Sustainable Aviation Fuel

The aviation industry is determined to develop sustainable solutions to produce cost-competitive, high-yield jet fuel with minimal environmental impact. Countries throughout North America, Europe, and Asia Pacific are currently at different stages in developing guidelines that will mandate the use of sustainable aviation fuel.

Today, the global aviation industry produces about 2% of all human-induced CO2 emissions. Transitioning to sustainable aviation fuel could help reduce aviation emissions by as much as 20% by 2030—and make it possible for the aviation industry to achieve net-zero emissions from petroleum fuels by 2050. Two of the most significant challenges for achieving this are 1) creating an adequate supply of sustainable aviation fuel, and 2) ensuring sustainable aviation fuel is cost-competitive with traditional petroleum-based jet fuel.

Challenge

The first SAF (sustainable aviation fuel) test flight on a commercial aircraft took place in 2008. Since then, over 400,000 commercial flights have used SAF at various blended proportions.

The aviation industry has strict standards for the approval of jet fuels. To become approved for use, SAF must meet certain ASTM specifications. At the time of this writing, there are nine approved pathways for producing SAF, with more in the process of balloting:

1. Fischer Tropsch (FT), [D7566 Annex 1]
2. Hydroprocessed Esters and Fatty Acids (HEFA), [D7566 Annex 2]
3. Synthesized Iso-Paraffins (SIP) from fermented sugars, [D7566 Annex 3]
4. Fischer Tropsch with aromatics, [D7566 Annex 4]
5. Alcohol to Jet from Ethanol or Isobutanol, (AtJ), [D7566 Annex 5]
6. Catalytic Hydrothermolysis (CHJ), [D7566 Annex 6]
7. Hydroprocessed Hydrocarbons, Esters, and Fatty Acids (HC-HEFA) from algae, [D7566 Annex 7]
8. Co-Processing with FT hydrocarbons, [D1655 Annex 1.2.2.1]
9. Co-Processing with triglycerides, [D1655 Annex 1.2.2.2]

Once proof of compliance has been completed, most SAF can be blended with traditional jet fuel to up to a 50% blend, and all quality tests are completed just as they would be with traditional jet fuel. The blend is then re-certified as Jet A or Jet A-1. At that point, it can be handled in the same way as a traditional jet fuel, making SAF easy to use within the existing fueling infrastructure.

PAC Ensures Proof of Compliance for Aviation Fuels

PAC offers an extensive product portfolio with industry-proven and ASTM-compliant solutions for aviation fuels, including elemental analysis, physical properties, fuel composition, and gas chromatography. With a long history of solutions for aviation, PAC meets stringent test requirements for both conventional jet fuels, as well as sustainable aviation fuels with extended requirements.

Parameter	Conventional Jet Fuel D1655, table 1 Def Stan 91-091	SAF & SAF Blend (D7566) Co-Processing (D1655, Table A1.1)	PAC Solution
Thermal Oxidative Stability	JFTOT @ 260 °C	Neat SAF - JFTOT @325 °C; Co-Processed HEFA - JFTOT @ 280 °C	D3241 / IP 323: JFTOT IV OptiReader
Freezing Point	≤-40°C (Jet A)	≤-40 °C for Annex 1-7, except Annex 3 ≤ -60°C *D5972 is the referee method for co-processed aviation fuel	D5972 / IP 435: JFA 70Xi Freezing Point & Viscosity @ -20°C & -40°C D7153 / IP 529: OptiFZP
Viscosity	Only @ -20°C	@-40 °C for D7566 Annex 2,3,5,6,7; @-40°C for co-processed FT, HEFA	D7945: JFA 70Xi Freezing Point & Viscosity @ -20°C & -40°C
Aromatics	≤ 26.5%	Typical ≥ 8.4%; ≤ 26.5%; ≤ 21.2% for Annex A4,6	D6379 / IP 436: MDA/Custom GC
Sulfur	≤ 0.3% by mass	≤ 15 ppm (Annex 1-7, except Annex 3 ≤ 2 ppm)	D5453: ElemeNtS
FAME	Not mandatory	Mandatory per batch of Annex 2, 6, & 7	IP 599: FAME in Avtur Analyzer
Hydrocarbon Composition	Not required	Mandatory for Annex 2-7	D8356: Custom GCxGC
Distillation			D86 / IP 123: OptiDist D2887 / IP 406: Sim Dist D7345 : OptiPMD
Flash Point			D56 / IP 170: OptiFlash Tag & Abel D3828 / IP 523: OptiFlash small scale

