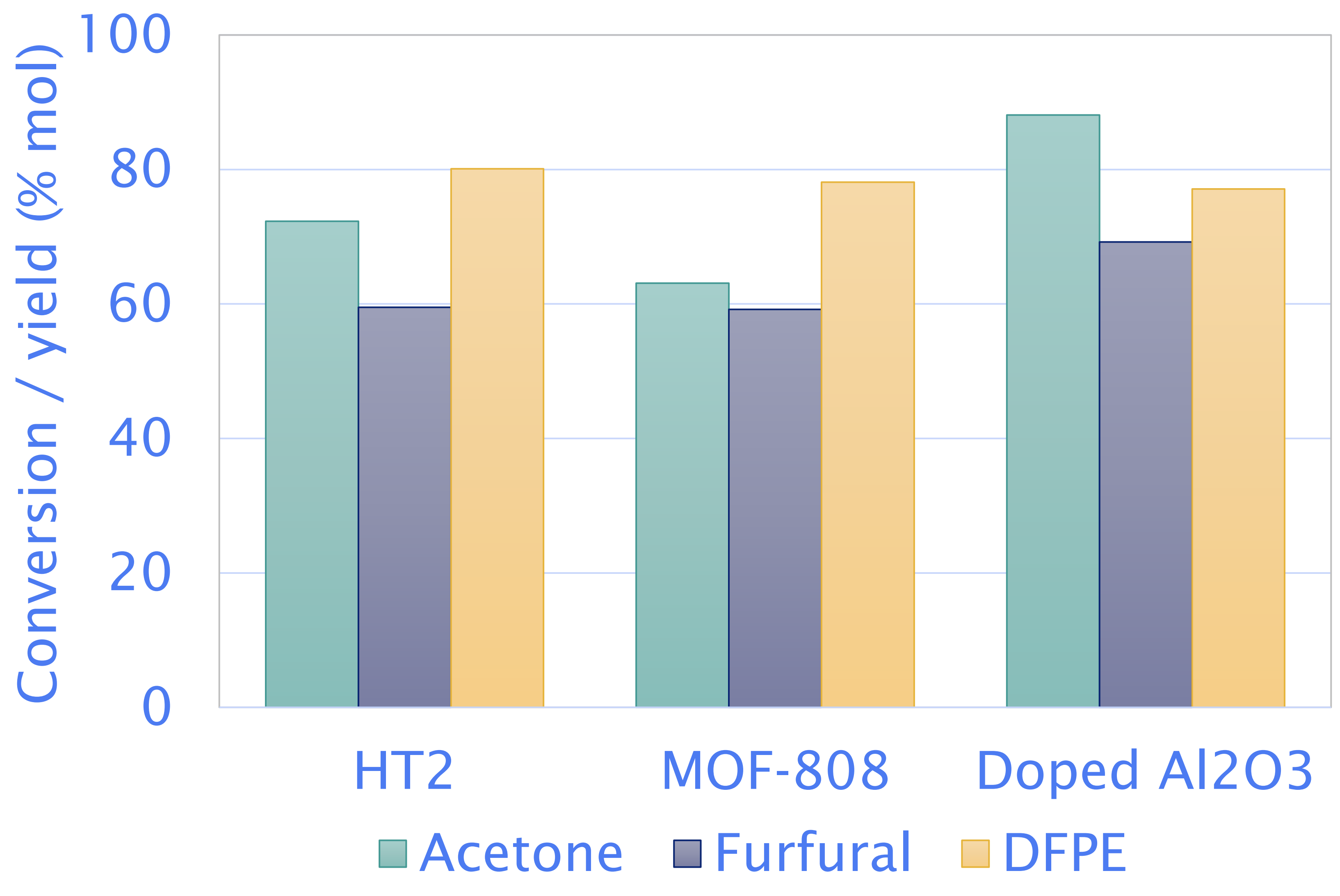
- ✓ Testing formed materials under flow conditions
- ✓ Effects of process conditions and feed composition

