



Sustainable fuels for clean skies
**UOP Ecofining™ Process for
Sustainable Aviation Fuel**

Honeywell UOP, a leader in refining technologies for more than a century, is leading the path to new sources of energy and clean skies.

Aviation fuel is the fastest growing fuel segment with global demand expected to increase from 106 billion gallons in 2019 to 230 billion gallons in 2050 (U.S. EIA 2020). There are many methods in practice available to reduce GHGs in aviation such as changes in equipment, but the use of sustainable aviation fuel (SAF) provides a simple solution today. Honeywell UOP was the first licensor to commercialize the production of SAF with the start-up of the Alt-Air (now World Energy) facility in Los Angeles, California in 2016. This project was a complete refinery revamp to the processing of 100% biofeed into renewable jet fuel. Today, it remains the only commercial 100% SAF production facility delivered by a technology licensor.

SAF PRODUCTION

The UOP Ecofining Process™ produces high-quality, renewable jet fuel that performs similar to petroleum fuels. Made from vegetable oils, animal fats and non-food-based, second-generation feedstocks such as camelina, jatropha and algae, SAF made by the Ecofining Process meets or exceeds critical specifications for flight. When used up to a 50 percent blend, it can be a drop-in replacement, requiring no changes to fleet technology or the fuel storage and delivery infrastructure.

SAF MANDATES AND INCENTIVES

SAF mandates exist today in Norway, Sweden and France with others in Europe expected to follow by 2025. In North America, incentives exist today under the California LCFS program and Federal \$1/gal Blender's Tax Credit. Potential US legislation is pending to increase the Blender's Tax Credit for SAF to \$1.25-\$1.75/gal, depending on feedstock and fuel carbon intensity. Together, these incentives support the production of SAF near to renewable diesel, and airlines are increasing commitments for SAF use.



SAF PRODUCT QUALITY

Honeywell SAF meets the ASTM D7566 specification for Aviation Fuel under Annex A2 for HEFA-SPK. The product qualities all meet or exceed the qualities of petroleum aviation fuel and deliver overall clean, high performance.

The UOP Ecofining process successfully converts many inedible feedstocks and many others to produce on-spec, renewable jet fuel. This flexibility gives fuel producers the option to choose the biofeedstock that best suits their location and operating goals.

SAF PROPERTIES

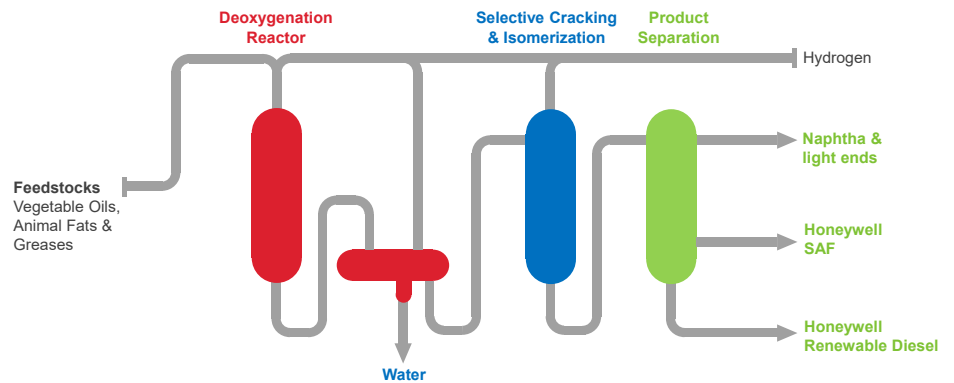
Properties	Jet A-1 specification	Honeywell SAF Bio-synthetic paraffinic kerosene (bio-SPK) made from camelina	50/50 Blend of camelina bio-SPK & Jet A-1
Flash point, °C	Min 38	45	46
Freeze point, °C	Max -47	-57	-57
Net heat of combustion, MJ/kg	Min 42.8	43.9	43.6
Thermal stability (JFTOT)			
• Filter pressure differential, mm Hg	Max 25	0.0	0.0
• Tube deposit rating (visual)	Max 3	1	1
Aromatics, % volume	Max 22	<0.3	8.5
Sulfur, % mass	Max 0.3	<0.001	0.05

UOP ECOFINING TECHNOLOGY FOR SAF

The Ecofining process for renewable jet fuel, commercially proven by UOP, is based on traditional refining hydroprocessing technology. It works by adding hydrogen to remove the oxygen from the feedstock and then further refining this product to meet the required specifications. The process produces a bio-synthetic paraffinic kerosene (bio-SPK) or Renewable Diesel that is then blended with standard jet fuel for use in flight. The resulting fuel meets all of the jet fuel specifications set by qualifying agencies.

SAF COMMERCIAL PRODUCTION TODAY

UOP is one of the leaders of the commercialization of renewable jet fuel production. Since 2016, World Energy in California has been using UOP Ecofining technology to deliver SAF to Los Angeles airport and customers worldwide. The plant has been so successful that they are now expanding the facility using the UOP Ecofining process.



