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Cleanup operation

The days of using leaded fuel in general aviation operations are numbered as the industry is working together to clean up its act and embrace greener alternatives. *Business Airport International* presents case studies for the unleaded and biojet fuel markets, examining the developments being made, the implications of each fuel for operators, FBOs and fuel suppliers, and which lead-free alternative is likely to become the mainstream fuel in the future

Words | Hazel King

UNLEADED CASE STUDY

“If the endangerment finding from the EPA is positive, that will set about a chain of events that would make unleaded fuel compulsory”

The general aviation industry is the last mode of transportation that still relies on leaded fuel, making it a target for environmental groups who have petitioned the USA’s Environmental Protection Agency (EPA) and filed lawsuits to speed up the introduction of unleaded fuels.

According to the FAA, approximately 167,000 general aviation aircraft in the USA (80% of the country’s total fleet) rely on 100 octane low-lead avgas (100LL), and the administration is working hard to reduce this number to zero in the next decade or so. To do this, it launched the Piston Aviation Fuels Initiative (PAFI) in 2012, which seeks to find a suitable unleaded alternative to 100LL.

“In 2011 the General Aviation Avgas Coalition – which is made up of the Aircraft Owners and Pilots Association, the Experimental Aircraft Association and the General Aviation Manufacturers Association (GAMA) – was concerned about the future uncertainty of an unleaded avgas, which was having a big impact on the growth of the industry in terms of new product sales and existing product upgrades,” explains Peter White, head of the FAA Alternative Fuels Program Staff, AIR-20, and the government co-lead for PAFI.

The Coalition approached the FAA and asked it to take a leadership role in helping the general aviation industry transition to an unleaded gasoline. “The resulting Piston Aviation Fuels Initiative is an industry/government collaboration whose goal is to help the industry make the transition to unleaded avgas. The 35 stakeholders from 30 general aviation organizations that participate in PAFI span the breadth of the industry,” comments White.

Phase 1 of PAFI – which involved primarily laboratory and rig testing of four candidate fuels – was completed in December 2015 and Phase 2 is now underway. This involves engine and aircraft testing using two shortlisted fuels from Shell and Swift Fuels. “The testing will provide data and reports that can be used to obtain a production specification from international standards developer ASTM for the fuel, which helps it to be produced and distributed throughout the infrastructure and to allow the FAA to authorize the general aviation fleet to operate on these fuels,” White explains.

While PAFI’s main focus is on the US market, the FAA will collaborate with foreign authorities to make sure approvals are accepted so those fuels can be used worldwide. “The



fuel producers are certainly interested in having a worldwide market. While the program is funded by US tax dollars and primarily focused on the US fleet, the expectation is that these solutions would be suitable worldwide,” White says.

Global fuel supplier Avfuel is working with Swift Fuels on the development of its unleaded fuel for PAFI, creating a distribution plan for Swift’s 102 MON no-lead solution to foster competition and availability and to keep prices in check. “Avfuel is also encouraging select FBOs to make Swift’s 94 MON no-lead alternate fuel available by providing the necessary equipment,” says Alfred A Pease, director of alternative fuels, Avfuel Technology Initiatives Corporation.

The road to unleaded

Michael G Mooney, VP and chief risk officer at EPIC Fuels, which is part of PAFI, explains why the aviation industry has been slow to adopt unleaded fuels: “Aviation gasoline producers have been trying to identify an alternative unleaded formula since the late 1980s, however no ‘drop-in’ solution [one that can be used transparently on engines and aircraft without the need for material or operational changes] has been identified. Evaluating the impact of completely new fuel chemistry on the full history of aircraft production is an immensely complicated undertaking; the safety implications of switching to a new fuel, rigorous testing, in multiple conditions and with multiple engine types, must be completed first.”



Above: There is currently no ‘drop-in’ alternative to 100LL fuel for aircraft, so an entirely new fuel must be found to meet environmental targets

Left: Avfuel has partnered with Swift Fuels to create a fuel distribution framework for Swift’s unleaded 94 MON Avgas

Fill Up and Fly Lead-Free!



