Engineering Conferences International
ECI Digital Archives

Pyroliq 2019: Pyrolysis and Liquefaction of Biomass and Wastes

Proceedings

6-19-2019

Upgrading of wheat/barley and miscanthus bio-oil over a sulphided catalyst

Bogdan Shumeiko
University of Chemistry and Technology, Czech Republic, shumeikb@vscht.cz

Miloš Auersvald
University of chemistry and technology, Prague

David Kubička
University of chemistry and technology, Prague

Petr Straka
University of chemistry and technology, Prague

Pavel Šimáček
University of chemistry and technology, Prague

See next page for additional authors

Authors
Bogdan Shumeiko, Miloš Auersvald, David Kubička, Petr Straka, Pavel Šimáček, and Dan Vrtiška

UNIVERSITY OF CHEMISTRY AND TECHNOLOGY PRAGUE

BioMates

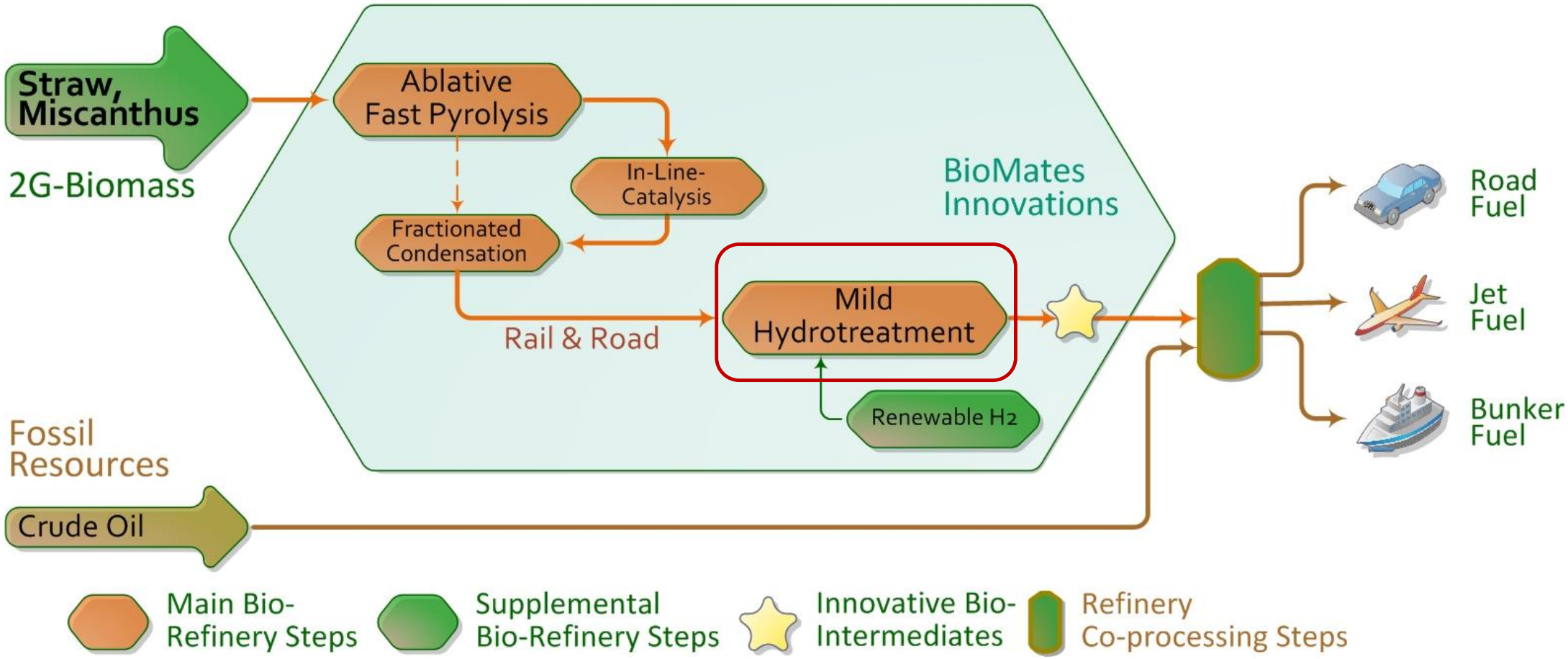
Upgrading of wheat/barley straw bio-oil over a sulphided catalyst

Shumeiko Bogdan, David Kubička, Miloš Auersvald, Petr Straka, Dan Vrtiška, Pavel Šimáček

Cork, Ireland

19/06/2019

BIOMATES SCHEME



Source: www.biomates.eu

OUR AIM

Bio-oil and catalysts

- Straw and miscanthus bio-oils
- Sulphided x transition metals

Hydrogenation unit

- one-step fixed-bed reactor
- Optimization of T and P

Products characterisation

- Use advanced analytical techniques to shed light on product nature

AIM

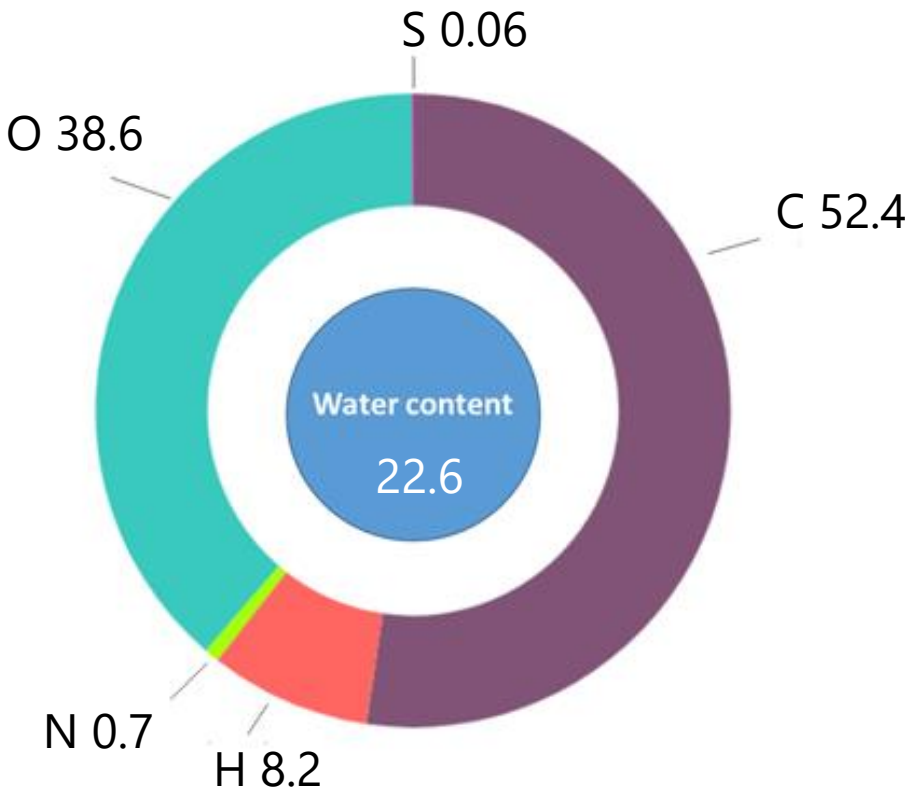
- Low-cost petroleum-refinery-compatible feedstock

