RENEWABLE FUELS

UOP Ecofining™ Process

UOP's solution for renewable feedstock processing

Introduction

UOP is dedicated to meeting the increased need for sustainable, high-quality renewable diesel and aviation fuel by offering process technology to refiners worldwide. The Ecofining process , which converts a range of sustainable feedstocks to Honeywell Green Diesel™ and/or Honeywell Green Jet Fuel™, leverages more than 100 years of refining technology and catalyst innovation by UOP. Developed by UOP LLC and Eni SpA of Italy, the Ecofining process is a solution for refiners looking to produce renewable fuels for added profit and to meet renewable fuel obligations.

Feedstocks

The Ecofining process can convert a range of renewable feedstocks derived from oil seed crops (vegetable oils) or waste animal fats and greases, as well as second-generation feedstocks such as algal oils.

These oils and animal fats contain triglycerides and free fatty acids that are converted to hydrocarbons using the Ecofining process.

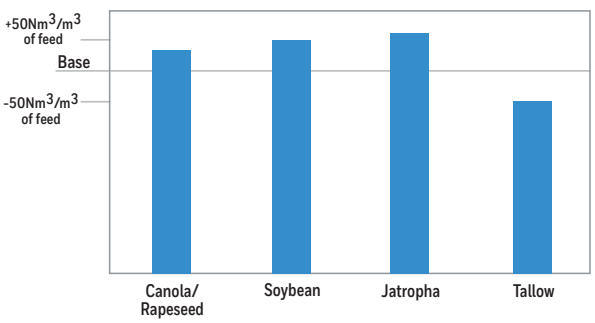
Yields

Typical yields from the Ecofining process:

	Unit Yields
Feeds	
Vegetable oils or animal fats, %	100
Hydrogen, Wt%	2.5 - 3.8
Green Products	
Diesel, vol%	85 - 95
Naphtha vol%	4 - 10
Propane vol%	2 - 4

The diesel yield and hydrogen consumption vary slightly according to the required product cloud point. The hydrogen consumption will also vary between different feedstock types, as is shown in the Hydrogen Consumption Variation chart. The Ecofining process can be designed with the option to produce 10% to 15% green jet fuel ("HEFA-SPK"), which subtracts from the diesel yield. For higher yields of green jet fuel, UOP offers the UOP Renewable Jet Fuel™ Process,, developed under a U.S. government funded

Hydrogen Consumption Variation





The Ecofining process is a versatile solution for producing renewable diesel and renewable jet fuel from a range of bio-derived feedstocks, allowing customers to both meet regulatory compliance obligations for renewable energy content in the transportation fuels sector, and to produce high-quality fuel that can enhance petroleum-based fuel.

FEATURES & BENEFITS

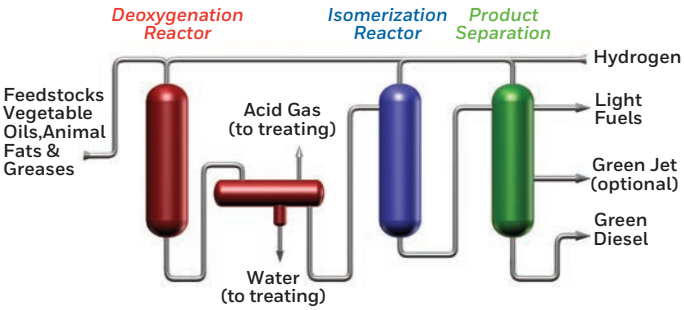
The Ecofining process produces high-quality renewable transportation fuels that meet or exceed the highest fuel quality standards, and can utilize existing infrastructure for fuel delivery and use. The Ecofining process can be implemented as a standalone plant or integrated with a petroleum refinery. In an integrated approach, for customers who want to incorporate renewable fuel production into a petroleum fuel facility, the Ecofining process can leverage existing infrastructure, allowing licensees to drive down capital and operating costs, while meeting renewable fuel targets. The advantages can be even more significant for refiners who want to convert idled assets in a retrofit design to produce renewable diesel and jet fuel at a fraction of the cost of a new installation.