Fuel standards

Rob Midgley, global technical and quality manager, Shell Aviation, explains why jet fuel needs to do more than pass specification tests

"It is tempting to assume that if a liquid passes the jet-fuel performance tests, then it can be used with confidence as jet fuel. However, there is more to it than that. The test limits reflect historical issues: for instance, a freezing-point limit was set in response to pilots flying at greater altitudes. Jet fuel must pass these tests, but the specification also states that the composition must be hydrocarbons and approved additives only, and thus, by implication, nothing else. For some contaminants, zero really should mean zero. For example, low levels of vanadium can damage turbine blades.

"Fuel-quality-related incidents are rare, but a few are reported every year. For confidence in their jet fuel, operators should ask their suppliers about jet fuel specifications, traceability (to be sure it was made as jet fuel without biofuel or other non-hydrocarbons in the feedstock) and the supply chain quality system that protects the molecules from refinery to wingtip.

"These questions are increasingly important as fuel supply chains become more complicated with additional opportunities for contamination and new refiners entering the market with different interpretations of how to correctly apply the specification standards."

Avfuel provides aviation fuels at 3,000 locations around the world

There is still a way to go before unleaded fuel becomes mainstream for the aviation industry – in fact, White predicts that Phase 2 of PAFI won't be completed until 2018.

"Meanwhile, the EPA is undergoing a process to determine if the lead emissions specifically from general aviation engines endanger health, and it is scheduled to make a preliminary finding in 2017 and a final ruling in 2018," he adds. "If it does determine that lead emissions endanger public health it will be compelled to set limits of emissions and the FAA will need to make sure the engines and aircraft meet those limits. If that endangerment finding from the EPA is positive, that will set about a chain of events that would make unleaded fuel compulsory."