WHEAT/BARLEY STRAW BIO-OIL

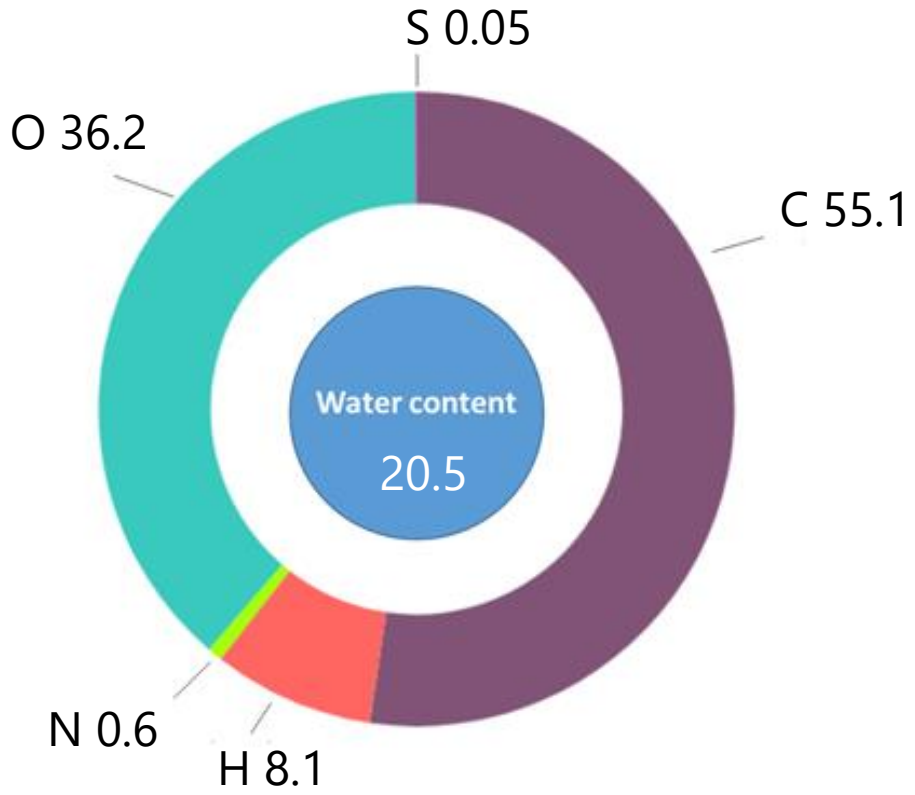
Wheat/barley straw bio-oil

- T_{cond} 2-5 °C
- Aqueous phase yield = 27.9 wt%
- Bio-oil yield = 20.9 wt%

- T_{cond} 75 °C
- Bio-oil yield = 23.3 wt%



C
O
H_2O
Yield



HYDROGENATION UNIT

R • Fixed-bed, co-current flow

F • Wheat/barley straw bio-oil

2-5 °C and 75 °C

C • 340 °C, 40 bar, TOS 80 h, LHSV $1h^{-1}$

C • Presulphided $NiMoS/Al_2O_3$

Based on our previous experiments

S_{BET}: 86.5 $m^2 \cdot g^{-1}$