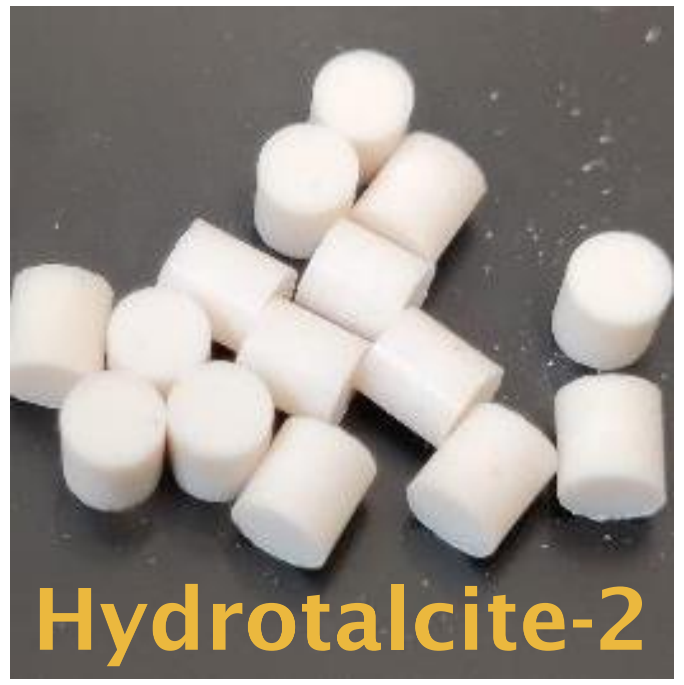
Concept validation

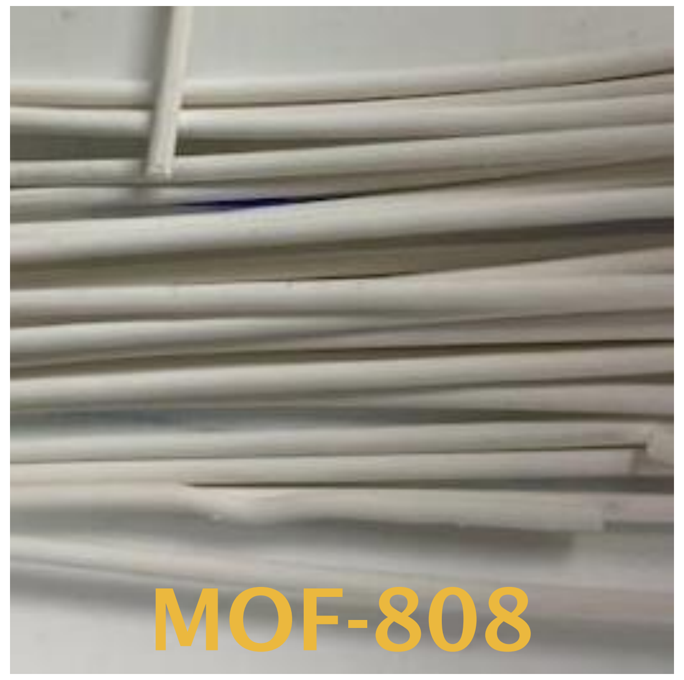
- ✓ Catalyst stability over long operation (100 h)
- ✓ Use of bio-based precursors (TRL4)
- ✓ Jet fuel characterisation

Condensation: Catalyst screening

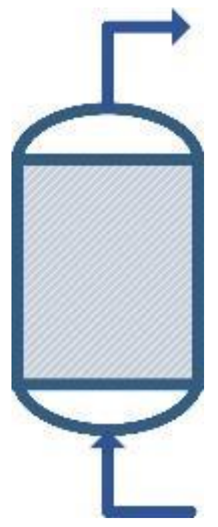
- +35 type of catalysts screened in low temperature reactions (<200 ºC)
- Three catalyst selected and formed into structures