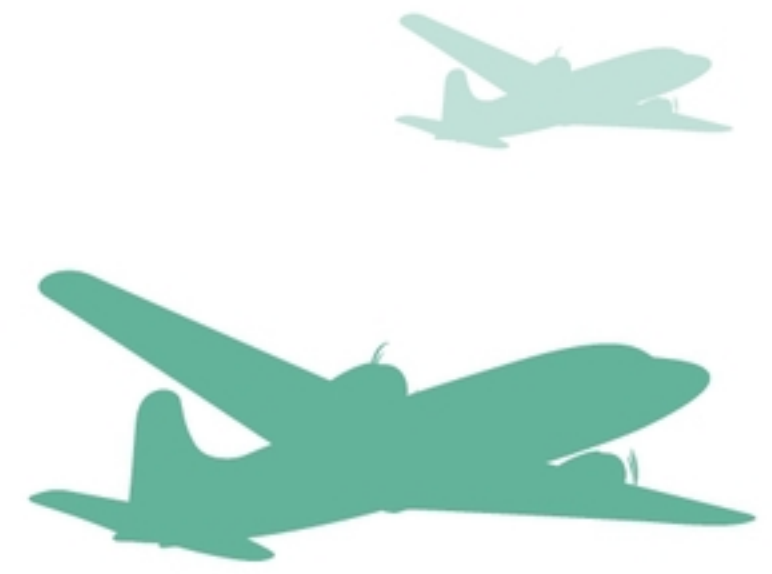
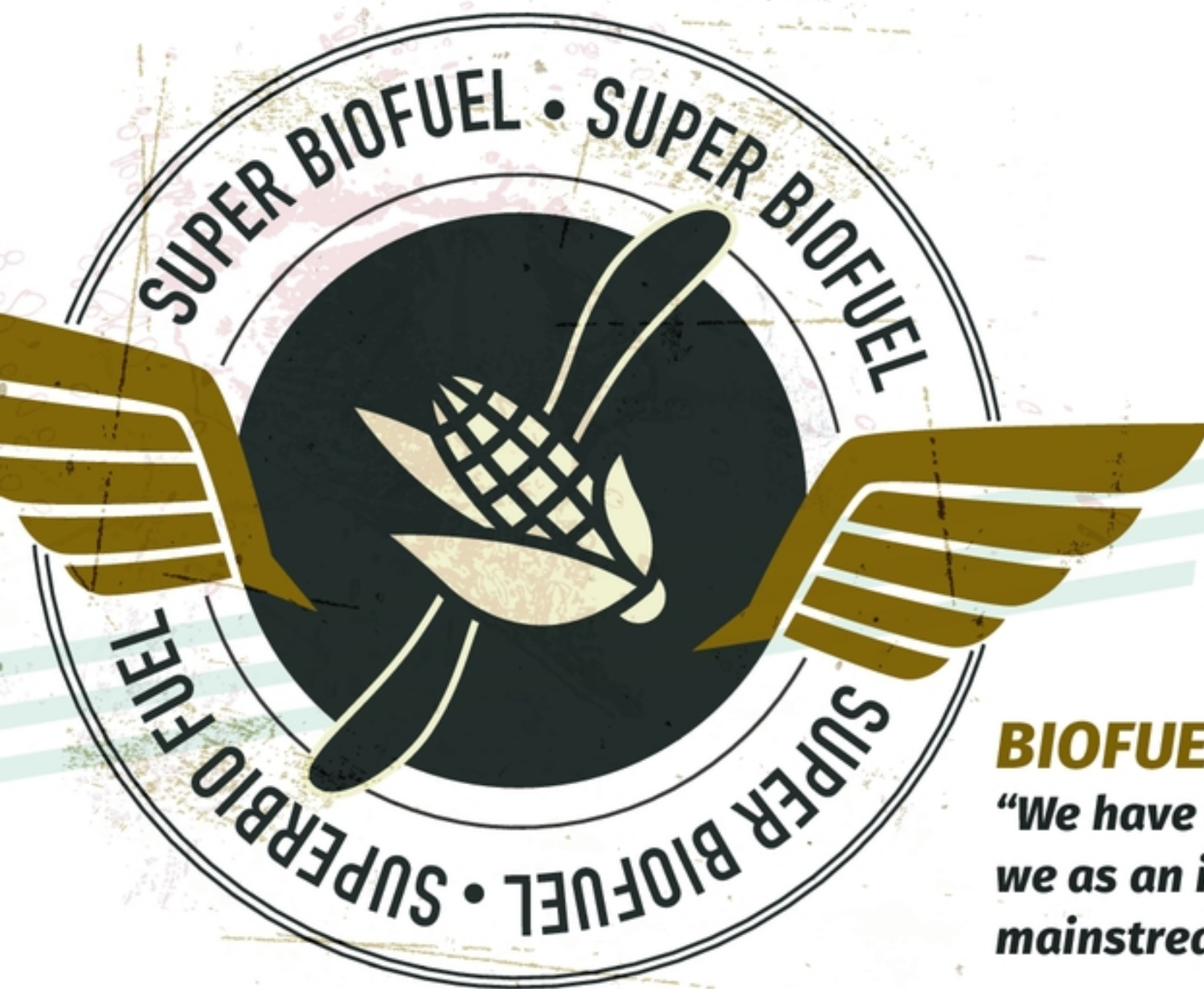
Further cooperation will be needed between all industry stakeholders to ensure that the impact on the general aviation fleet is minimal. EPIC Fuels' Mooney says, "The supply of an unleaded replacement to the current grade of 100LL must be coordinated with all potential manufacturers and distributors to ensure a safe and appropriate roll-out across North America." EPIC Fuels has recently built and commissioned a large capacity railcar supplied avgas facility in southern California, one of the larger avgas markets in the USA, to ensure it is fully prepared to deliver whatever solution is agreed upon by the industry.

