


Co-processing of renewable feedstock

TOPSOE

# FAST-TRACK YOUR RENEWABLE JOURNEY WITH CO-PROCESSING



Take the first and simple step on your renewable fuels journey by co-processing renewable feedstock in your existing kerosene or diesel hydrotreater or in your hydrocracker

# FOSSIL REFINERY TODAY. RENEWABLE REFINERY TOMORROW.

Climate change is one of humanity's biggest challenges. We need to take urgent action to reduce the detrimental effects of how we produce and consume. This shift is already supported by regulations, mandates, and policies worldwide, demanding an increase in the production of renewable fuels, such as renewable diesel and sustainable aviation fuel (SAF).

Proven technologies to produce these renewable fuels at scale already exist. But for refineries, making the transition to a biorefinery requires significant financial investment and time.

Co-processing provides a simple alternative to these major revamps. It provides an accessible pathway for a conventional refinery to transition into a renewable refinery.

At Topsoe, we have been supporting our customers in their co-processing ambitions since our initial project with Preem in 2011. Since then, we have expanded our support to over 50 different projects.

## Co-processing and its pathways

In co-processing, even small amounts of fossil feedstock, e.g. crude oil, can be replaced with renewable feedstock (HEFA-based), e.g. vegetable oil, animal fat, used-cooking oil etc. These are processed together to produce renewable fuel.

At Topsoe, we offer three different co-processing solutions, helping you to introduce renewable feedstock into your existing kerosene hydrotreater, diesel hydrotreater, or in your hydrocracker.

Topsoe's extensive commercial experience and R&D developments within refinery technologies have made us pioneers in renewables hydroprocessing, ready to provide services, technologies, and catalysts that will help you overcome the difficulties often associated with renewable feedstock.



## QUESTION

What is the link between Charles Darwin and the transformation of a refinery to a biorefinery?



## ANSWER

We believe that the journey between a 100% fossil refinery to a 100% renewable refinery (biorefinery) is an evolution.

# YOUR BUSINESS' FAST-TRACK TO SUSTAINABLE AVIATION FUELS

By replacing the fossil feedstock in your existing kerosene hydrotreater with up to 5 vol% renewable feedstock, you can produce Sustainable Aviation Fuel (SAF) through the approved HEFA-pathway.

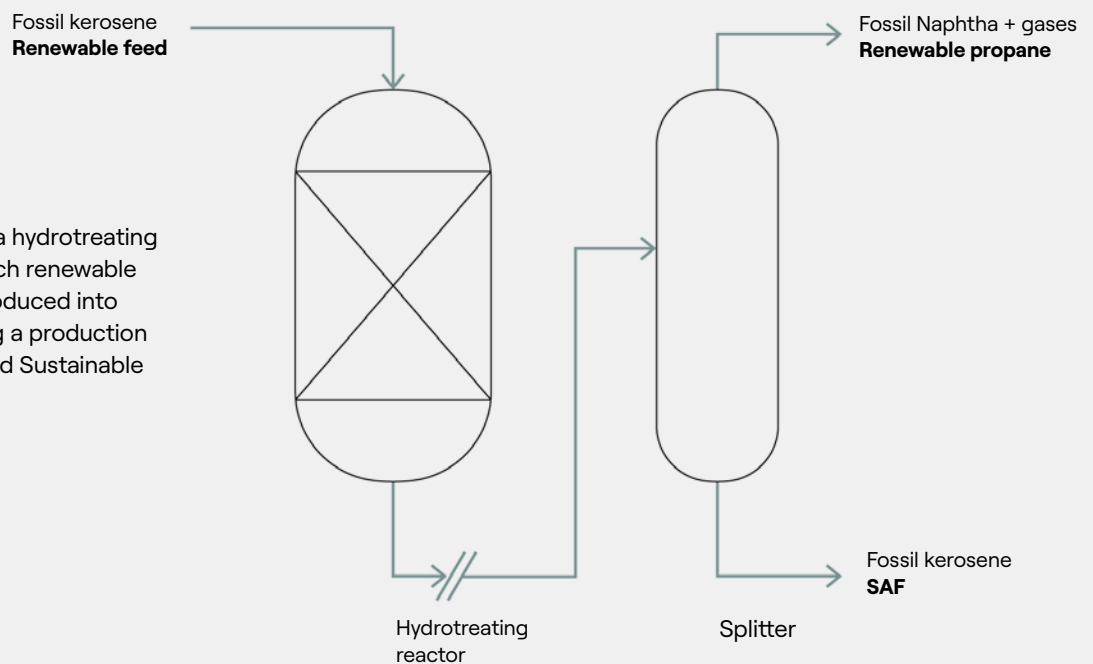
### Benefits of choosing renewable co-processing in your kerosene hydrotreater for SAF production