JFTOT 230 Mark IV

Thermal stability remains a critical parameter so that no significant biomass residues and contaminants remain in the SAF. The JFTOT IV is ready for the potentially more viscous SAF streams, and provides accurate and reliable thermal oxidative stability analysis with enhanced safety features and simplified operational capabilities, with a small-footprint design.

OptiReader

The multi-wavelength ellipsometric jet fuel heater tube rater offers accurate and fast results, with excellent data integration capabilities.

JFA-70Xi

A self-cleaning instrument that performs freeze point, density, and viscosity at both -20 and -40°C in a single instrument. It features a new, side mounted automatic sample injection port, or a full-function 48-place autosampler for increased productivity.

Mid Distillates Analyze/Custom GC

The MDA Incorporates high-performance liquid chromatography (HPLC) technology to detect aromatics in jet fuel in the 150ºC to 400ºC (752ºF) range within 25 minutes.

ElemeNtS

Detects Total Sulfur and/or Total Nitrogen efficiently using ultraviolet fluorescence (UVF) and chemiluminescence (CLD) in solid, liquid, gaseous materials and LPG samples, including SAF.

FAME in Avtur Analyzer

Specifically designed to measure FAME (biodiesel) in jet fuel, this gas chromatography application features a unique combination of Deans switching and a re-focus module that eliminates the need for cryogenics.

Custom GC*GC

Provides enhanced, detailed and reliable compositional information on jet fuel streams.

See PAC's complete portfolio of solutions for jet fuel: https://www.paclp.com/lab-instruments/application/jet-fuel

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Conventional Jet Fuel versus Sustainable Aviation Fuel

Identical properties and test methods are used for both jet fuel and sustainable aviation fuel, although there are extended requirements for SAF, and unique requirements for various pathways.

For example, JFTOT is performed at different temperatures. Conventional fuel is measured at 260°C, while neat SAF is processed at 325°C, and co-processed HEFA is processed at 280°C. The JFTOT Mk IV can be used for both types of fuels, although at different temperatures.

With freezing point, PAC's JFA-70Xi is the referee method for sustainable aviation fuel. This is because the automatic freezing point test method has been demonstrated to be more capable in detecting heavy paraffins or contaminants that may impact cold flow properties.

There are other low-temperature fluidity and compositional requirements. Both co-processed fuels and several of the pathways have a requirement to determine viscosity at -40°C to be no higher than 12 mm2/s. Aromatics contents are also controlled in both 100% SAF and blended fuels.

When it comes to understanding the specific needs of processing SAF, no one has a better understanding of the application nuances than PAC. With decades of experience in analyzing jet fuel, PAC is uniquely positioned to support the future of sustainable aviation fuel.

Summary

Commercializing sustainable jet fuel has the potential to be one of the most important efforts toward meeting long-term, global emissions goals and reducing the human impact on climate change.

PAC has decades of experience in helping the aviation industry comply with strict standards for jet fuel. We have instruments for a wide range of parameters, including JFTOT, freezing point, viscosity, aromatics, sulfur, FAME, and more. Beyond our product capabilities PAC has depth of application knowledge and a deep understanding of specifications as ASTM D1655, D7566, DEF STAN 91-91, and many other national specifications.