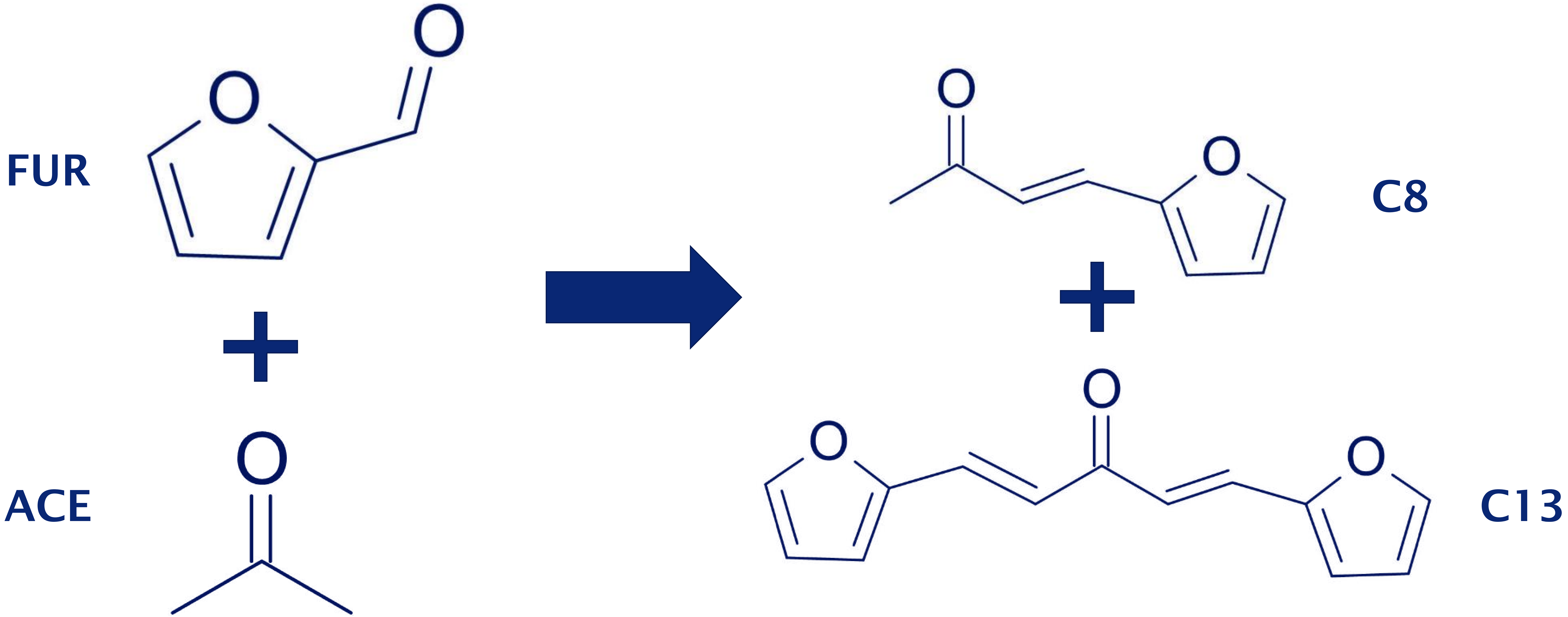






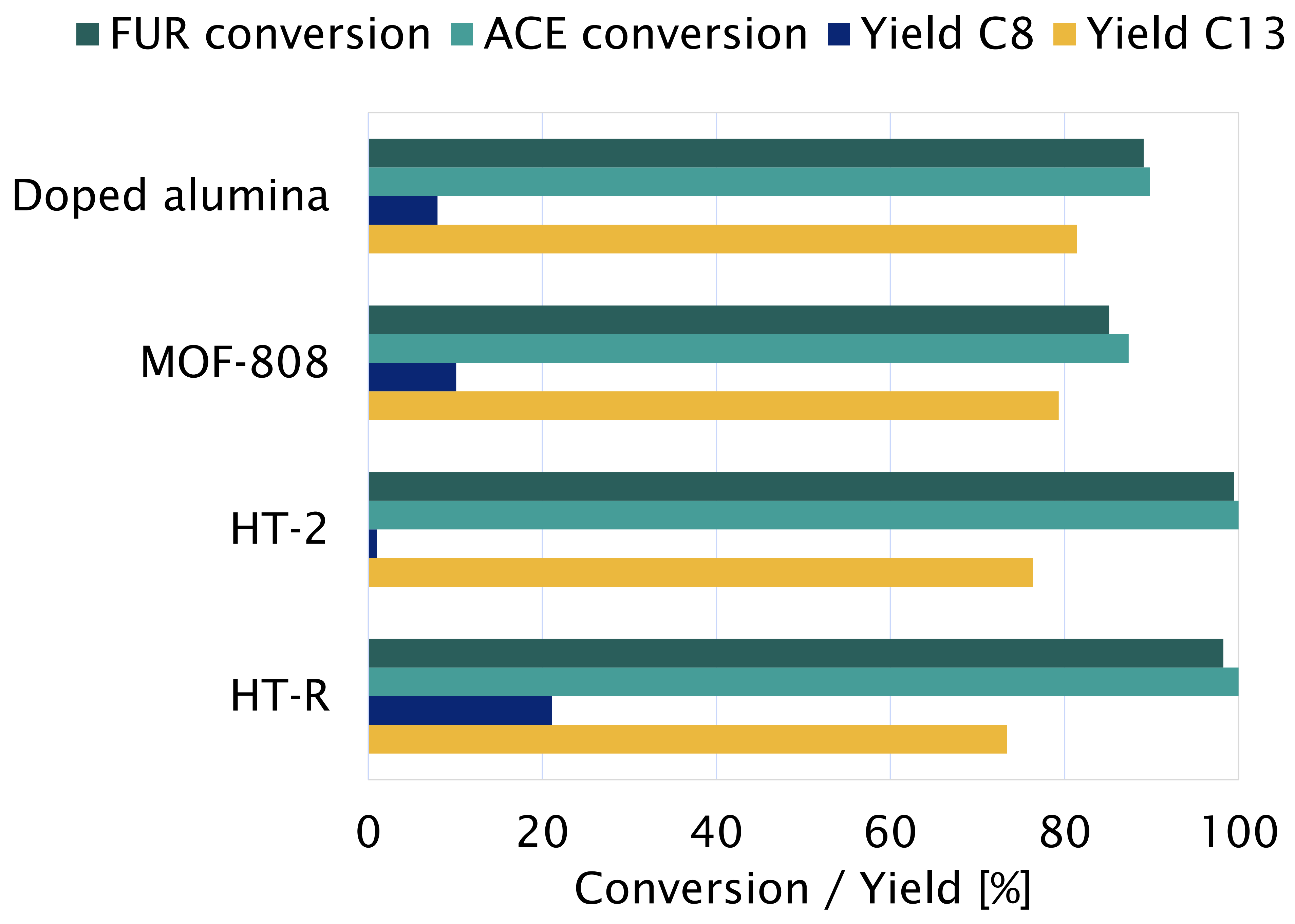
Low temperature cross condensation: Catalysts under flow