- It's the fastest and easiest way to start producing SAF as the implementation can be done without major modifications to your existing units
- It's a low OPEX and low CAPEX solution (with very low payback period)
- It's possible to choose your own co-processing starting point – the amount of renewable feed can be as high as 5 vol%.

### TK-930 D-wax™: Market-leading catalyst for co-processing

Choosing Topsoe's high-performance and high selectivity catalyst TK-930 D-wax™ for co-processing renewable feedstock in your existing kerosene hydrotreater will retain highest possible biogenic carbon in the jet fuel and ensure that it meets the demanding freeze point specifications. This is due to the unmatched isomerization selectivity of the catalyst. The renewable fraction in your product will comply with the most demanding fuel specifications on the market: Sustainable Aviation Fuel.

This illustration outlines a hydrotreating unit with a splitter in which renewable feedstock has been introduced into the existing unit enabling a production of a mix of fossil fuels and Sustainable Aviation Fuel.





As we write this, three co-processing pathways are approved to meet the criteria for the Standard Specification for SAF (ASTM D1655).



CO-PROCESSING IN DIESEL HYDROTREATER

## PAVE YOUR BUSINESS' PATH TO RENEWABLE DIESEL PRODUCTION

Renewable feedstock can be introduced directly into your existing diesel hydrotreater together with your fossil feed. The product will be a combination of renewable and fossil diesel.

### Benefits of choosing renewable co-processing in your diesel hydrotreater for production of renewable fuel

- Limited or no revamp of plant required
- Renewable grading and HDO catalyst can be included fast, e.g., by next turn-around or even sooner by skimming
- It's a low OPEX and low CAPEX solution (with low payback period)
- Easy implementation – no need to wait for 100 vol% renewable grassroots unit
- You can choose your own co-processing starting point.

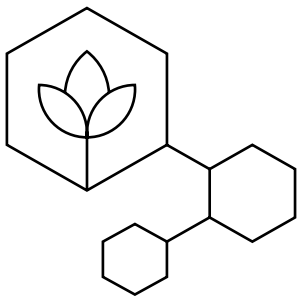
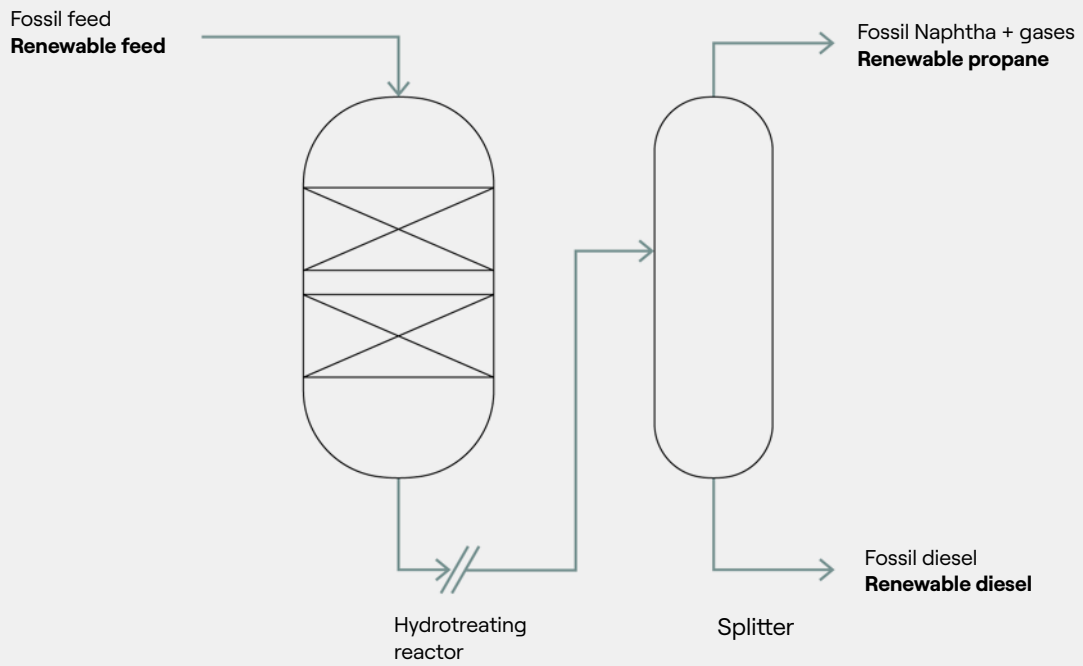
### Up to 10 vol% renewable feedstock

