Emissions Implications of Alternative Aviation Fuel Combustion and Production

TIM EDWARDS
Air Force Research Laboratory
PRTG Building 490
1790 Loop Rd N
Wright-Patterson AFB, OH 45433-7103
(937) 255-3524
james.edwards@wpafb.af.mil

The use of alternative (non-petroleum) aviation fuels can have emissions implications in two areas. The first is the obvious effect on aircraft engine emissions. The second area involves the emissions from the fuel production facility. The emissions of primary concern during fuel production are greenhouse gases, primarily CO₂. The primary alternative fuel of interest currently is a blend of Fischer-Tropsch isoparaffinic kerosene (IPK) and conventional jet fuel. Fuels produced directly from biomass (without going through the F-T process) are also of high interest.

In extensive emissions testing across a number of gas turbine engines, it has been found that Fischer-Tropsch fuel blends significantly affect only two engine emissions: particulates (soot) and sulfur compounds. The higher H/C ratio, relative to current jet fuels, and zero sulfur content of F-T IPK leads to significant reductions in soot and sulfur emissions. Data is currently available for T63, TF33, and T700 engines, with other engines planned for testing in the near future. The higher H/C ratio also leads to a slightly lower CO₂ emission index for F-T fuels, relative to petroleum, and a slightly higher H₂O emissions index.

In the aircraft equivalent of “well-to-wheels” CO₂ assessment, it is found that a F-T fuel plant increases CO₂ emissions by about 80% over petroleum fuels. However, carbon capture and storage/sequestration (CCS) can reduce the carbon footprint to a level roughly equivalent to that for petroleum-derived fuels. Recent reports and calculations have shown the co-feeding of biomass and coal to a F-T plant can reduce the fuel’s carbon footprint significantly below petroleum, and in some cases can produce essentially a carbon-neutral fuel – where the CO₂ absorbed during production (through the use of biomass and CCS) completely offsets the CO₂ released during combustion. The CO₂-reduction potential of biomass-derived fuels is recognized in draft EU legislation for carbon taxes on jet fuel – where biomass-derived fuels are exempt from carbon taxes.