3.9% Ni and 15% Mo

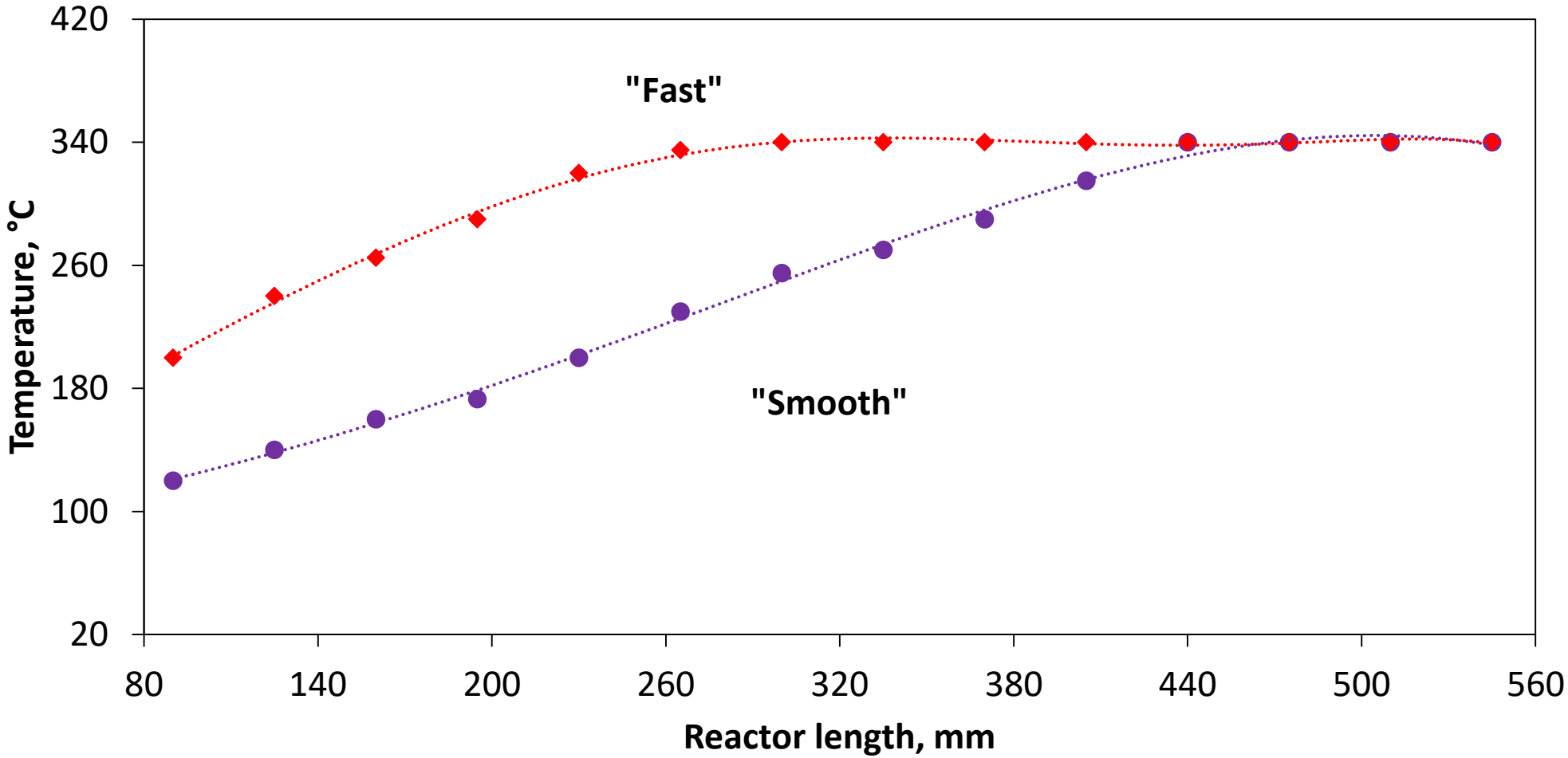
0.8-1.2 mm particle size

Hydrogenation of wheat/barley bio-oil 2-5 °C

Part 1: effect of thermoprofile

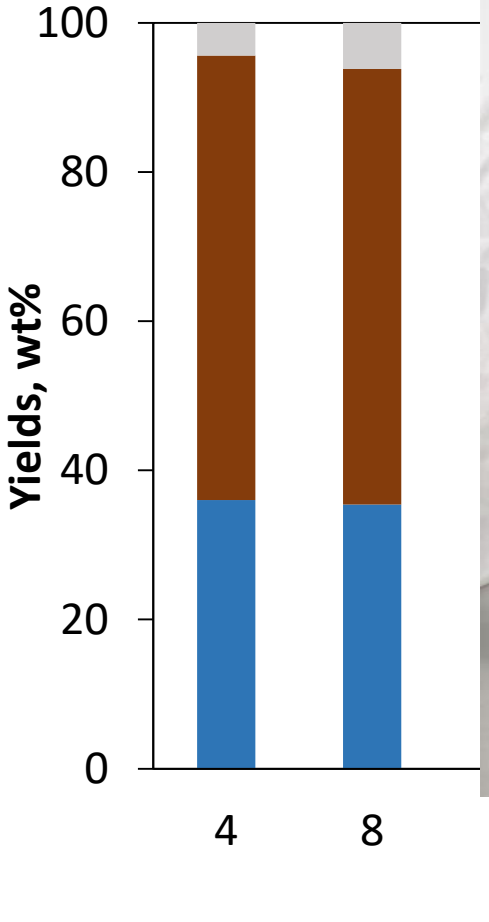
EFFECT OF TERMOPROFILE ON PRODUCTS QUALITY

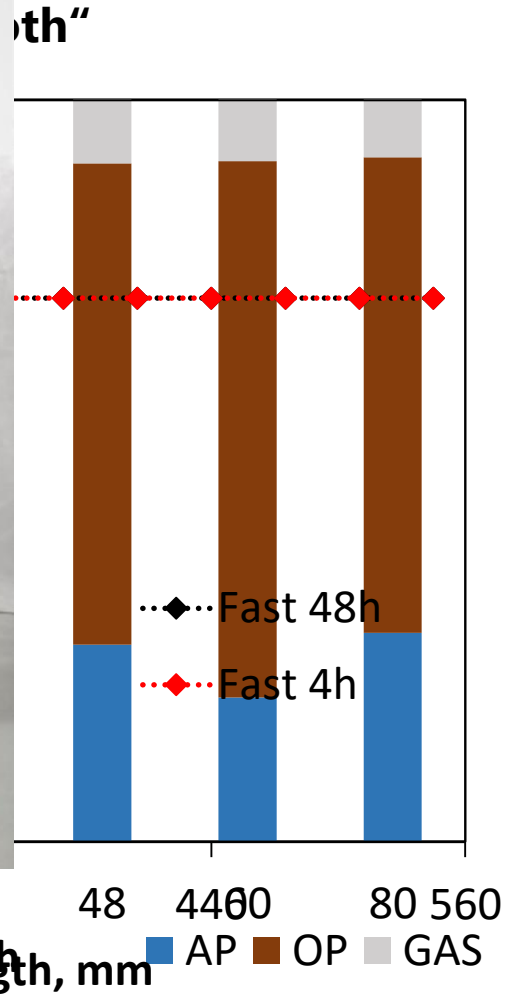
Hydrogenation of bio-oil (2-5 °C) at two different thermoprofiles: fast increase to 340 °C and smooth increase to 340 °C



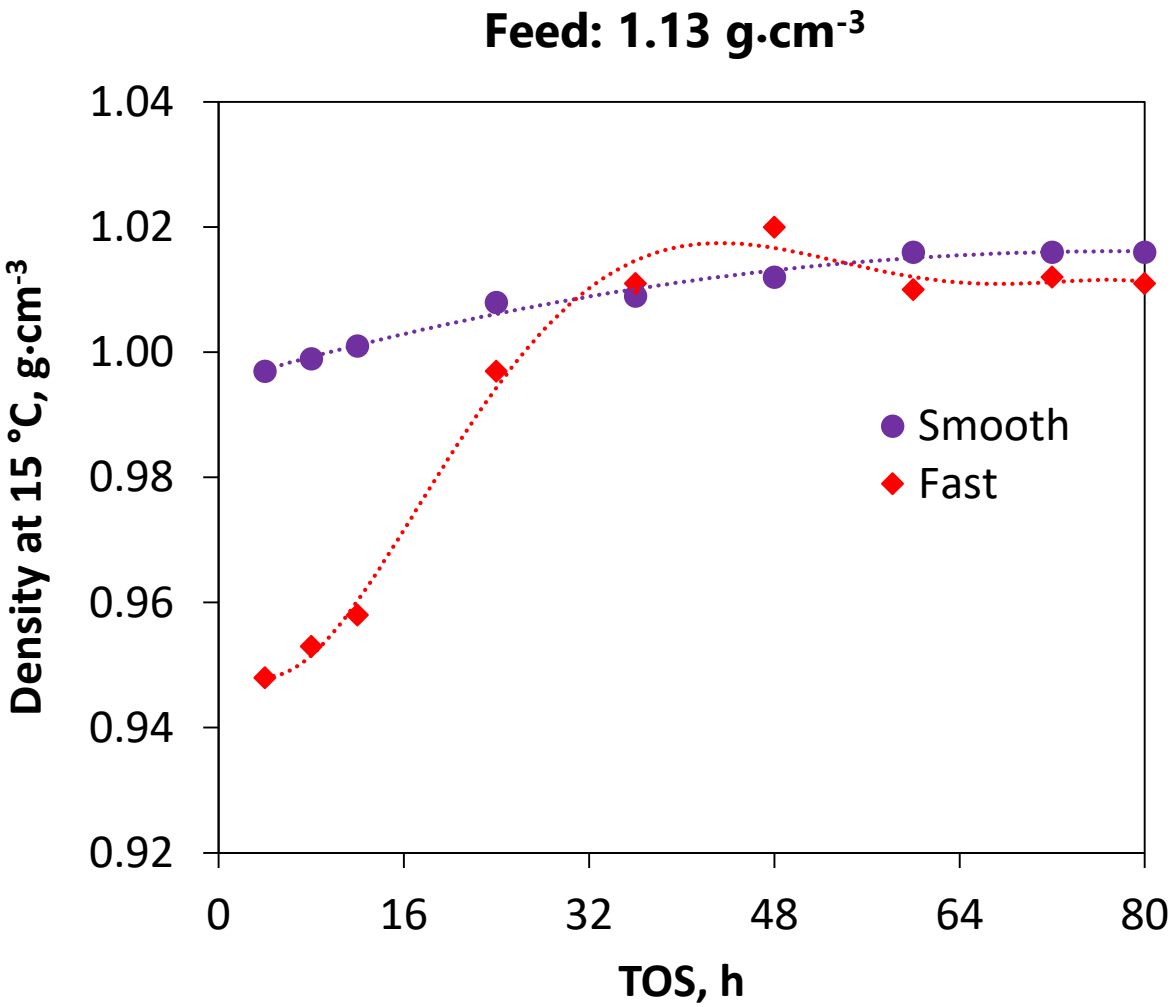
EFFECT OF TERMOPROFILE ON PRODUCTS QUALITY