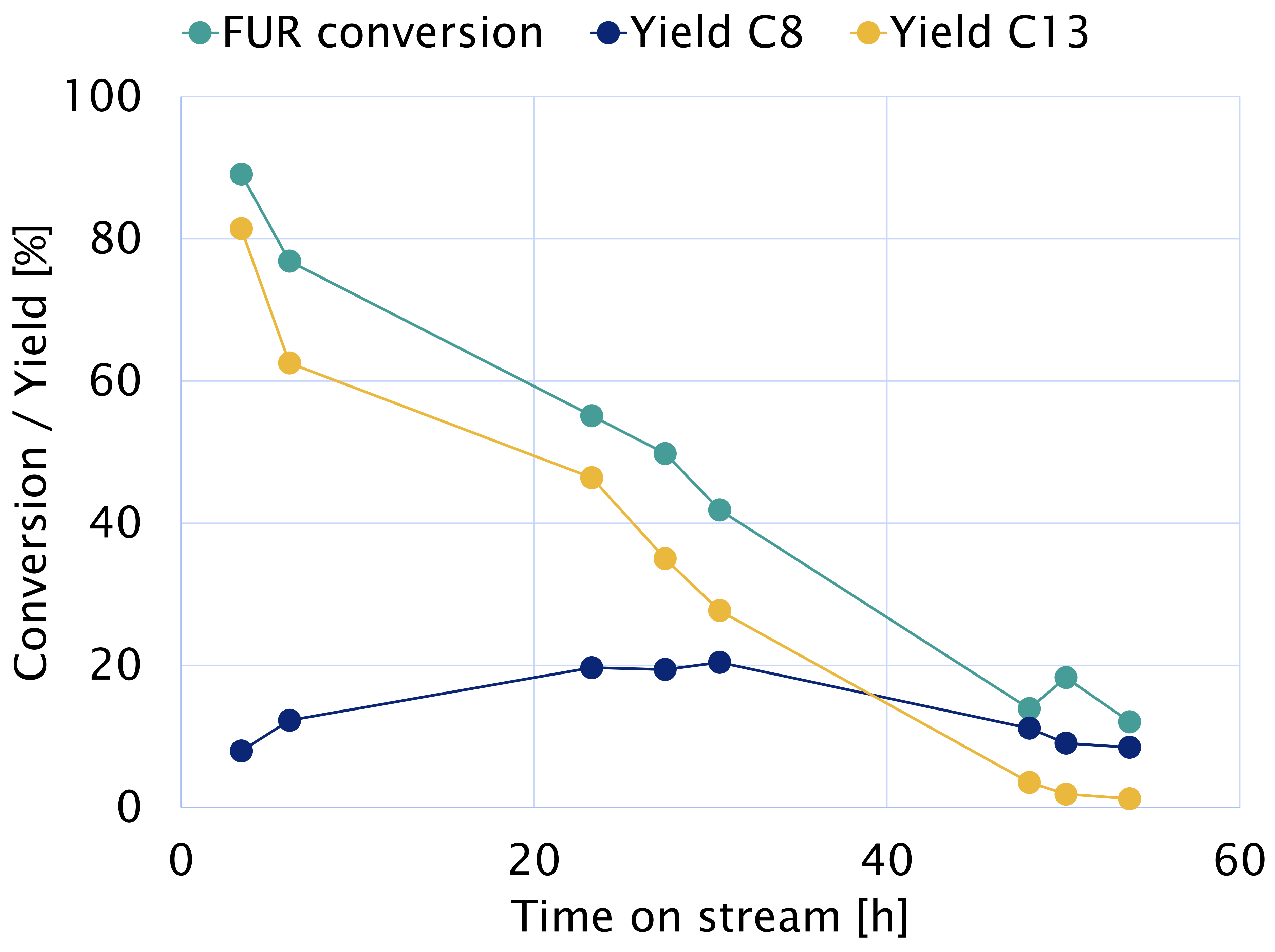


Low temperature cross condensation: Catalysts under flow

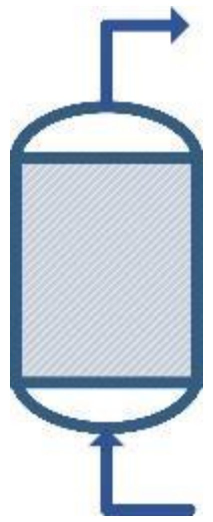
Initial catalyst activity at 120 ºC

