Co-refining of bio-based and fossil feedstock in a continuous slurry hydrocracking pilot plant

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Co-refining of bio-based and fossil feedstock
Slurry hydrocracking

- Important with efficient conversion processes of unconventional feedstocks when reserves are depleted.
- Higher environmental regulations lead to lower market demands on heavy petroleum products high in sulphur.
- Difficult feedstock – important to avoid coking, pressure drop, poisoning, hot spots etc. and ensure high conversion.
- Slurry hydrocracking has shown to be one process of high interest.
- Preem is performing a study for a large scale installation in Sweden. Approximate cost 15 000 MSEK.
How does it work?

- Slurry with dispersed homogenous catalyst
- 100 – 200 bar
- 400 – 500°C
- Catalytic hydrogenation and thermal cracking.
- 90 % conversion is state of the art.
- Often sulfided metal catalysts such as Co, Mo, W or Fe

Slurry Hydrocracking Pilot Plant (SHC)

- Flexible and available open research infrastructure
- Financed by the Swedish Energy Agency, Preem, RISE and the Kempe foundations
- Temperature up to 500 °C and pressure up to 180 bar (hydrogen)
- 2 dm³ reactor volume (CSTR), LHSV 0.5 – 2 h⁻¹
- Liquid feed rate about 1 dm³/h
- Batch or continuous trials with continuous hydrogen flow
- In operation since March 2017
Process flow scheme

- Slurry prep feed #1 (V-1200)
- Slurry prep feed #2 (V-1210)
- Vacuum residue tank (V-1220)
- Feed pump (P-1230)
- Slurry tank (V-1240)
- Feed pump (P-1250)
- Hydrogen compressor (C-1750)
- Reactor (R-1350)
- HP-HT Separator (S-1400)
- Heavy fraction interlock (XY 1400 & XY 1401)
- Condenser (C-1440)
- Vent pot (V-1810)
- Pressure decrease (PV 1410)
- LP-LT Separator (S-1420)
- Light fraction interlock (XY 1430 & XY 1431)
- Double valve interlock (XY 1420 & XY 1421)
- Water (V-1530)
- Double valve interlock (V-1510)
Production of pyrolysis oil for co-refining tests

- Fast pyrolysis pilot plant (POC)
- Cyclone reactor with heated walls (ablative)
- About 30 kg feedstock/h
- Oil collected in two fractions
- Commissioned 2011
- 7 scientific publications (peer-reviewed)
- Willow and pine/spruce
Co-refining of pyrolysis oil and fossil feedstock in the SHC pilot

- Pyrolysis oil produced in the POC pilot plant was used as feedstock together with a low value fossil oil.
- The pilot plant produced a heavy fraction, a light fraction and a water fraction as intended.
- Results evaluated by conventional research methods:
  - Mass balance
  - C, H, N, S, O balance
  - $^{14}$C analysis of feed and products
  - 2D GC-MS, Simulated distillation
Co-refining of pyrolysis oil and fossil feedstock in the SHC pilot

- Continuous operation during 10+ hours.
- 100 +/- 5% closure of mass balance
- Detailed results to be published
Conclusions

• Successful co-refining of bio-based pyrolysis oil with fossil feedstock in continuous mode

• We believe that this pilot can be used to validate previous data obtained in batch experiments.
Thank you!