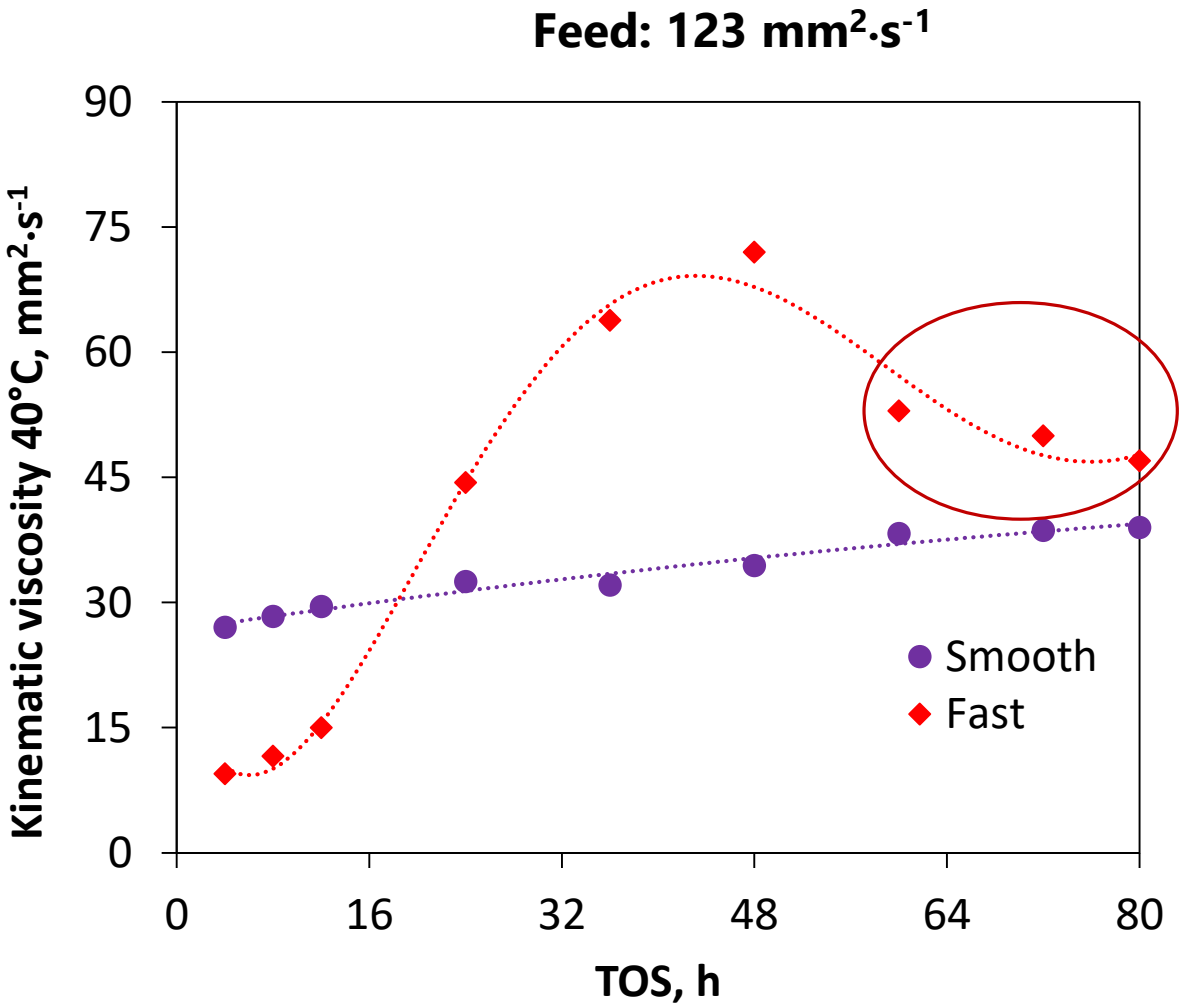
All hydrogenated products were separated at two phases: organic and aqueous phase (OP and AP)