In most cases, up to 10 vol% renewable feedstock can be added with limited or no equipment modifications. We do, however, recommend installing a selective renewable grading and hydrodeoxygenation (HDO) catalyst for maximum yield and contaminant pick-up capacity.

For co-processing with more than 10 vol% renewable feedstock, a revamp may be required, but this solution is still faster and with lower CAPEX and OPEX than a grassroots unit.

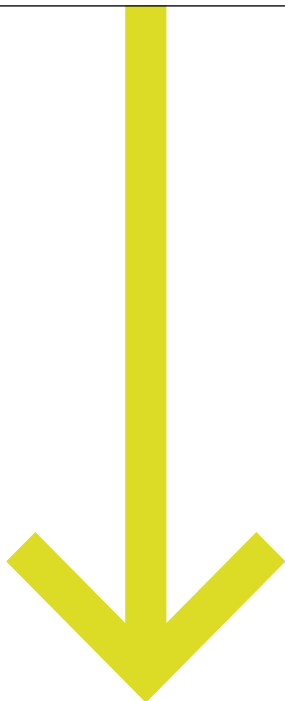
The illustration shows how introducing renewable feedstock into your unit enables your production of a mix of fossil diesel and renewable diesel.

# ILLUSTRATION OF HYDROTREATING UNIT WITH A SPLITTER



CO-PROCESSING IN HYDROCRACKING

## **FLEXIBLE CHOICE OF FEEDSTOCK AND END-PRODUCT**



As co-processing of renewable feedstock in hydrotreating units becomes more established, refineries are exploring additional ways to incorporate renewable feedstock into their existing units.

Given their versatility, hydrocracking units are particularly suited for co-processing renewables. We anticipate their usage will become indispensable in the future, particularly as the need to process more demanding second- and third-generation feedstocks increases.