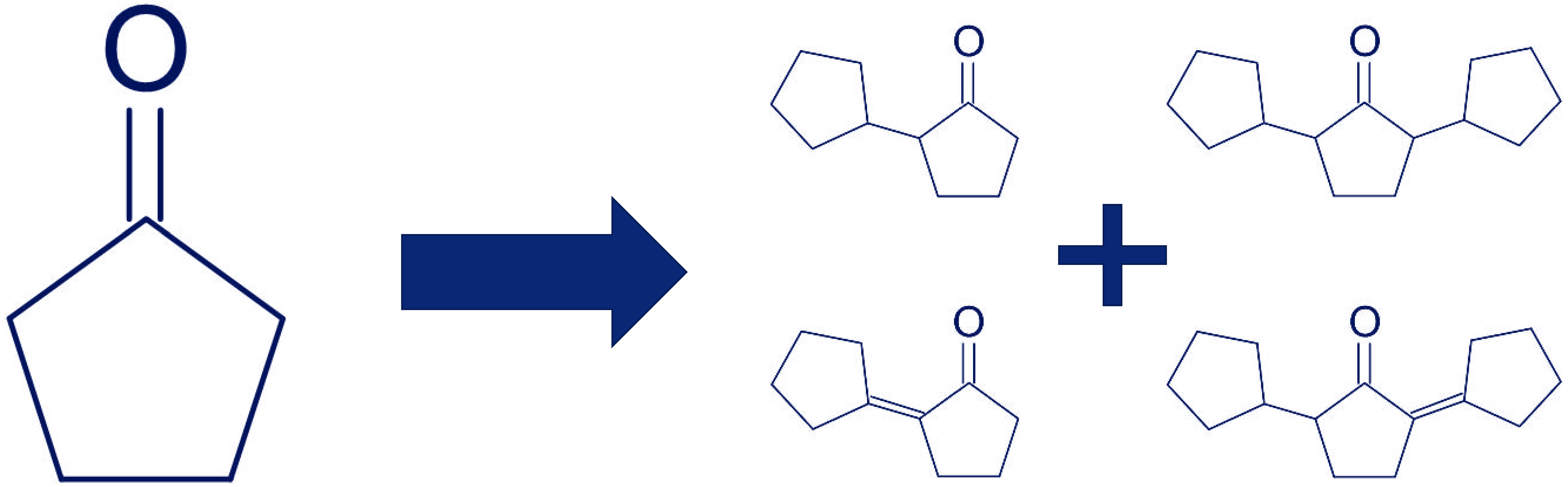


Doped alumina deactivation at 120 °C



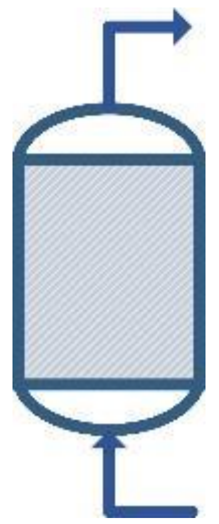
High temperature condensation: Catalysts under flow