When blended into an existing petroleum diesel pool, the high cetane and low density of green diesel can enhance the pool's performance characteristics. This brings synergistic blending benefits beyond simply meeting bio-component target or mandate levels. Life Cycle Analysis (LCA) of Honeywell Green Diesel shows greenhouse gas (GHG) reductions up to 85% compared with diesel from petroleum.

Process Overview

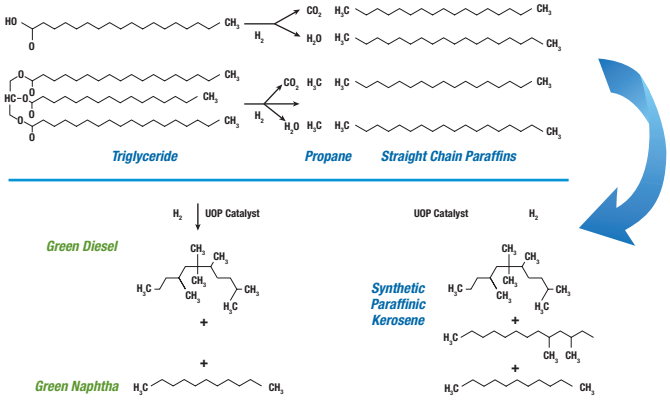
The Ecofining Process is a two-stage hydroprocessing technology. In the first stage, feedstocks such as vegetable oils and animal fats are hydrogenated to remove the oxygen contained in the triglyceride and/or free fatty acid molecules to produce paraffinic hydrocarbons. In the second stage, the paraffins are isomerized and/or selectively hydrocracked to produce Honeywell Green Diesel and/or Honeywell Green Jet Fuel.

Ecofining Process



Process Chemistry

In the triglyceride molecule, the carbon chain lengths and number of double bonds in the "fatty acid" portions of the molecules can vary, but they are consistent on average within a specific feed type (e.g. all palm oil has similar distribution). The carbon chain length of these natural oils fits directly into the diesel boiling range. Key chemistry for the conversion of natural oils and fats to fuels is summarized in the figure below.



The final diesel and jet fuel products contain the same molecules as their petroleum-derived counterparts, and the final product is independent of the starting feedstock.

The Ecofining process utilizes UOP's proprietary catalysts, which are specially developed for high conversion and maximum yields of highquality renewable diesel and jet fuel products.

Product Properties

Honeywell Green Diesel meets or exceeds the most rigorous diesel standards for performance, and is suitable as a blending component for EN590 or ASTM D975 diesel.

Product Properties vs Fossil Diesel

	Fossil Diesel	Green Diesel
Oxygen content, %	0	0
Specific gravity	0.84	0.78
Cloud point, °C	-5	-20 to +10
Cetane	40-52	70-90
Sulphur, ppm	<10	<2
Energy density, MJ/kg	43	44
Polyaromatics, vol%	8-12	0
Oxidative stability	Good	Good

The Ecofining process operates flexibly to make diesel product cloud points from +10°C to -20°C (+50 to -4°F), with yields increasing at higher cloud points.

Technology Delivery

UOP offers licenses and basic engineering design packages for the Ecofining process. UOP can also provide complete project implementation services via our alliances with leading contractors worldwide.

Economics/Investment

Typical ISBL (Inside Battery Limits) erected capital cost estimates are between $80-100 million USD for an Ecofining process unit with a capacity of 90 million gallons per year (~312,000 tonnes/year) of feedstock. Variable production costs per gallon of Honeywell Green Diesel are significantly lower than alternatives such as biodiesel (Fatty Acid Methyl Ester, or FAME, technology) due to the highly selective catalysts employed, and the low density of the fuel. Ecofining technology is also an ideal candidate for the revamp of a distillate hydrotreating unit, which reduces capital investment significantly.

Commercial Experience

Diamond Green Diesel LLC (a JV between Valero Energy Corp. and Darling International Inc.) began operating a UOP Ecofining unit in 2013. Eni SpA revamped a unit in their Venice, Italy, refinery to an Ecofining unit, and began production in early 2014.

For more information

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