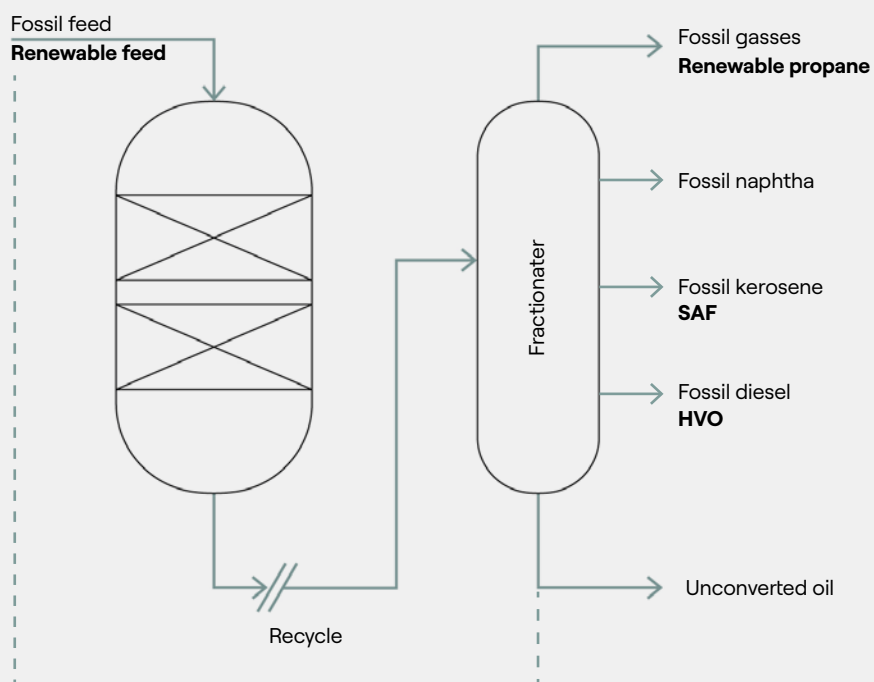
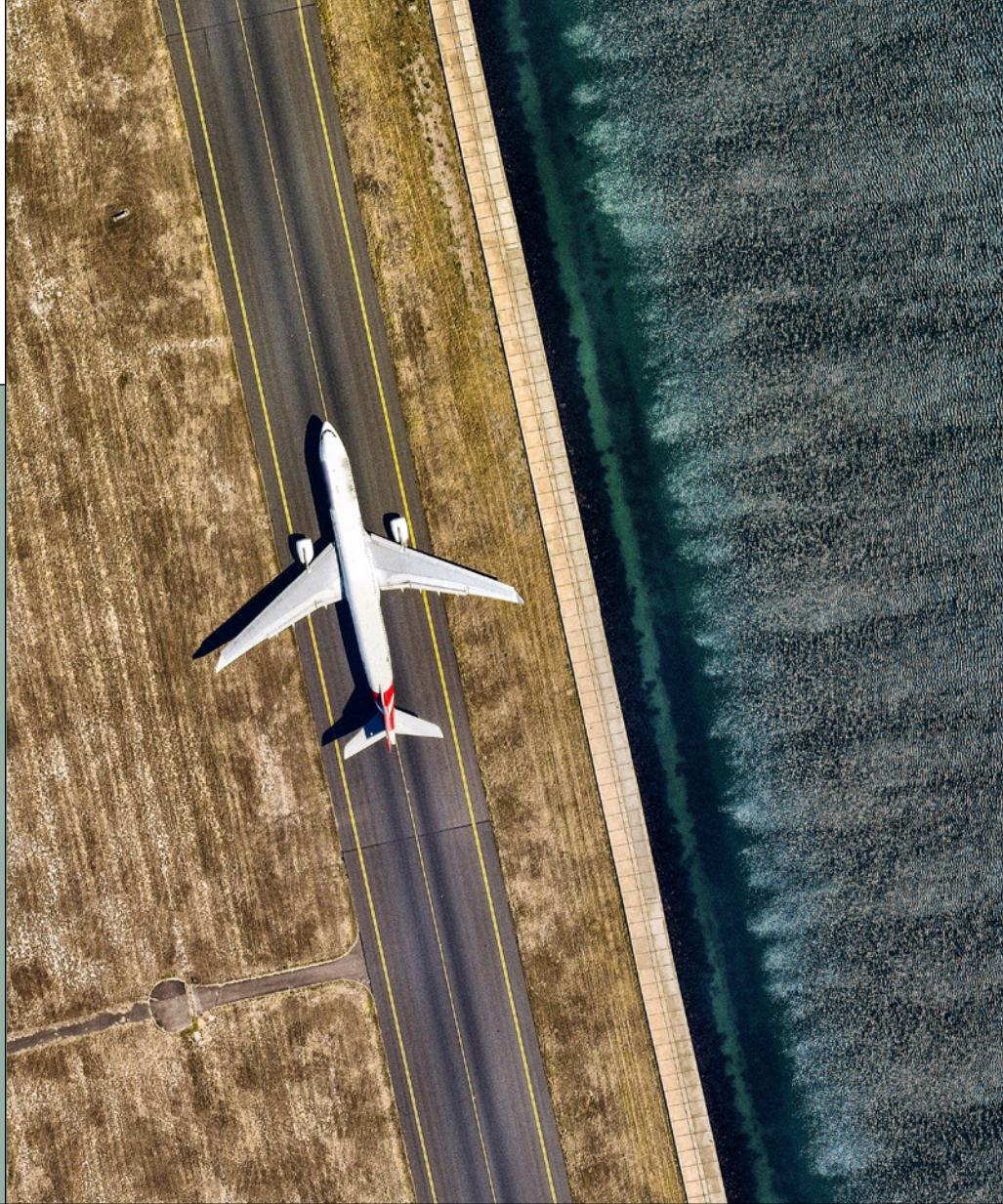
### **A gateway to diverse renewable end-products**