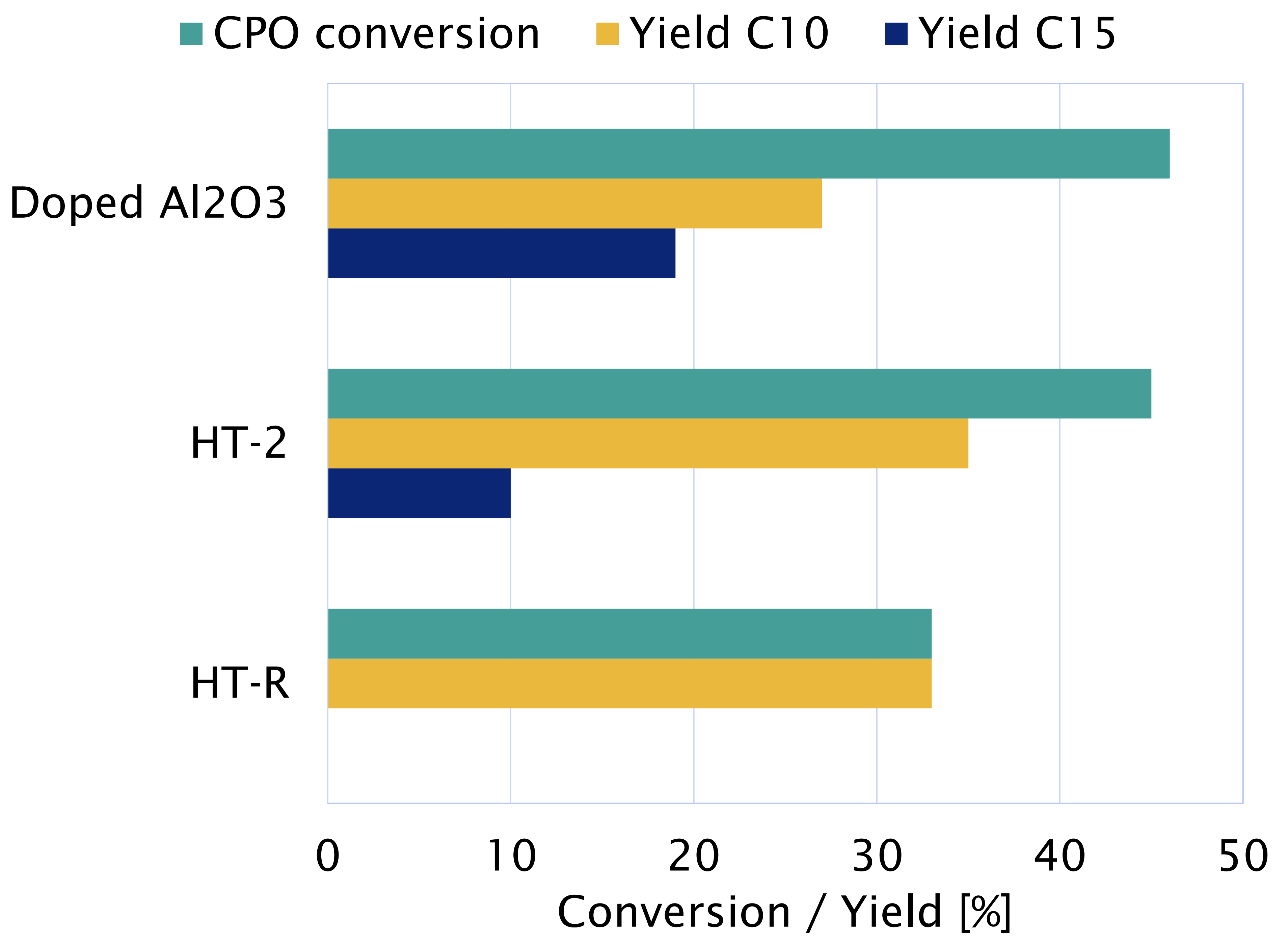


CPO　　C10　　C15

