REFOLUTION
Unlocking the potential of biofuels

Refinery integration, scale-up and certification for aviation and marine biofuels production

Scaling 200 L HPO for marine biofuels

The technological heart of REFOLUTION lies in the transformation of raw pyrolysis oils, substances known to be highly oxygenated and heterogeneous, into a stable, high-performance fuel called **Hydrotreated Pyrolysis Oil** (**HPO**). This conversion process, developed and led by BTG Biomass Technology Group, overcomes the limitations of traditional precious metal catalysts (such as Ru, Pd, and Pt), which tended to deteriorate rapidly. Instead, it introduces a sequential multi-phase approach that ensures product stability and protects the catalysts.

The first stage of this process its 'stabilization' to produce a Stabilized Pyrolysis Oil (SPO). This is critical because it selectively hydrogenates reactive aldehydes into stable alcohols, effectively reducing the oil's carbohydrate content and associated charring tendency. The stabilization allows water to be evaporated from the product, a feature not practically manageable for untreated pyrolysis oils due to a corresponding strong increase its viscosity.

200–250°C
Stabilization temperatures

200 bar
Stabilization pressures, using the proprietary nickel-based catalyst, **Picula**™

5–10 wt.%
Evaporation of water from the product up to 5-10% by weight

Having demonstrated the feasibility of large-scale stabilization with the production of 300L of SPO for Deliverable 3.3, the project transitioned to Deliverable 3.4, which marks the move toward a fully refined product. The current objective focuses on the production of 200 L of a Hydrotreated Pyrolysis Oil (HPO), an advanced hydrocarbon fuel obtained through further deep refining of the intermediate SPO. This transition is done by processing the SPO at conditions (catalysts, pressures, temperatures) similar to conventional refinery hydroprocessing, allowing higher hydrogen consumption to obtain specific fuel applications.

Source: Canva

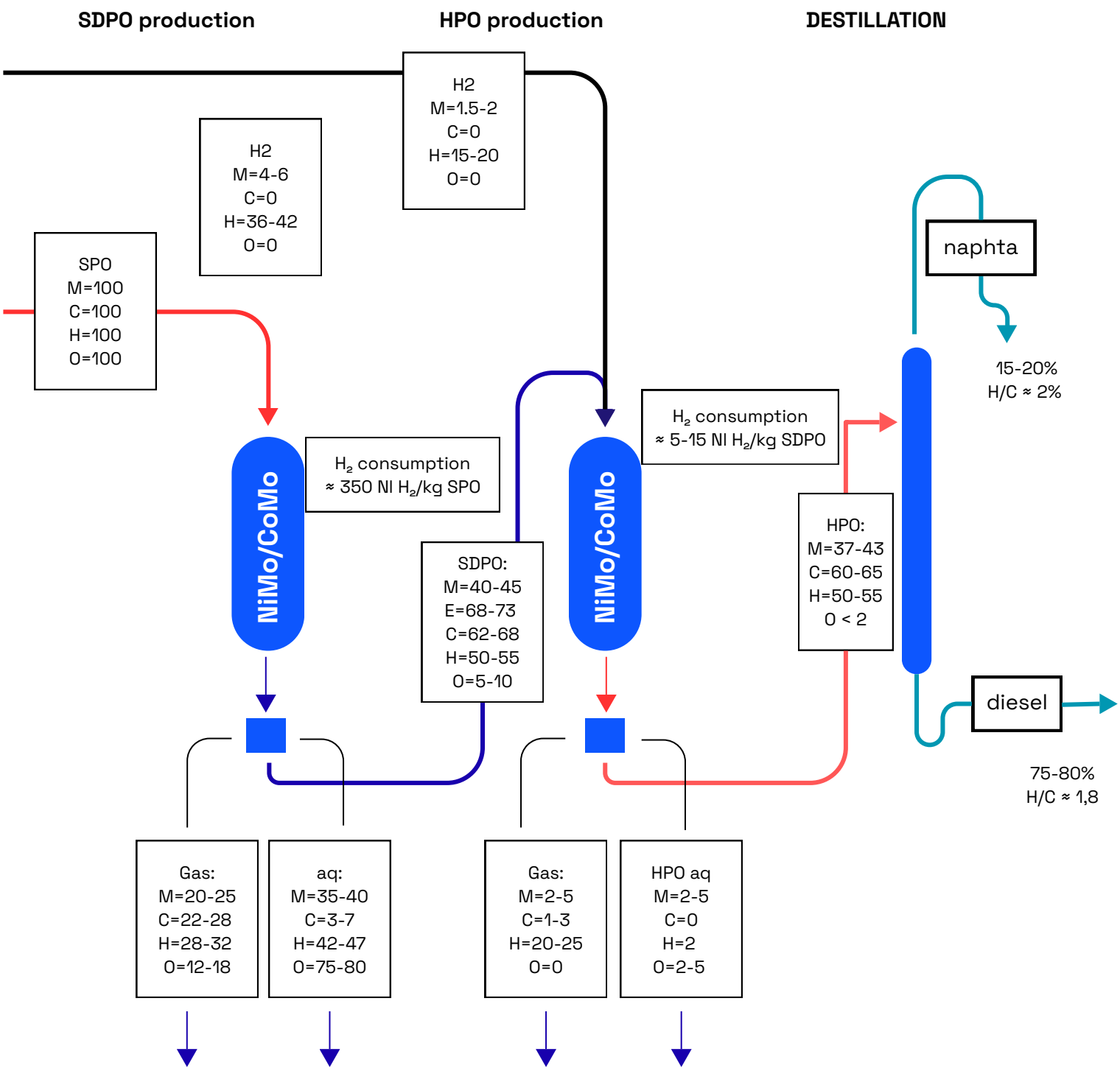

Figure 1. Ranges for the overall mass balances for the process of the conversion of SPO to HPO

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The production of HPO requires successive stages of increased severity:

- **SDPO Production:** SPO is treated with commercial NiMo or CoMo catalysts at higher temperatures (up to 370°C) to remove oxygen in the form of water and gas. During this stage, water separates spontaneously (residual water typically < 1 wt% in the organic phase)

- **Final Refining (HPO):** Through a further hydrodeoxygenation step, HPO is obtained—a hydrocarbon oil almost entirely free of oxygen (< 0.5 wt.%), with properties comparable to crude oil derivatives

Figure 2. Series of treated samples derived from pyrolysis oils

Quantitative results and certified quality

Deliverable D3.4 documents the production of a 200L batch of HPO (yielding approximately 150L of final product after distillation to meet flash point requirements). This biofuel exhibits exceptional characteristics that clearly distinguish it from the intermediate SPO:

- **Density**: Reduced to below 920 kg/m³, typically < 900 kg/m^3

- **Heating Value**: Increased to over 40 MJ/kg

- **Compliance**: The product fully satisfies ISO 8217 standards for marine fuels, demonstrating outstanding cold behaviour with a Pour Point as low as -36°C

Strategic use and conclusion

High Fidelity Testing: unlike SPO, which is primarily intended for refinery co-processing, the 200 L of HPO produced in this phase are allocated for direct testing at the University of Rostock (UROS). The fuel will be tested in a high-pressure marine injection chamber and a single-cylinder marine engine, both in its pure form and in methanol blends, to validate its performance under real operating conditions.

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This factsheet is based on D3.4 – Production of 200 L HPO of BTG.