

HydroFlex™ – bridging economy and environment

RESEARCH | TECHNOLOGY | CATALYSTS





A proven technology

At the Preem Refinery in Göteborg, Sweden, Topsøe's technology converts tall oil from the paper industry into ultra-low sulphur diesel. Tall oil is a non-edible bio feedstock, which means that Topsøe's renewable fuel production process – HydroFlex™ – does not add to the problems of global food shortage and rising food prices.

The photo shows the Preem Refinery, where Topsøe's technology is one of the processes in operation at the refinery.

Renewable feeds – meeting tomorrow's energy needs

Around the globe, the need for energy is rising. As the world's population grows, so does the demand for transportation fuels and power. At the same time, the world is facing significant environmental challenges. Topsøe's HydroFlex™ provides environmentally sustainable solutions, which meet concerns about greenhouse gas emissions and climate change.

Clean fuels based on renewable feeds are an important element in meeting the energy requirements of the future. With Topsøe's HydroFlex™ catalysts and technology, feedstocks derived from a wide range of biomass and waste materials can be processed into fuel.

The fuels meet all existing fuel specifications and are fully compatible with the current energy infrastructure, making it possible to add renewable fuels directly into the existing fuel systems without any adjustments.

Your feed – our expertise

Based on decades of experience as a provider of process solutions for refineries, we can supply you with high-performing solutions tailored to meet your exact needs. Production of gasoline, jet fuel and diesel from any feed is possible with Topsøe's HydroFlex™ technology and catalysts.

Topsøe has researched innovative solutions for producing renewable fuels since 2004, and plants using Topsøe HydroFlex™ solutions for renewable fuel production have been in operation for several years.





Full feedstock flexibility

As the world's resources are growing scarce, there is increasing focus on feed for renewable fuels which do not deplete global water and land resources.

Topsøe's HydroFlex™ solutions provide full feedstock flexibility, and it is possible to produce clean fuels from a wide range of feeds.

The following examples demonstrate the flexibility of our hydro-processing catalysts and technology for renewable feeds:

- using non-edible waste from paper industry, black liquor, Topsøe's HydroFlex™ catalysts and technology produce ultra-low sulphur diesel and ultra-low sulphur gasoline
- based on yellow grease and chicken tallow, Topsøe's catalysts and technology produce ultra-low sulphur diesel
- pyrolysis oils and extracts derived from wood chips, plastics and coal are used for the production of high quality diesel and jet fuel

Flexible plant size

The plant size is adapted to the client's needs. Current projects range from a production capacity of 350 barrels per day to 50,000 barrels per day, and Topsøe designs plants based on renewable feeds for all capacity ranges. Renewable fuel plants are typically at the lower end of the range due to availability of the feedstock.



Topsøe's production process

Renewable feeds are converted into hydrocarbons identical to those found in diesel or gasoline in a hydrotreating process.

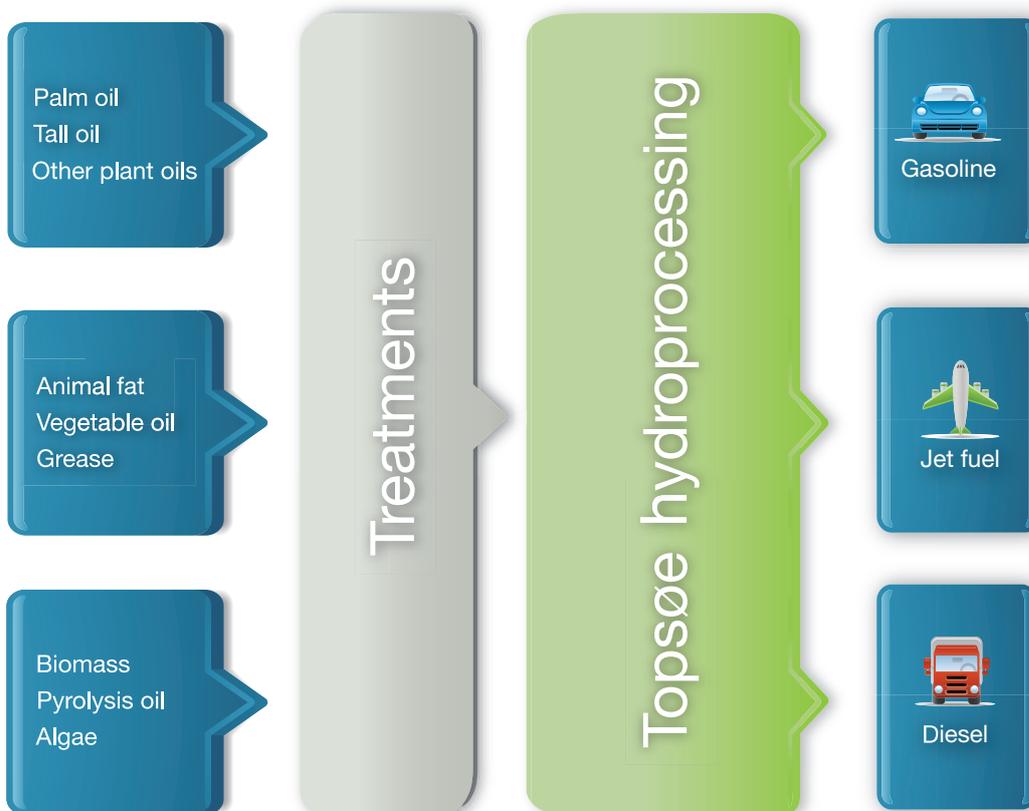
In the process, the renewable organic material is reacted with hydrogen at high temperature and high pressure in a catalytic reactor. The high oxygen content in renewable feeds presents a number of challenges including control of the high heat release, fouling due to gum formation and CO and CO₂ in the product gas stream. High acidity of the feeds can also lead to excessive corrosion.