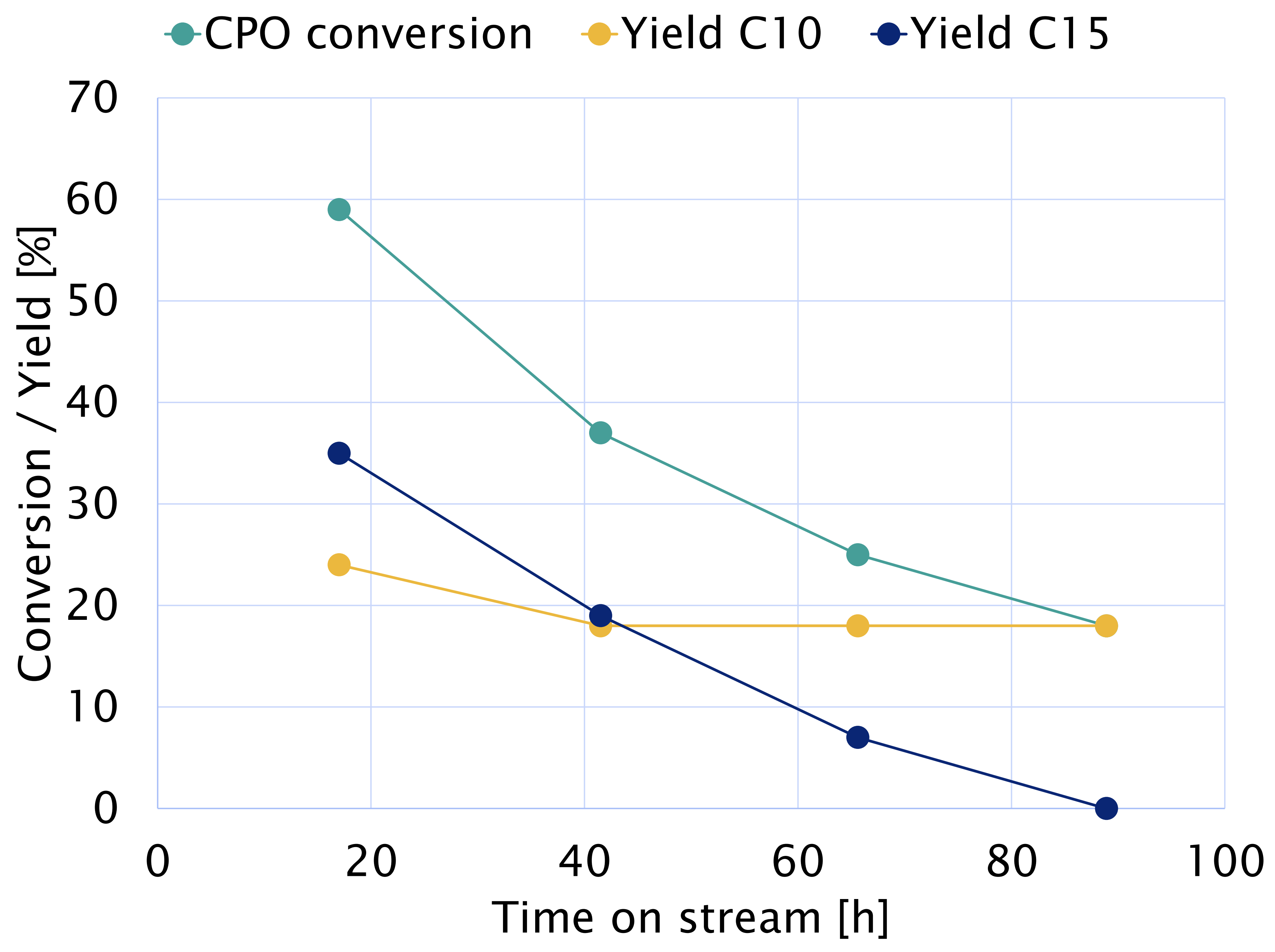
High temperature condensation: Catalysts under flow



