“Swift Fuel” is now UL102

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According to their president Mary Rusek, Swift Enterprises (swiftenterprises.com) has been developing an unleaded replacement for 100LL since 2005. Their early fuel formulations were multi-component, and some of those components were petroleum derivatives. Since 2007, they've settled on a primarily two-component formulation codenamed “Swift 702 fuel”. 702's two main components, mesitylene (1,3,5-trimethyl benzene) and isopentane (2-methyl butane), can be derived from biomass. Thus, 702 can be made from completely renewable resources as described in Swift's most-recent patent application (http://www.faqs.org/patents/app/20080244961). The ASTM taskforce recently agreed to the designation UL102 to fit into the new ASTM nomenclature; it has a minimum octane rating of 102, compared to the 99.6 rating for 100LL under ASTM D910.

According to Dave Atwood's report DOT/FAA/AR-08/53 issued in January of 2009, he and other researchers at the FAA's William J. Hughes Technical Center “performed detonation and power performance tests on the Swift 702 fuel as compared to a locally purchased 100LL in two of the highest octane requirement engines in the fleet. A Lycoming TIO-540-J2BD and a Lycoming IO-540-K were evaluated on both fuels... Any fuel satisfying the octane requirement of these two engines would satisfy the octane requirement of the majority of the piston, reciprocating engine fleet... The Swift 702 fuel had a motor octane number (MON) of 104.4, as determined by the international standard test ASTM D 2700, and the locally purchased 100LL had a tested 103.6 MON... A power baseline and detonation test was run in the IO-540-K engine, comparing the performance of the Swift 702 fuel to 100LL fuel, and a detonation performance test was run in a Lycoming TIO-540-J2BD engine... At all engine speeds and manifold pressures, the Swift 702 fuel produced more than 98% of the horsepower as the 100LL and produced an average increase in EGT of approximately 50°F... The Swift 702 fuel met most of the current leaded aviation gasoline specification ASTM D 910, except for the 50%, 90%, end distillation points, and heat content... and outperformed the 100LL in detonation testing... Further endurance testing is required to determine the significance of operating with 50°F higher EGTs... Future full-scale engine endurance tests will verify whether there will be issues with oil dilution, nozzle and fuel system deposits, bearing failure, induction varnish buildup, or cylinder and valve deposits from using Swift 702 fuel.”

Aside from octane rating, there are two other significant differences between UL102 and 100LL. One is that UL102 weighs more; its density is about the same as jet fuel. Like jet fuel it also has greater per-volume heating value, although the per-mass heating value is slightly less. As Dave explained in his January 2009 report, “The Swift 702 fuel was roughly 1.01 lb/gal heavier (or 17.5%) than the 100LL at 87°F. However, since the Swift 702 fuel had 96.3% of the energy density on a mass basis as the 100LL, the Swift 702 fuel has approximately 13% higher energy per gallon of fuel than 100LL. On a fuel mass flow basis, the Swift 702 fuel will produce slightly less power than the 100LL; however, on a fuel volume flow basis, which is typically more of a concern to a pilot, the fuel will produce more power than the 100LL. Therefore, the same number of gallons of fuel will weigh more for the Swift 702 fuel than the 100LL, but will provide a greater range of flight.”

The other main difference between UL102 and 100LL is vapor pressure, or volatility. Avgas must be volatile enough for good vaporization when starting an engine at low temperatures, yet not so volatile that it boils easily at altitude. These characteristics were not investigated in the testing summarized in the January 2009 report. As Dave Atwood stated, “The Swift 702 fuel did not meet the 50%, 90%, or end point of the distillation curves. This was due to the high aromatic hydrocarbon content of the fuel.

Previous and extensive FAA tests determined that an unleaded fuel could meet the current detonation performance of the current ASTM D 910 100LL leaded aviation gasoline only if it contained at least 10% of a specific aromatic amine or it contained a very high concentration of aromatic hydrocarbon. In either case, it is highly unlikely that any such fuel would meet the distillation specification for an aviation alkylate-based fuel. Further tests are planned on the Swift 702 fuel using two separate high-power engines, a Continental and a Lycoming, for long-duration tests."

The full-scale engine endurance tests Dave mentioned have been completed. A report is being written and should be available around 7/19/2010; look in: http://ACTlibrary.tc.faa.gov/ for DOT/FAA/AR-10/13 "Full-Scale Engine Endurance Test of Swift Enterprises UL102 Fuel" by D. Atwood.

Given differences in aircraft weight & balance, flying range, and possibly different starting procedures in cold weather, an STC looks like one way for a certified aircraft to use UL102. In a joint project with Swift Enterprises, Pat Anderson of Embry-Riddle's Eagle Flight Research Center in Daytona Beach, Florida is now doing certification testing for an STC allowing use of UL102 in its fleet of 172s; see http://www.eaa.org/news/2010/2010-02-25_swift_fuel.asp . After a little more than 40 hours of initial testing on their Piper Seminole, Pat has noticed only two problems. One is relatively hard starting at temperatures below 30 degrees F; this may be related to the fuel distillation curve differences vs. 100LL, as mentioned by Dave Atwood. Swift is working on that now. The other is that an engine adjusted to idle properly on 100LL will idle rough and emit black smoke on UL102; a clean idle is achieved by manually leaning the mixture during ground operation, which is good practice even when using 100LL.

According to Pat Anderson, STC certification testing must be done with normal volume-production fuel, rather than with laboratory-prepared samples. This creates a chicken-and-egg situation; it's difficult to invest in a volume production plant without the STC-enabled markets.

An additional problem is that, using unoptimized processes and without economies of scale, early quantities of UL102 will probably be expensive. Fortunately, UL102 can be blended in any ratio with 100LL.

Swift Enterprises will give five presentations at EAA's AirVenture Oshkosh 2010 in the Learning Center and the Forums Plaza, covering their fuels and fuel cells. Check the AirVenture forums schedule for times and places. Swift representatives will be in Embry-Riddle's booths 397 to 401, adjacent to Aeroshell Square and also in the Learning Center.

[Swift enterprises will also be speaking about SwiftFuel in the ABS tent on Wednesday, July 28 at 11 am and Saturday, July 31 at 11 am)—*ABS*]