Processes

Topsøe's extensive hydroprocessing expertise has enabled us to overcome these challenges through:

- an innovative feed mixing system preventing corrosion problems
- clever reactor design that controls heat release
- tailored catalyst system to avoid hot-spots and pressure drop build-up
- down-stream technology solutions handling CO, CO₂ and other gases

Routes to produce biofuels



Feed sources for renewable fuels typically originate from many sources ranging from forestry waste, garbage and vegetable/animal oil. After different treatments followed by Topsøe's hydrotreating process, these materials are converted into high quality gasoline, jet and diesel fuels.

Catalysts

With Topsøe's catalysts it is possible to process a wide range of renewable feedstocks. Topsøe's catalyst portfolio includes a range of speciality catalysts for biofuels hydroconversion which make it possible to control the heat release and potential associated pressure drop build-up. The catalyst portfolio also includes isomerisation catalysts for the improvement of the cold flow properties and pour point where needed.

Topsøe's specialised catalysts for renewable fuel production are in commercial operation in many units in Western Europe and North America.

Stand-alone and co-processing

Any renewable oil can be hydrotreated in a stand-alone unit or co-processed with diesel in a refinery. The optimal solution depends on several parameters:

- product requirements e.g. cold flow properties
- product off take
- existing refinery capacity
- location of unit

Topsøe has experience designing stand-alone units as well as co-processing units. Topsøe provides sound advice based on industrial experience and proven technology.



The colour of biofuels differs depending on source and blend ratio. After going through Topsøe's hydrotreating process, biofuel becomes waterwhite. The photo shows three biofuel samples containing 10%, 20% and 30% raw tall oil in conventional diesel. After hydrotreating, the samples have become clear.

Meeting standards

Topsøe's technology for hydrotreating of renewable fuels and catalytic expertise ensure high quality products which meet all legislative requirements for gasoline, jet fuel and diesel.

Fuels produced from renewable feeds are fully compatible with the requirements of the automotive industry, meaning that no modifications of the vehicle engines are needed

Single point of responsibility

Topsøe provides clients with a single point of responsibility. We assist our clients through the entire process, starting with the initial feasibility study which serves as basis for the crucial decisions on feeds, fuels and capacities of the future plant.

During the design phase we take into account which design provides the highest level of flexibility while still focusing on the economics of the project.

During construction of the plant, Topsøe will be present to ensure plant quality and project progress, and Topsøe is on site during start-up of operations.

The advantages of renewables

The high quality of renewable diesel produced with Topsøe technology allows refiners to blend green diesel with conventional diesel. Due to the very low sulphur content of renewable diesel, it may be blended with low quality fossil diesel and still meet product requirements.



Renewable fuels have several advantages over first generation fuels such as FAME (fatty acid methyl esters) and conventional fuels. The table below shows the most common product qualities for conventional diesel compared with a FAME product and with Topsøe renewable diesel products.

	Conventional diesel	1 st generation diesel FAME	Renewable diesel
Cetane	40-55	50-60	70-80
Cold flow properties	++	+	+++
Blend in	-	max. 7%	0-100%
Market value	++	+	++++

Figures are based on diesel after dewaxing

A commitment to renewables

Haldor Topsøe is market leading in the field of heterogeneous catalysis. Based on 70 years of catalytic experience, Topsøe has a long term commitment to the market, providing customers with excellent service.

The Topsøe business model is unique, integrating all aspects from fundamental knowledge to practical implementation to achieve optimum industrial efficiency. The synergy between research and development, process design, engineering, catalyst production and sales forms the basis of the continuous optimisation of our catalysts and technologies.

With Topsøe you will have a competent and reliable partner for today and for the future. Our commitment to catalysis is a commitment we share with our clients.

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The information and recommendations have been prepared by Topsøe specialists having a thorough knowledge of the catalysts. However, any operation instructions should be considered to be of a general nature and we cannot assume any liability for upsets or damage of the customer's plants or personnel. Nothing herein is to be construed as recommending any practice or any product in violation of any patent, law or regulation.