Unlike the hydrotreater, the hydrocracker offers significant process flexibility. It can be adjusted to accommodate your specific feedstock availability and to produce your desired end-product.

Co-processing second-generation renewable feedstock with Vacuum Gas Oil (VGO) enables the simultaneous production of a variety of renewable fuels, including Sustainable Aviation Fuel (SAF), diesel, and naphtha.

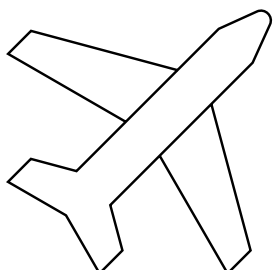


Hydrotreating units may have been the primary choice so far for co-processing of renewable feedstock, but hydrocracking units should not be overlooked.



HVO = Hydrotreated vegetable oil

# HYDROCRACKERS VS. HYDROTREATERS FOR CO-PROCESSING

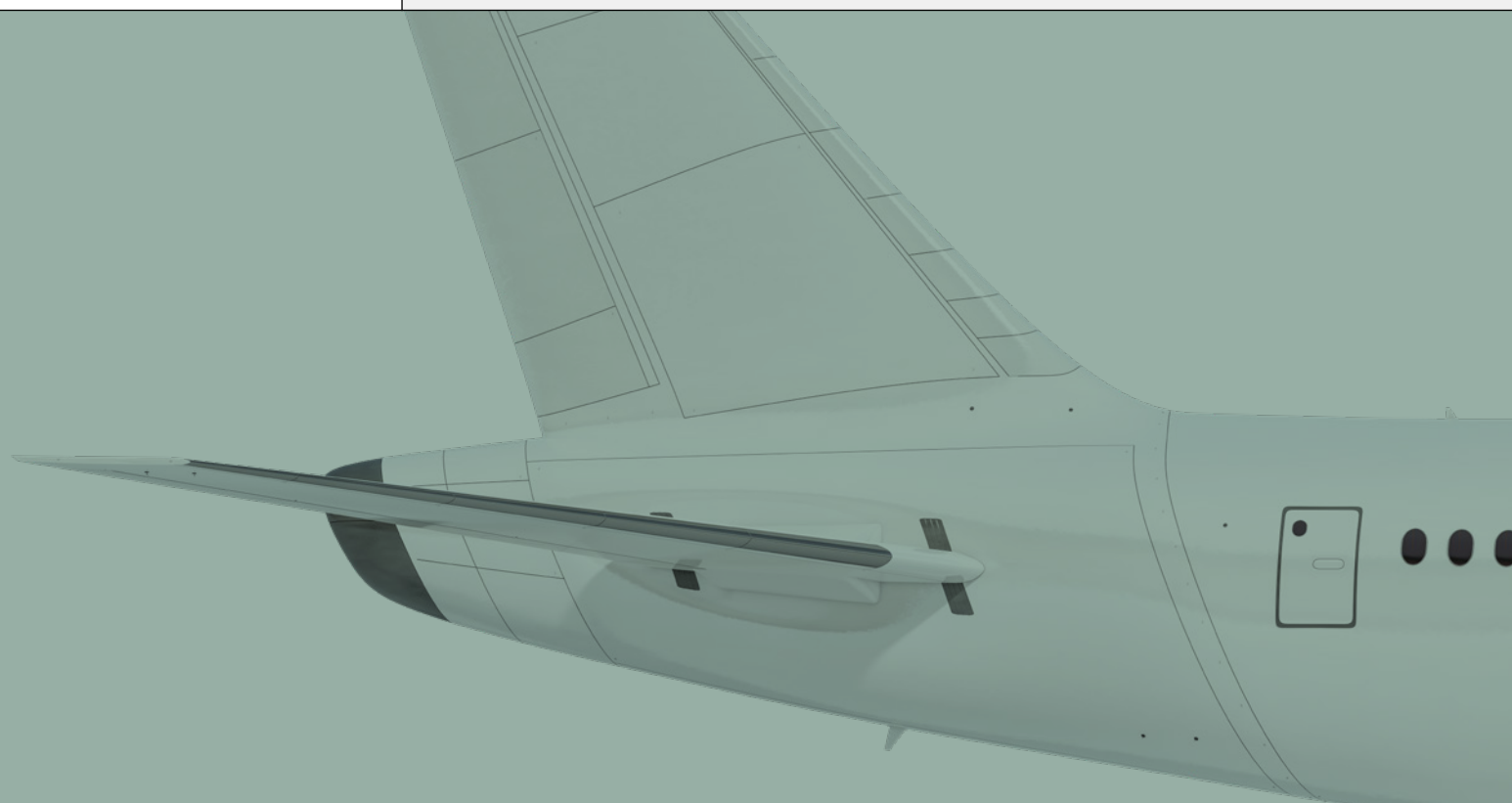


## The advantages of co-processing in your hydrocracker

**Greater quantities and significant flexibility in feedstock and end-product selection:** These benefits are enabled by the hydrocracker's larger size compared to the hydrotreater, as well as the increased availability of hydrogen.

