Aircraft Fuel-Saving Measures Debated

By Michael L. Yaffe

Reston, Va.—Vertical, cambered winglets, developed at National Aeronautics and Space Administration's Langley Research Center as vortex spoilers, show promise as a simple, near-term approach to saving significant amounts of aircraft fuel by reducing induced drag.

Also, by disrupting vortices, these aerodynamic fingers can reduce waiting times—and fuel consumption—of trailing aircraft waiting to take off. The winglets were developed by Richard T. Whitcomb, head of the transonic aerodynamics group at Langley.

The full merit of these winglets remains to be proved by more studies and evaluations of larger units. But so do most of the other suggestions made here at the recent American Institute of Aeronautics and Astronautics workshop conference on aircraft fuel conservation.

For the mid- to long-term, workshop conferees agreed that after suitable development, high (40:1) pressure ratio engines operating at high (2,500°F) turbine inlet temperatures should produce significant savings in required fuel.

Along the same line and in the same general time period, additional conservation of aircraft fuels will result from the use of variable-pitch, variable camber fans; variable-area turbines and/or nozzles; regenerative engine cycles with and without inter-stage cooling and ultimately the development of different multicycle engines that would be capable of operating efficiently at more than one design point.

Hydrogen Fuels

Use of liquid hydrogen fuels and nuclear aircraft propulsion also will require a great deal of additional work on fuel distribution, aircraft design and safety measures that will carry them into the 21st Century before they see aerospace applications.

On the other hand, for the present, most of the things that can be done to conserve aircraft fuel are being done, the conferees agreed. These include changes in ground and flight operations that so far have saved approximately 4% in domestic fuel consumption.

Stretching aircraft, which was already under way before the fuel shortfall occurred, will continue to be a significant factor in fuel conservation, said one airline representative. It is enabling airlines to obtain 30% more seating capacity for only a 5% to 8% increase in fuel consumption.

Refueling—not just refanning—narrow-bodied transports could save the airlines a substantial amount—30% to 40%—in fuel. But, it is estimated this would cost $4 billion.

Farther in the future is the suggestion to recycle carbon by cultivating sugar beets or trees, or by splitting carbon from atmospheric carbon dioxide. The carbon would be combined with hydrogen split from water by solar or nuclear energy to form simple hydrocarbon fuels such as methane. Some attendees indicated they would favor this approach to alternatives such as the direct use of nuclear propulsion (based on plutonium fission) or pure liquid hydrogen for powering future transport aircraft.

For mid-term solutions to fuel shortages, the group suggested starting work now on pilot plants to produce jet type fuels primarily from shale oil reserves initially, and later from coal-derived hydrocarbon products, to determine what additional refining steps would be required to make these substitute fuels suitable for use in jet engines and/or what modifications would have to be made to the engines in order to use these fuels without increasing exhaust emissions.

Added Funding

Along the same line, workshop conferees suggested adding impetus and funding to the related studies now under way by the Navy and Air Force on burning coal-derived synthetic fuels in present jet engines.

Most of the experts who gathered here were divided into four major working groups—aircraft operations, aircraft design, aircraft propulsion systems and aircraft fuels—or subgroups of these four. The concepts for conserving aircraft fuels that the conferees could agree on were generally classified as near-term (zero to 3 years), medium-term (3 to 6 or possibly 10 years) and long-term (beyond 10 years). These were then presented to all 90 attendees for their review and comments.

The final working group report took into account the more significant suggestions and, in effect, became an AIAA preliminary position paper on which virtually all the attendees could agree.

This "final" document will be further refined before it is presented to congressmen and other concerned government committees and individuals as an official AIAA position paper.

On measures for near-term conservation of aircraft fuel, attendees generally agreed that what could be done to save fuel was already being done by aircraft operators.

Among the measures identified or suggested by ground operations, flight operations and air traffic control:

- Use of onboard auxiliary power units to do additional jobs such as providing powered-wheel drive capability. This could minimize the use of tow vehicles and aircraft engines for taxiing and moving aircraft.
- Optimal flight planning for civil and military aircraft to reduce fuel consumption.
- Continued upgrading of the air traffic control system to improve aircraft flow control. Also alleviation of air traffic control constraints on optimal flight paths, such as relaxing speed limits at low altitudes for departure.
- Wider use of simulators for training qualification, pilot proficiency checks, aircraft certification and simulation of military missions.

The mid-term to long-term suggestions were selected as being the most practicable paths to pursue to achieve significant fuel savings and/or developing alternative energy sources.

Among the medium- and long-term fuel conserving measures proposed by the AIAA working groups:

- Greater use of active control surfaces in control-configured vehicles for load alleviation and relaxed flutter design speed margins together with optimized, integrated structural designs, could save significant amounts of fuel. Work already under way in these areas by NASA and the military services should be expedited and directed more toward the civilian transport sector, as should the government’s work on supercritical wing aerodynamics.
- Laminar flow control, air injection and compliant skins for turbulent drag reduction were suggested as areas for further studies over the long term.
- Introduction of low-energy boundary layer air into engine inlets was another long-term proposal. This has been tried; it has the disadvantage of increasing engine weight; but some aircraft designers and engine researchers believe it still has the potential for a significant overall savings in fuel consumption.
- Studies of large distributed-load airplanes.
- Greater use of small aircraft to simulate the flight characteristics of larger aircraft for training and greater use of small remotely-piloted vehicles in place of manned missions could prove a major fuel conservation measure.
- Tightening and increasing the frequency of certain maintenance procedures may now prove meaningful in light of the rising fuel costs if they can offset or retard the usual 3% to 8% increase in fuel consumption due to general engine deterioration.
- Relaxation of certain fuel specifications such as freeze point and flash point.