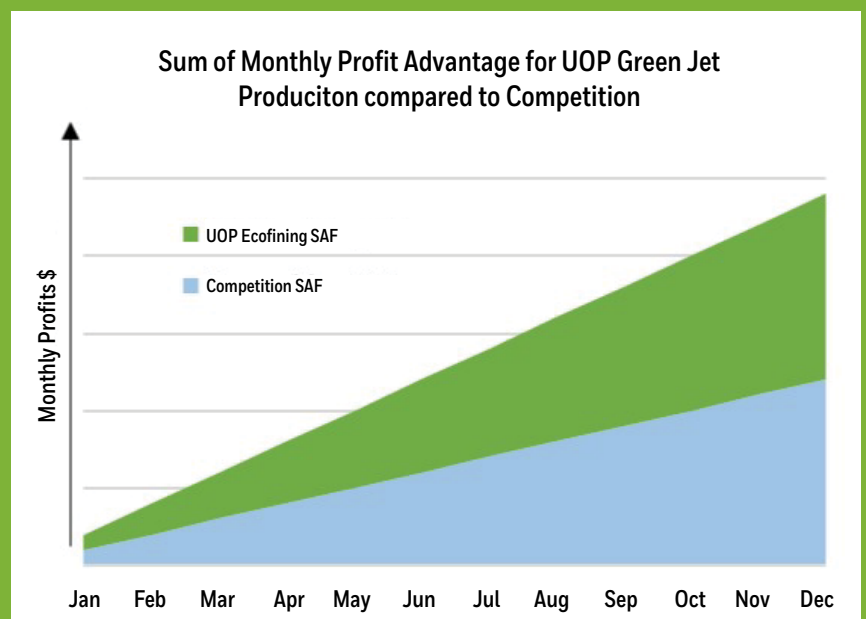
World Energy site in California producing SAF since 2016 with UOP Ecofining technology

UOP RENEWABLE JET FUEL YIELD ADVANTAGE

UOP Ecofining delivers high renewable jet fuel yield and value to our customers. And as the only proven commercial SAF technology licensor, UOP yields have been demonstrated at scale.

Using proprietary catalyst and proven process design, UOP customers can produce high quantities of SAF and capture significant profits. With incentives available today in the US, even an additional 1wt% distillate yield provides a substantial benefit. For example, at a 10,000 BPD feed rate, a 1wt% yield advantage is worth approximately \$500,000 in profits per month or \$6 million per year. This additional profit goes directly to the bottom line.

With UOP's experience on many types of sustainable feedstocks, we can guarantee catalyst cycle lengths based on actual operating data. The value of avoiding a 5-day shutdown for catalyst reload is worth approximately \$8 million revenue for a 10,000 BPD unit.

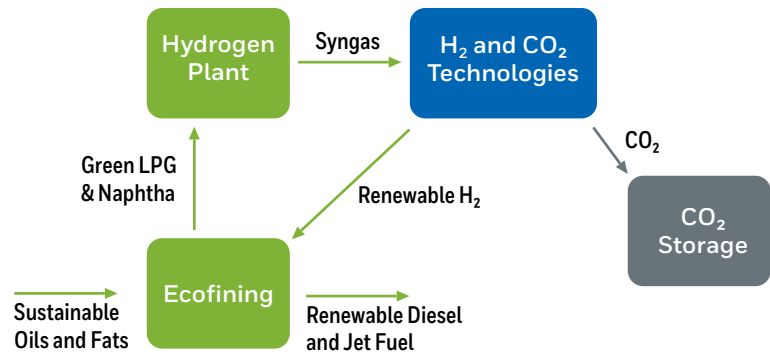


RENEWABLE HYDROGEN SUPPLY

For sustainable aviation fuels, all opportunities to reduce fuel carbon intensity should be captured. UOP can make available integrated hydrogen production using the secondary products from the Ecofining process. By using the LPG and naphtha by-products for the generation of renewable hydrogen, a significant reduction between 4–8 gCO₂/MJ in fuel carbon intensity compared to fossil fuel hydrogen production can be achieved.

For further carbon reductions, UOP offers carbon capture and storage (CCS) solutions from our Honeywell H₂ Solutions portfolio. Multiple UOP technologies exist to capture the CO₂ from the hydrogen production or other refinery operations to potentially produce carbon-neutral fuel.

UOP can offer all of these technologies as a comprehensive solution.



Comprehensive hydrogen solution to produce low-carbon fuels.



EXPERIENCE YOU TRUST

UOP is a recognized leader in process technology for the refining and petrochemicals industries. UOP has developed technology to support every major change in the refining industry since 1914.

In renewable fuels, UOP technology is used in the most operating facilities producing renewable diesel and jet fuel from 100% bio-feedstock. UOP led the ASTM certification process for renewable jet fuel back in 2011 and has produced more than 1 million gallons of Honeywell SAF to support military and commercial application testing. UOP can bring this experience in SAF for alternatives to traditional petroleum refining technology to help address the world's energy challenges.

SUCCESSFUL TRACK RECORD

2009 - 2011: Honeywell UOP led committee for approval of HEFA SPK as aviation turbine fuel under ASTM D7566 Annex 2.

2012 - 2015: AltAir Fuels installed first commercial renewable jet fuel (HEFA SPK) production unit using UOP technology with offtake by United Airlines.

2016: present: United Airlines became first commercial airline in US to use renewable jet fuel on regular scheduled flights from LAX.

2019: Gulfstream Corporate Aircraft Fly More Than 1M Nautical Miles On SAF produced by UOP Renewable Jet Fuel Process at World Energy (AltAir).

2021: First commercial passenger flight on 100% SAF with United Airlines using fuel produced at World Energy (AltAir) using UOP Renewable Jet Fuel Process.

For more information

For more information, please contact your UOP representative or visit us online at www.uop.com

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