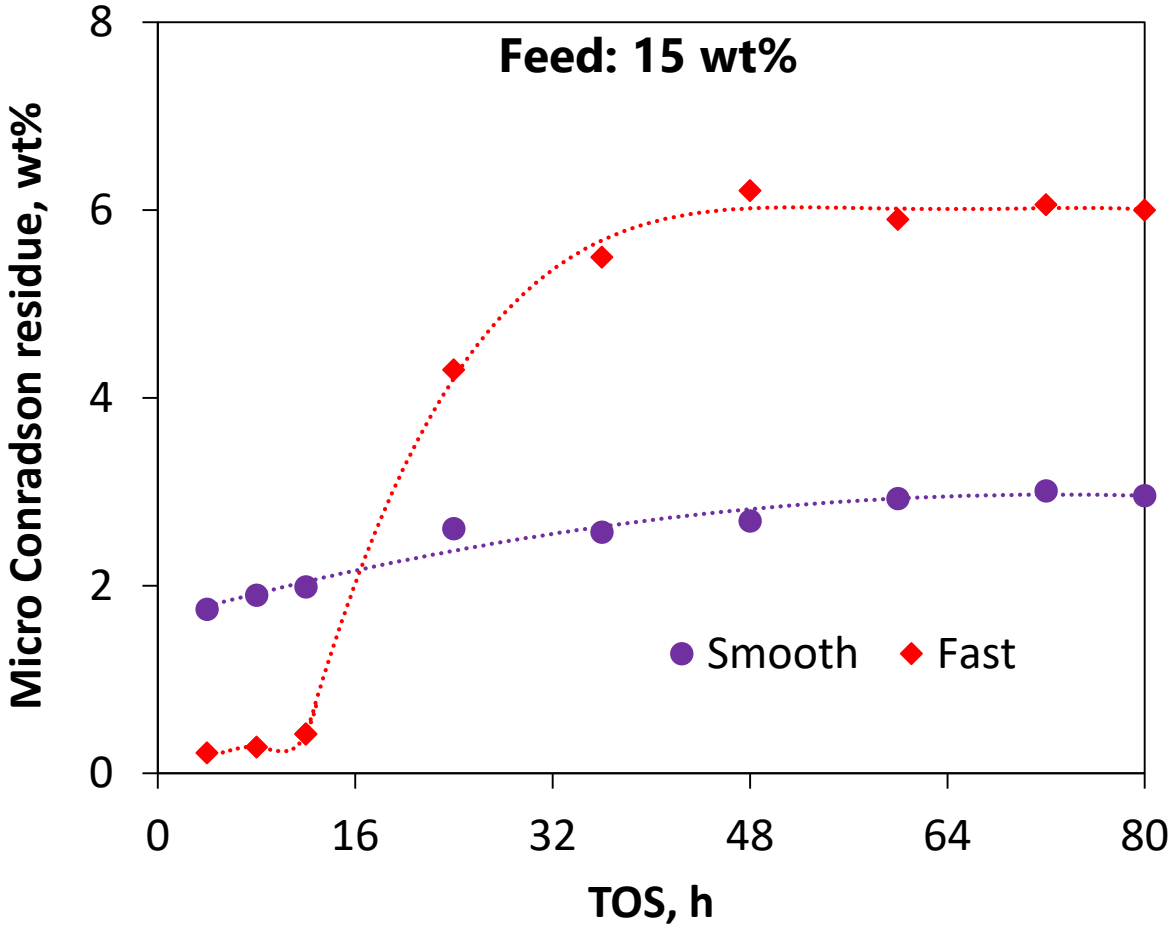


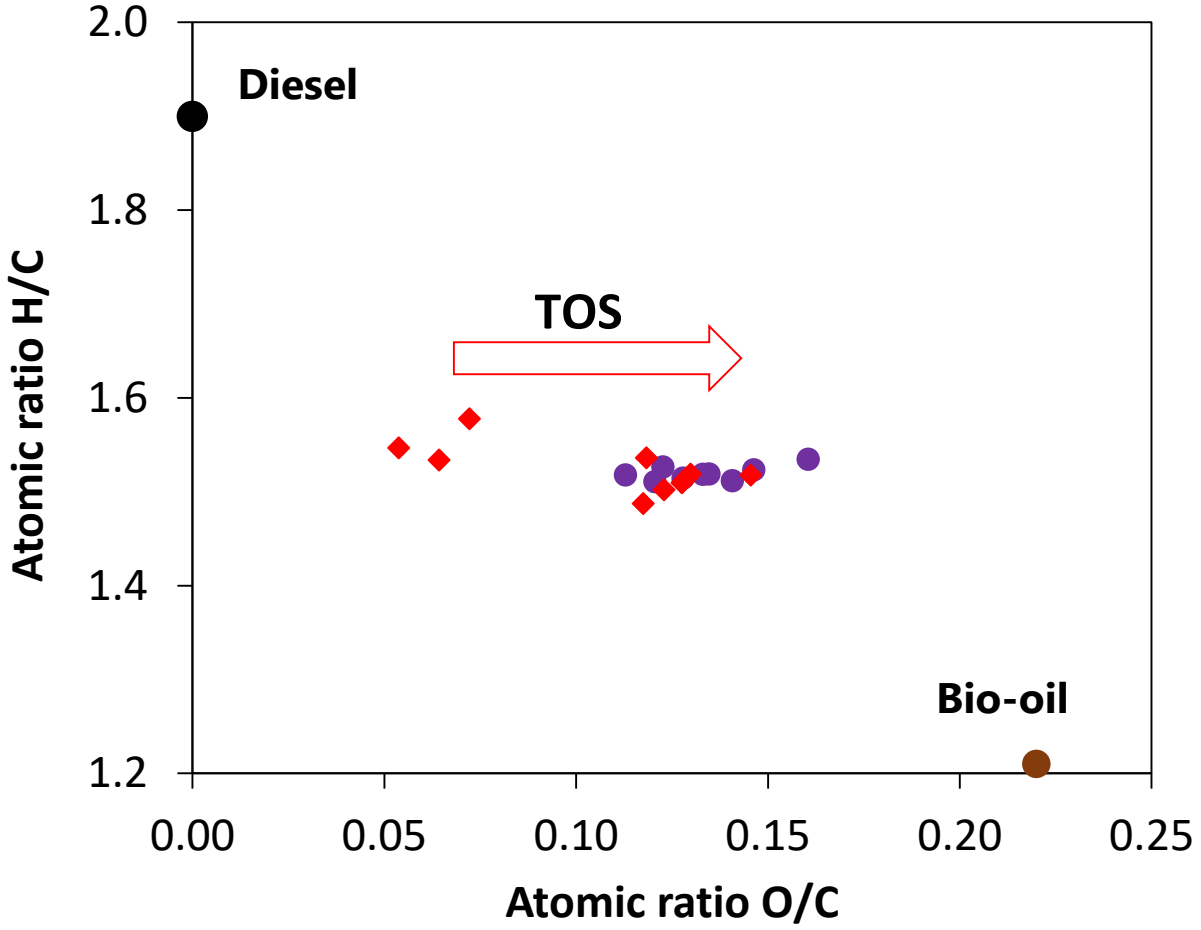
- High catalytic activity loss after 12 hours TOS leads to decrease of products properties („Fast“)





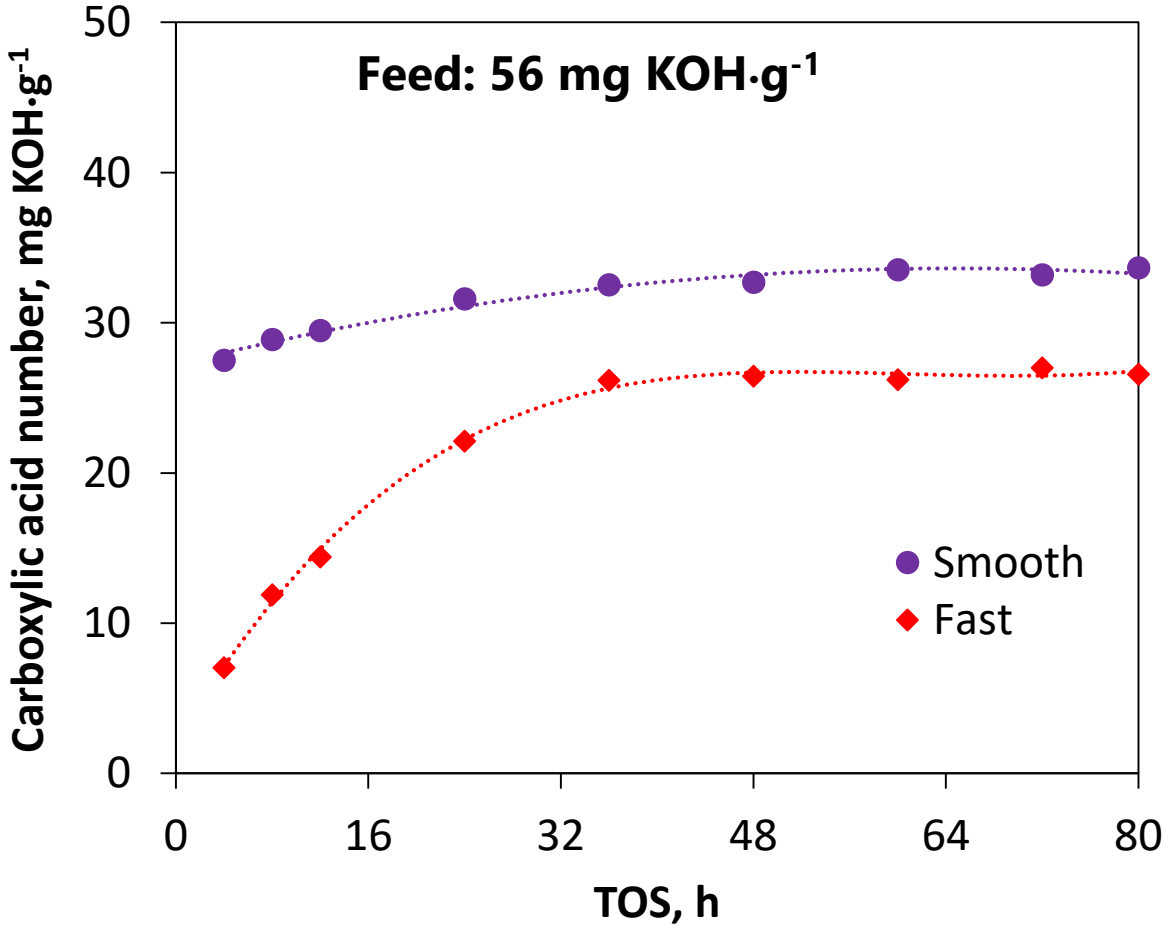
Significant increasing MCR value can be assumed as the most negative point of „Fast“ products even with other better properties