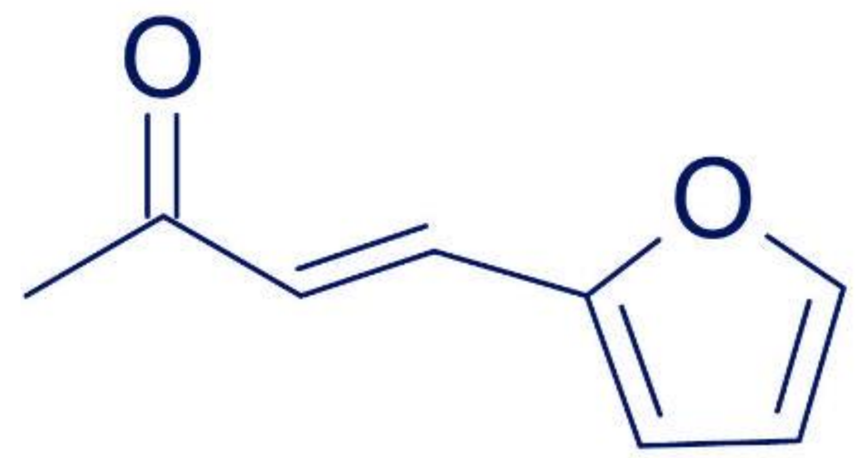
Initial catalyst activity at 280 ºC



HT-R deactivation at 320 °C



Hydrotreatment: Preliminary outlook



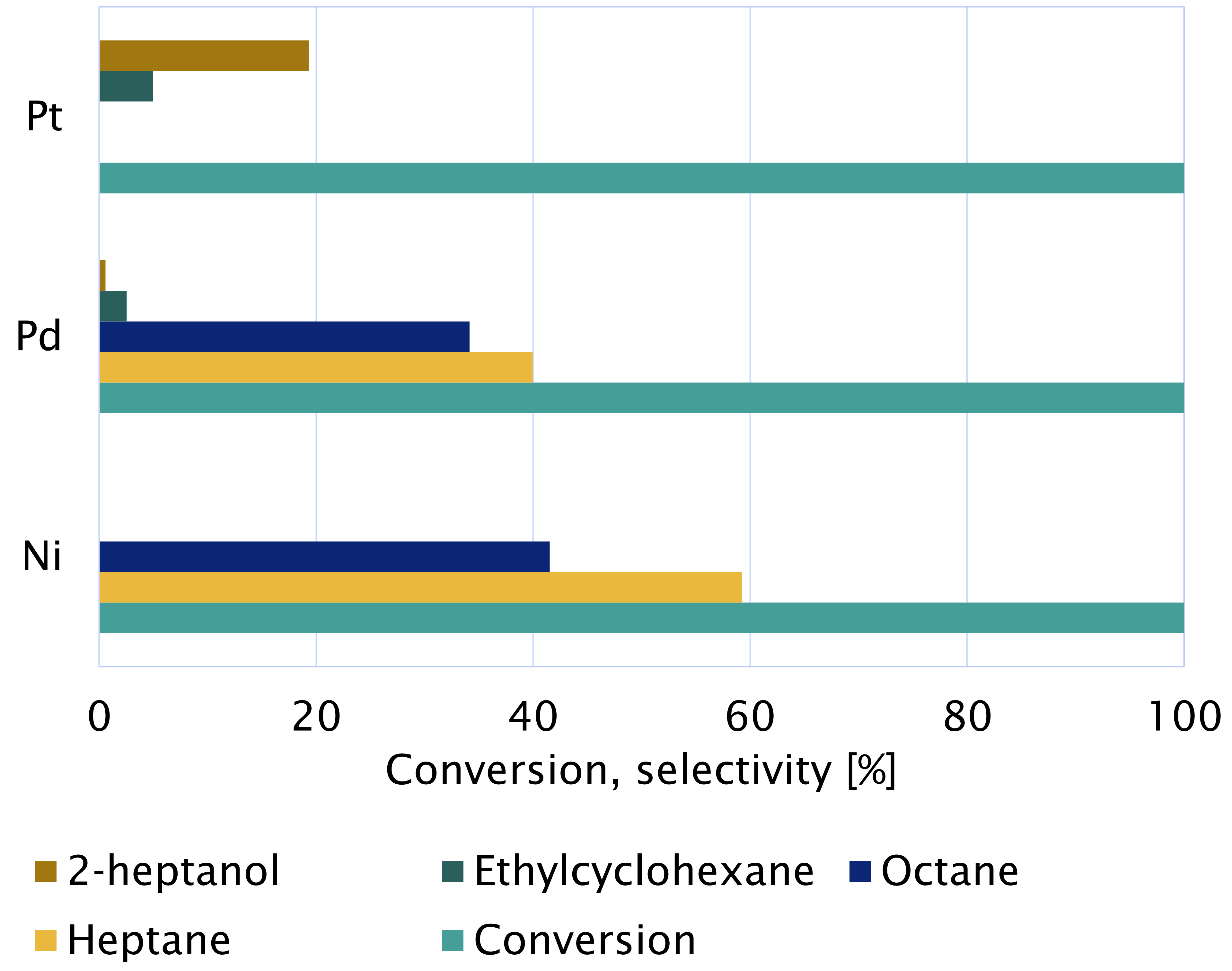
- 4-(2-furyl-)-3-buten-2-one (C8) model reactant compound
  - Functionalities present from condensation products

- Hydrotreatment product distribution varies depending on catalyst type, under similar reaction conditions.

  T = 275 °C, P = 50 bar H_2, time = 6h

  Liquid product mixture analysed by GC

- Reaction conditions and catalyst optimisation ongoing



Conclusions & outlook

- Production of jet fuel hydrocarbons via cross/self condensation of hemicellulose sugar-based precursor molecules
- Two feasible routes (low vs. high temperature) for flexibility: Precursors, number of carbons and functionality in product
- Activity loss due to carbon deposition: Regeneration via recalcination
- Future work:
    - Reuse of regenerated condensation catalyst in various cycles
    - Hydrodeoxygenation of condensed molecules under flow

Acknowledgments

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