TOTAL, HJELMCO and Air BP are also heavily involved in finding an unleaded replacement for 100LL – they have been working on unleaded avgas research since 1992 and are members of PAFI's Technical Advisory Committee. "Working with the FAA, EASA, ASTM, the Co-ordinating Research Council and other industry members, Air BP has made a significant contribution to the development of ASTM D7547 and Defence Standard 91-090 Issue 4 unleaded Avgas specifications. These cover the mid-octane grades UL91 and UL94 respectively developed by TOTAL and Swift. This has been a major project and directly offers over 50% of the global general aviation fleet an unleaded fuel option," says Miguel Moreno – Air BP global marketing director GA.

TOTAL, who submitted one of the four unleaded fuel formula tested for PAFI Phase 1, was the first to produce and distribute UL91 on a European scale. Originally AIR TOTAL launched UL91 to offer ultralight aircraft pilots an aviation fuel that was safer and of better quality and performance than motor gasoline (mogas). Quickly after its introduction on the market, Lycoming and Continental approved AIR TOTAL's unleaded avgas for most of their engines.

In April 2016, Air BP improved access to, and distribution of, its UL91 product in Norway by installing a self-serve automat facility at Kjeller Airport. "This is the first of a network to stretch across Scandinavia and demonstrates Air BP's commitment to support the supply of unleaded fuels," adds Moreno.

"Come 2018, we hope to have identified fuels that can be used on a broad portion of the fleet but the steps to fully integrate these fuels into production, distribution and supply infrastructure are challenging," explains the FAA's White. "There are a lot of issues involved but we believe we've got the right organizations involved to support a smooth transition that will not impact the reliability of general aviation."



BIOFUEL CASE STUDY

“We have a limited supply of fossil fuels; we as an industry must work toward mainstream usage of biofuels”

For the past few years, the aviation industry has been working on developing environmentally friendly fuels that will help it to meet the environmental targets set out by GAMA and the International Business Aviation Council (IBAC): improve fuel efficiency by 2% per year between 2009 and 2020; achieve carbon-neutral growth from 2020; and halve CO₂ emissions by 2050, relative to 2005 levels (see *On the right track*, April 2016, p38-42).

Pease from Avfuel explains, “The entire global aviation industry produces only 2% of all human-induced CO₂ emissions. Of that number, 80% of the CO₂ is emitted from flights of over 1,500km [930 miles], travel for which there is no other practical alternative mode of transport. The Air Transport Action Group has asserted that if commercial aviation were to get up to 6% of its fuel supply from biofuels derived from biomass by 2020, they could reduce the overall carbon footprint by 5%, to 1.9% of all human emissions.”

This year’s EBACE in Geneva, Switzerland, in May, was a prime example of the rising popularity of biojet fuels in business aviation aircraft operations, with Gulfstream using its own renewable fuel blend to fly in a G450 and G550 to the static display. The low-carbon, drop-in renewable fuel is derived from agricultural waste and combined with Jet-A fuel to provide a 50% reduction in greenhouse gas emissions.

A number of fuel suppliers are also developing their own biojet fuels in partnership with OEMs. “We are working on a number of different pathways to develop biojet in a bid to become a leader in the sustainable aviation fuel market as and when this market becomes established,” explains Philippe Marchand, director of biotechnologies at TOTAL.

The pathways for the French fuel supplier are sugar-to-biojet (in partnership with US company Amyris); hydro-processed esters and fatty acids-to-biojet; and alcohol-to-biojet (in partnership with developer Gevo), and TOTAL – an ASTM approved company – has already begun commercial



Biojet fuel makes up one part of Air BP's environmental solutions offering

use of some of these biojets with Air France-KLM, Lufthansa, GOL and Cathay Pacific.