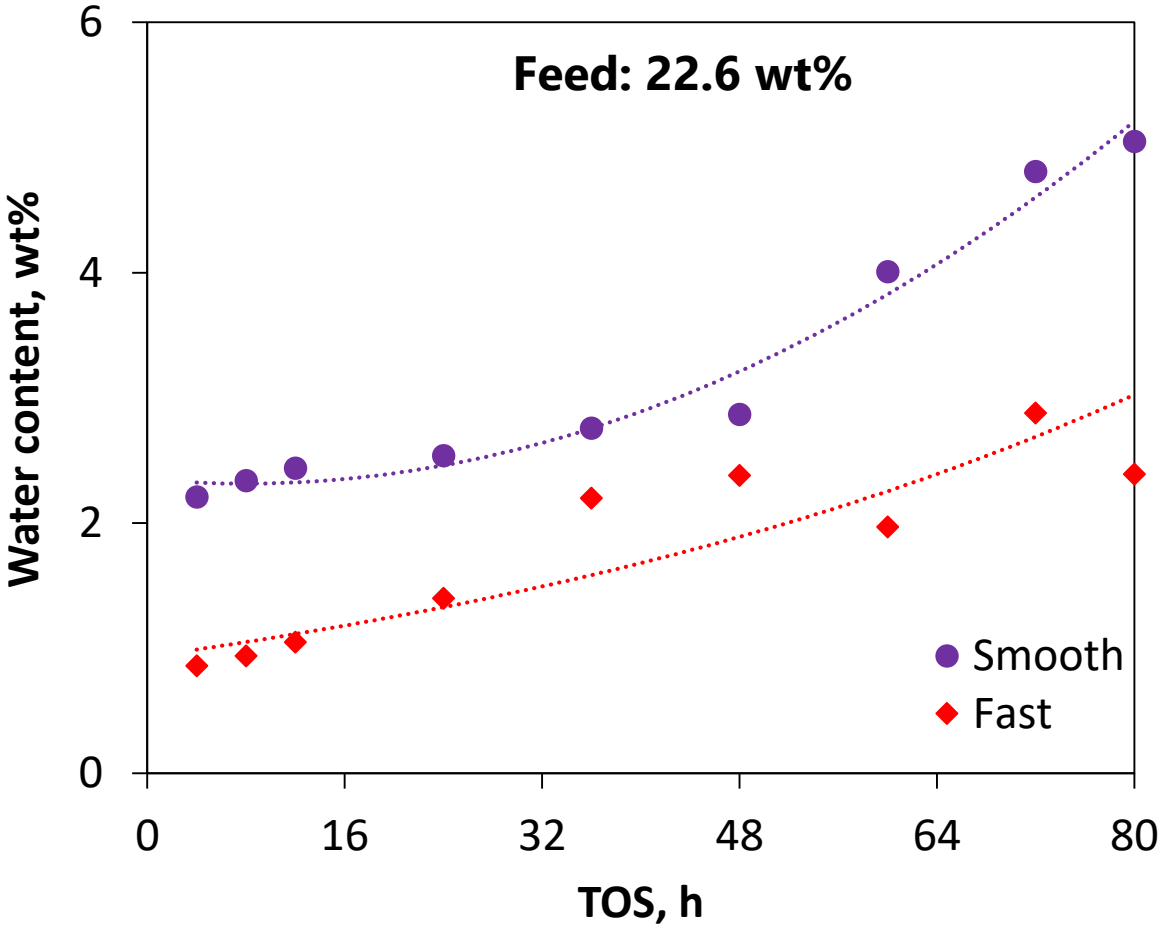




PHYSICOCHEMICAL PROPERTIES – TITRATION METHODS

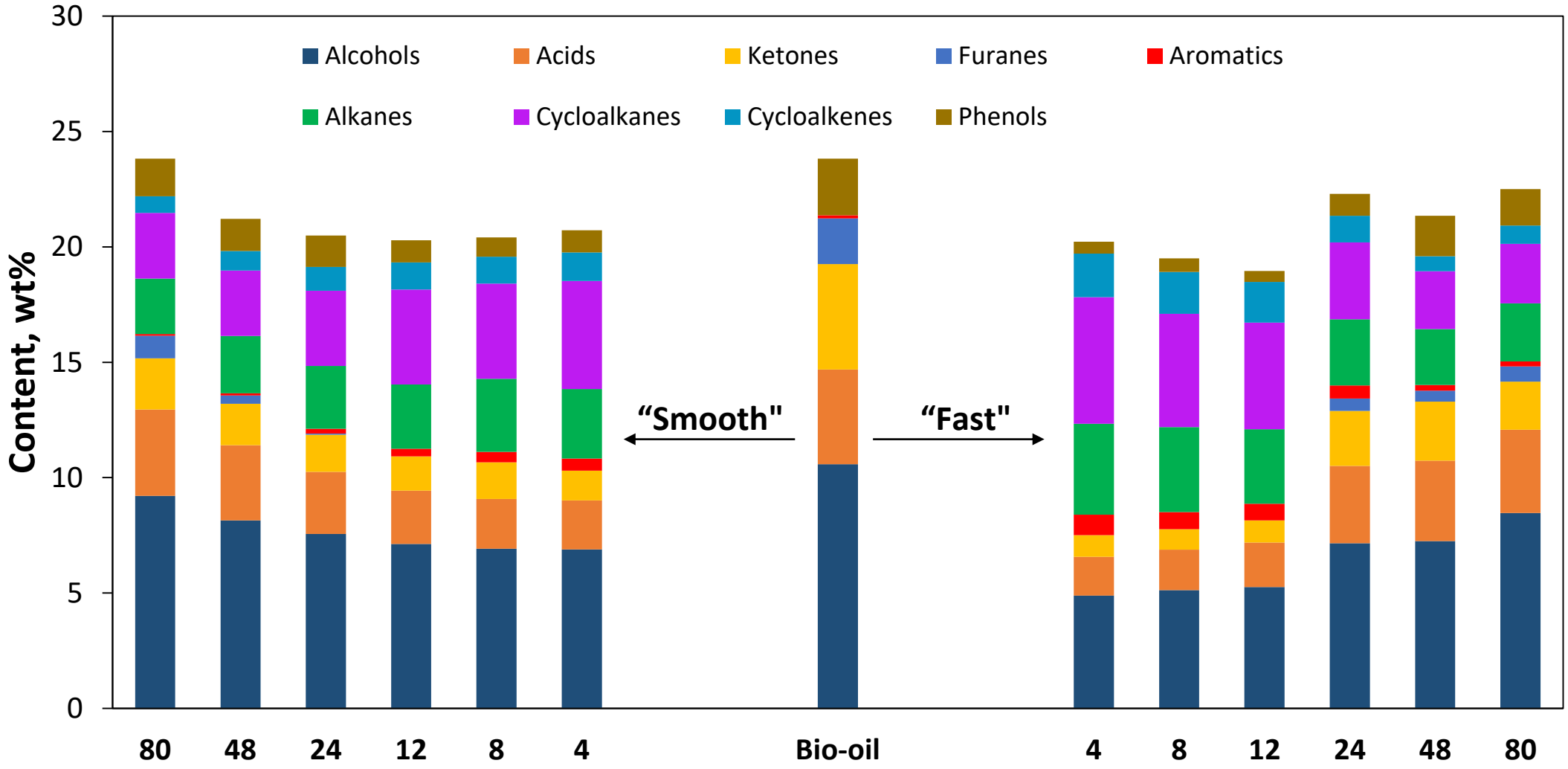
Corrosivity of bio-oil products can cause huge problems in refinery – should be blended with crude-oil/distillates





