

Synthetic and Biomass Alternate Fueling in Aviation

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Why are we interested in alternate and biomass fueling in aviation and transportation?

While transportation fueling can accommodate a broad range of alternate fuels, aviation fueling needs are specific, such as the fuel not freezing at altitude or become too viscous to flow properly or of low bulk energy density that shortens range. The fuel must also be compatible with legacy aircraft, some of which are more than 50 years old.

Worldwide, the aviation industry alone uses some 85–95 billion gallons of hydrocarbon-based “fossil” fuel each year, which is about 10% of the transportation industry. US civil aviation alone consumes nearly 14 billion gallons. The enormity of the problem becomes overwhelming, and the aviation industry is taking alternate fueling issues very seriously.

What fundamental problems are areas of active research in biofuels?

Biofuels—IF sourced from Halophytes, Algae, Cyanobacteria and “Weeds” that use wastelands, waste water and seawater—have the capacity to be drop-in fuel replacement for petroleum fuels. As such, biojet from such sources SOLVES the Aviation CO₂ emissions issue without the downsides of “conventional” biofuels, such as competing with food and fresh water resources. Most of the existing fuels infrastructures are applicable. Processed biofuels, also termed synthetic paraffinic kerosene, have thus far proven to be equivalent in performance to jet-fuel (Jet-A) in actual flight experiments as the Virgin Atlantic flight from London to Amsterdam with no discernable problems. For this flight demonstration, one of the four 747-400 engines was fueled on a biojet blend of 80% Jet-A and 20% processed babassu nut and coconut oils. At this time, processed-biofuel operational feasibility is essentially proven, or soon will be.

Of the many current fundamental problems, THE MAJOR Biofuel problem is COST. We have not yet invested significantly in the halophyte, algae, cyanobacteria and “weeds” biofuel arenas, and algae is still a “boutique” crop. Halophyte costs are of the order of those for conventional agriculture, with much reduced land and water costs; therefore, the halophyte cost picture is currently more favorable than algae. Algae Bioreactors are currently very costly and previous studies indicate that open ponding algae cultivation is preferred from a cost standpoint. However, even open ponding is not yet financially feasible. Both R&D and creative engineering are required to reduce these biofuels costs. The capacity and operability are there, but cost is THE ISSUE. Research is also ongoing in several “improvement” areas including refining/processing and biologics with greater disease resistance, greater bio-oil productivity, reduced water/nutrient requirements, etc.

How do your current research projects support or oppose the efforts by industry to develop marketable products in the area of biofuels?

Our current research is aimed at aiding industry efforts in several areas, By industry here we mean the end-to-end industrial and research activities including biology, growth/capacity, processing and refining as well as the aviation industry. NASA in collaboration with industry and other government agencies are working the cost reduction issues from a systems standpoint, including looking into power plant and waste water treatment plant synergisms and at-sea or open water scaffolds using continent-sized nutrient streams, such as the Gulf of Mexico below the Mississippi River outflow. We are considering different modeling approaches, growth media and refining approaches, different biologic feedstocks, methods of sequestering carbon in the process[es], fuel certification for aviation use and, overall, ensuring that biofuels are feasible from all aspects – operability, capacity, carbon cycle and financial. We are providing common discussion grounds/opportunities for the various parties, disciplines and concerned organizations involved to share both issues and potential ways for moving forward, and overall, we are trying to educate those concerned regarding the innate limitations of “conventional” biofuels [lack of fresh water and arable land, essentially a LACK OF CAPACITY] and the solution spaces provided by non-traditional feedstocks such as halophytes, algae, cyanobacteria and “weeds” (e.g., jathropha, castor, camelina) that use waste lands/water or saline/salt water and have an immense capacity potential.

How will biofuels mitigate the energy crisis that we currently face today, from both a local and global perspective?

There are five major renewable energy approaches, each of which has an order of magnitude greater capacity than that required to replace all of the “fossil” fuels These are Wind, Drilled Geothermal, Solar Photovoltaic, Solar Thermal and Biomass sourced from halophytes/algae/cyanobacteria/”weeds” on wastelands using waste/salt water. All of these are either now or soon to be of lower cost than coal with sequestration. Biomass/biofuels are unique in providing heavy transportation fuels. Even if electric vehicles are widely deployed, they nominally apply to some 40% of the 70% of the petroleum that is used for heavy transportation fuels. Remaining will be aviation, heavy rigs and petrochemical feed stock, for example, that will still require heavy fuels. Biomass, once the “oils” are extracted, can provide both food stocks and 24/7/365 base electrical load via burnt biomass. Biofuels are nearly “Carbon Neutral.” The plants take up the atmospheric CO₂, and sequester some of the carbon in their roots etc; the rest of the CO₂ is recycled back into the atmosphere when the fuel is burned. It should be noted that current proposals to feed algae CO₂ extracted from fossil fuel plant stacks would increase the net energy produced by a given amount of fossil CO₂, but the generated fossil CO₂ is still largely released into the atmosphere. It is important to ensure that biofuels utilize/recycle/sequester existing/exhausted atmospheric CO₂ if they are to be truly “Green” and useful in combating climate change to the extent possible. The other energy aspect of biofuels is a combination of financial and capacity. Most are projecting peak oil in the near(er) future and large demand increases, leading to greatly increased prices and potential shortages. This is in addition to the climate aspects and makes biofuels a win-win approach proffering as they do, at least the ones we are studying, massive capacity , climate neutral-to-some sequestration and, ultimately, reasonable costs.