EPIC Fuels is also in the biofuel and biofuel blend market. Kai Sorenson, bio/renewable fuels commercial manager, comments, “We have been primarily working with Boeing on the OEM side – we conducted the Boeing ecoDemonstrator 757 flight with US-made ‘green diesel’ biofuel in June 2015 and Boeing’s first-ever flights using a HEFA blend during the ecoDemonstrator 787 flight test program in December 2014 – and we’re also working with multiple carriers including Alaska, KLM, Nippon Cargo, United and others. The results have been very promising. We expect that there will be multiple options for sustainable fuel for aviation, whether its green diesel, alcohol-to-jet or other combinations; these flights are clearly demonstrating the advantages of using a biofuel blend to improve the aviation industry’s environmental sustainability.”

The FAA is also working on a biofuel option – the Commercial Aviation Alternative Fuels Initiative (CAAFI) is a collaborative biofuels effort similar to PAFI on the avgas side. “These fuels are all ‘drop ins’, unlike the avgas solution,” says White.

In January 2016, Air BP, in partnership with Norwegian airport operator Avinor and sustainable biofuel specialist

COVER STORY: FUEL

SkyNRG, became the first supplier at Oslo Airport Gardermoen to supply biojet to commercial operators via the airport's existing hydrant mechanism.

Air BP's Moreno comments, "Air BP anticipates this will lay the foundations for the increased adoption worldwide of jet biofuel supply. Air BP is working closely with Avinor in its assessment of market demand. The key challenge in this area is the supply of biofuel. Air BP is evaluating many options to determine how best to source and market biojet to customers. We want to be a leader in the supply of biojet as we recognize its importance for our customers and the wider industry in meeting ambitious industry environmental targets."

According to Moreno, other airports have also expressed their interest, particularly in Sweden where Air BP has started to supply biojet at Karlstad Airport.

Work to be done

Despite Air BP's Scandinavian supply, the aviation industry is yet to fully embrace biofuels, with cost and regulations being barriers to market. "Cost is certainly an issue as most biofuels, even for road transport, are more expensive than fossil fuels, especially as the price of crude oils has dropped in the last few years," TOTAL's Marchand says. "However, biofuels in road transport have been in place for decades – more than 40 years in Brazil and more than 10 years in the USA and Europe – and the reason why biofuels have been able to be incorporated into road transport is because there were the proper regulations and legislations in place. In an emerging market you need some support to make sure that you can reach a decent level of competitiveness with the right level of technology and volume growth."

EPIC Fuels' Sorenson argues that the lack of infrastructure is also limiting the widespread use of biofuel. "Given that we have a limited supply of fossil fuels, we as an industry must work toward mainstream usage of biofuels. What's currently lacking are large-scale production facilities to produce the alternative fuels, but we're seeing progress there. Whether it's fuel from Gevo's alcohol-to-jet production facilities in Colorado that was first used on Alaska Airlines flights this summer, or biofuel produced by Diamond Green Diesel, a refiner in the Gulf Coast region, more and more alternatives will come online in the next few years."

Air BP's Moreno agrees: "As the biojet industry develops, we will hopefully see more plants producing biojet. While biojet is more expensive than regular jet fuel, it can be blended at small percentages, resulting in a manageable incremental cost."

One positive for biojet as opposed to unleaded is its ability to be 'dropped in' to current airframes. "In essence, the bio molecules that are blended together with fossil fuels to make biojet are drop-in, so all biojets comply with the existing jet fuel specifications and no modifications need to be made to the aircraft," explains Marchand. "Biojet, generally speaking, improves the behavior of the engine and the airframes because they are cleaner and their energy content is higher so they improve operations."

For Marchand, the mainstream use of biojet is still a way off – he predicts it will not happen within the next 10 years – but its popularity will continue to grow in line with GAMA and IBAC's 2020 target for carbon emissions. ○



EPIC Fuels' tanker fills an Alaska Airlines 737 for the first-ever commercial flight using a blend of petroleum-based fuel and Gevo's alcohol-to-jet fuel

Photo courtesy of Alaska Airlines



TOTAL developed a biojet fuel with Amyris for its Lab'Line for the Future project

TOTAL / Manuel Blondeau / Capa