CHEMICAL COMPOSITION – GC/MS

In all products were found alkanes, cycloalkanes/-alkenes that have not been observed in the raw bio-oil

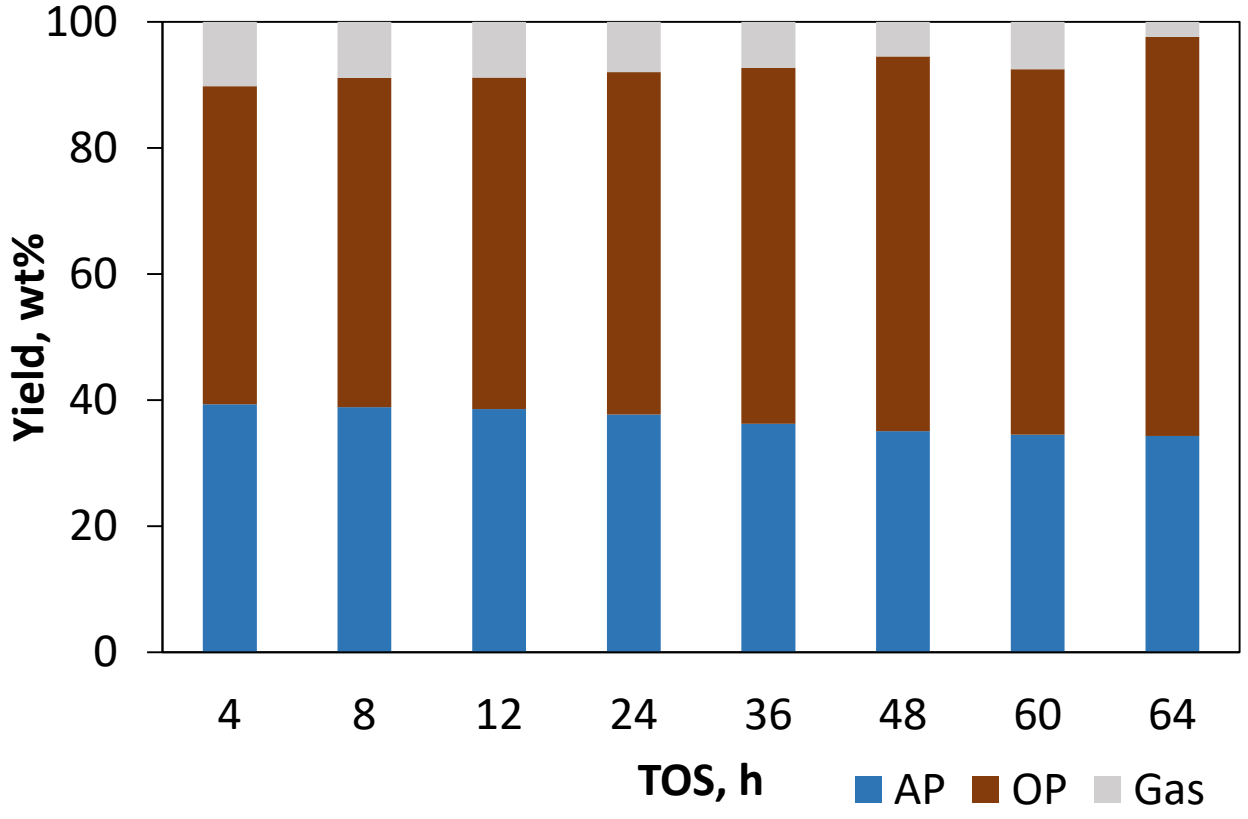


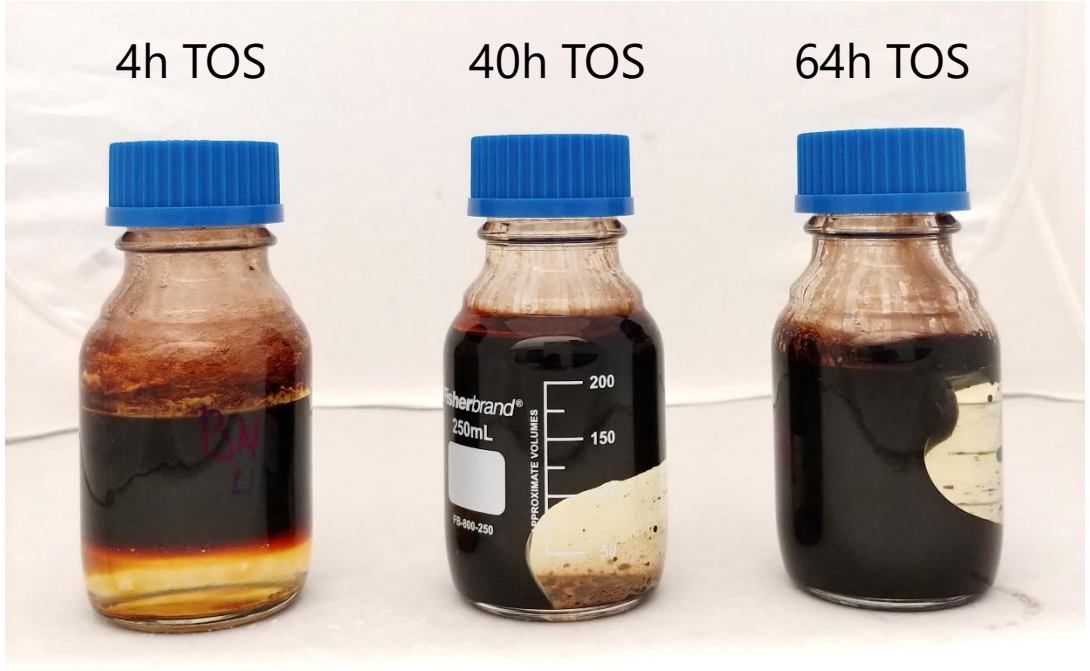
Hydrogenation of wheat/barley bio-oil 75 °C