**Operational challenges are better overcome:** Considering the high content of oxygen in renewable feeds, the H<sub>2</sub> consumption associated with these reactions is in the range of 300–500 Nm<sup>3</sup>/m<sup>3</sup>, which is orders of magnitude greater than what is normally seen in hydrotreaters. However, compared to hydrocrackers, the difference is less, and the impact from processing in a hydrocracker would therefore be less.

**Processing of greater quantities of renewables without compromising catalyst cycle length:** The contaminants present in the renewable feeds pose a challenge to the hydrotreaters, and significant amounts of bulk catalysts need to be replaced to manage the contaminants. In hydrocrackers, the feedstocks like VGOs and Heavy Coker Gas Oil (HCGOs) often processed also have considerable amounts of contaminants, and hydrocrackers are therefore normally already designed to include volume for grading catalysts.



# CATALYST SELECTION IS KEY

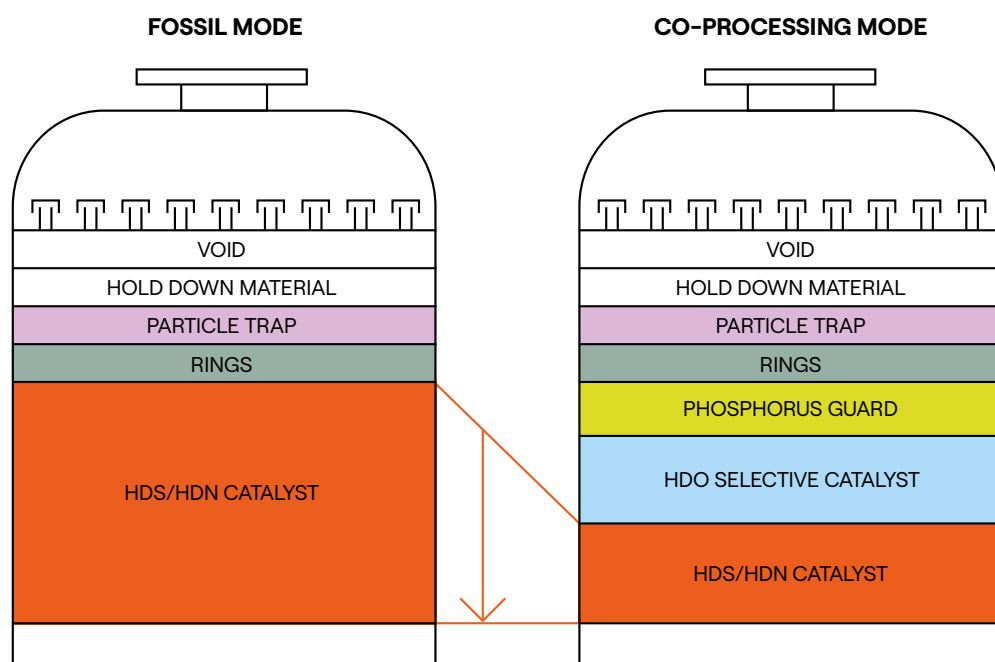
Renewable feedstock differ from conventional feedstock. But these differences can easily be handled by a renewable catalyst system. By using the right catalysts, you can minimize CO<sub>2</sub> formation while maximising cycle length, yields and co-processing rates.