Part 2: application of „smooth“ thermoprofile

HYDROGENATION OF STAGED CONDENSATED BIO-OIL

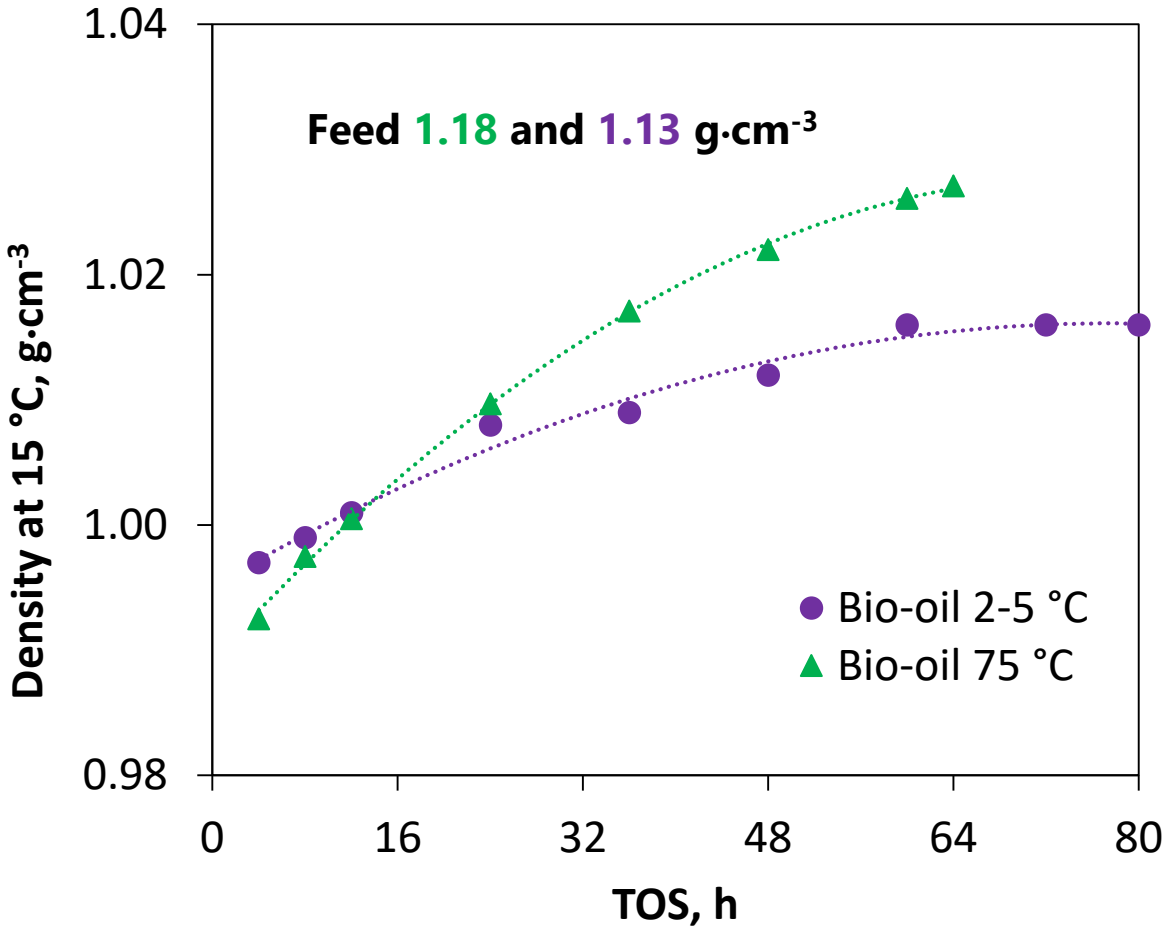
- „Smooth“ thermoprofile mode was applied for the hydrogenation of staged condensate bio-oil (75 °C) for 64 hours experiment
- After 40 h TOS organic phase density increased and all further products were not separated so well on two phases

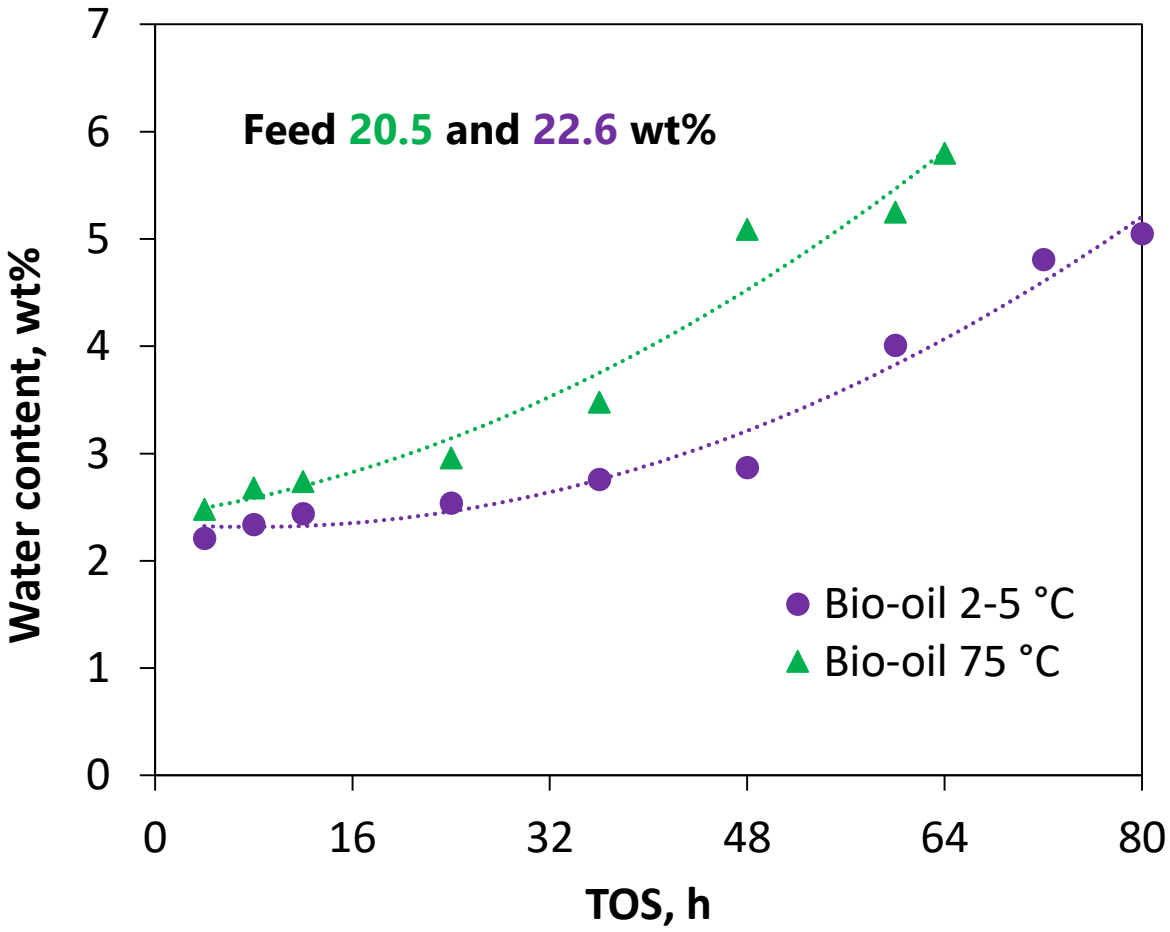




HYDROGENATION OF STAGED CONDENSED BIO-OIL

- Higher loss of the catalytic activity during hydrogenation of staged condensed bio-oil was dominantly caused by higher CAN of feed (80 mg KOH·g^{-1})





CONCLUSION

- Raw bio-oil is a complex mixture with unacceptable properties that should be upgraded to fulfil limits for transport fuels
- Hydrotreatment is a suitable technology for bio-oil upgrading in the fixed-bed reactor for producing low-cost petroleum-refinery-compatible feedstock
- Hydrotreatment thermoprofile play significant role in the upgrading process: „Smooth“ mode is preferred due to:
    - stable products properties
    - convenient unit operation
- Upgrading of bio-oil condensed at 2-5 °C gave more valuable products with similar properties at all TOS

Future plans: test two thermoprofiles for the hydrtotreatment of miscanthus bio-oil (2-5 and 75 °C) and beech-wood bio-oil

UNIVERSITY OF CHEMISTRY AND TECHNOLOGY PRAGUE

BioMates

Thank you for your attention!

The results were obtained in the BioMates project. This project has received funding from the European Union`s Horizon 2020 research and innovation program under grant agreement No 727463. The publication reflects only the authors' view; the Commission and its responsible executive agency INEA are not responsible for any use that may be made of the information it contains.