By selecting Topsoe's high-performance and highly selective catalysts for co-processing renewable feedstock, you can maximize the retention of biogenic carbon in jet fuel while meeting stringent freeze point requirements. This is achieved through the catalyst's exceptional isomerization selectivity.

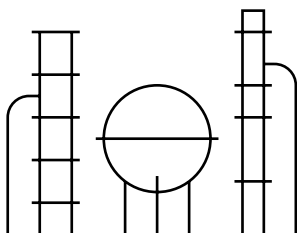
## Catalyst grading in co-processing mode

- **Phosphorus guard:** Phosphorus cause catalyst poisoning, and reactor pressure drop build-up. A phosphorus guard is loaded as a top layer
- **HDO Selective catalyst:** HDO selective catalyst can significantly reduce HDS/HDN inhibition. HDO selective catalyst increases liquid yields of fuels while minimizing the production of CO/CO<sub>2</sub> and methane.
- **HDS/HDN catalyst:** Reduction in HDS/HDN catalyst volume may be solved by installing higher activity bulk catalyst.

This illustration shows grading in co-processing of conventional and renewable feedstock.



# GENERAL CONSIDERATIONS FOR RENEWABLE FUELS PRODUCTION

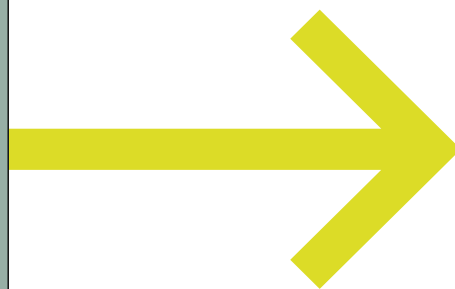


## Overcoming new types of contaminants

Compared to the processing of fossil fuels, the conversion of renewables to transport fuels introduces new types of contaminants, such as phosphorus, potassium, and sodium. Furthermore, renewable feedstock may lead to increased corrosion due to high TAN from oxygenated compounds. Topsoe has developed specialty guard materials and catalysts to handle these contaminants enabling profitable operation processing renewables.

## Dewaxing

Since the cold flow properties like cloud point and freeze point of renewable fuels are in general worse than what is normally achieved from processing of fossil fuels, dewaxing becomes especially important when producing diesel and SAF from renewable sources. Topsoe has developed state-of-the art dewaxing catalysts that improve the cold flow properties of renewable fuels by selective isomerization, with minimum yield loss to byproducts.





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**Name**

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TK-920 D-wax™

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TK-930 D-wax™

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**Catalyst properties**

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Fossil and renewable isomerization dewaxing catalyst with noble metals

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Fossil and renewable isomerization dewaxing catalyst with base metals



## WHY PARTNER WITH TOPSOE?

Topsoe is a leading global provider of technology and solutions for the energy transition. We combat climate change by helping our customers and partners achieve their decarbonization and emission reduction targets in a most optimal manner.

Based on decades of scientific research and innovation, we offer world leading solutions for transforming renewable resources into fuels and chemicals for a sustainable world, and for efficient and low-carbon fuel production and clean air.

We are founded in 1940 and headquartered in Denmark with over 2,800 employees serving customers all around the globe.

To learn more, visit  
**[topsoe.com](https://www.topsoe.com)**



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