Future Fuels for Aviation

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Our global fleet of planes consumes a whopping 227 billion litres of aviation fuel every year. This amount of fuel could fill over 90,000 Olympic sized swimming pools! Aircraft are currently responsible for 2% of the anthropogenic (or man-made) carbon dioxide emissions. This is set to increase to 3% by 2050, due to an expected threefold increase in current passenger miles.

With rising fuel costs, the inevitable depletion of fossil fuel reserves and the impending threat to our environment, substantial efforts have been made into finding alternative fuels for the aviation sector, a sector whose fate is tied irrevocably to their dependence on fossil fuels. The International Air Transport Association (IATA) aim to have 10% of aviation fuel coming from alternative sources by 2017 and they have recently set a target of achieving carbon neutral growth by 2020. Many of the major airlines are committed to reducing their carbon emissions and fossil fuel dependency. As there is little potential for electric or hydrogen planes at present, the mantle of alternative sources lies on the shoulders of biofuels.

Bioenergy

So, what are biofuels? Firstly, what is bioenergy? Bioenergy is energy from plant and other biological matter. As plants and crops grow, they absorb carbon dioxide and sunlight and convert the sun's energy into energy which is stored within their cells. When these plants are burned or processed, they release the stored energy as well as the absorbed carbon dioxide. One of the advantages of bioenergy sources is the fact that, if they are grown sustainably, they can be renewable sources of energy. Added to this is the theoretical ability for bioenergy to produce less carbon dioxide than conventional fuels, which would help in the mitigation of greenhouse gas emissions. Biofuels are fuels that have been derived from particular bioenergy crops. The crops are put through various processes and the oils and sugars derived from them are converted into biofuel products.

Generations of Biofuels

First generation biofuels are fuels that have been derived using existing technologies from feedstocks that are conventionally used as food. First generation fuels include ethanol from corn and biodiesel from vegetable oil. Second generation biofuels are from non-food crops, usually from cellulosic crops, and are processed using advanced technologies. Third generation biofuels, or green hydrocarbons, are also from non-food crops. Algae are the most promising of this generation. Fourth generation biofuels are fuels from genetically engineered crops.

Biofuel Flights

Since 2008, there have been a number of landmark flights involving biofuels. In February 2008, Virgin Atlantic became pioneers in biofuel flight when they flew a plane from London to Amsterdam with one engine using 20% biofuel and 80% conventional fuel. The flight proved that it is possible to power a commercial jet using a biofuel mix. Air New Zealand, Continental Airlines and Japan Airlines have also demonstrated the potential of different biofuels during test flights.

A report released recently by Boeing, in collaboration with many members of the aviation industry, confirmed that the biofuels used in the flights were comparable to, or better than, conventional fuels as regards meeting all the technical parameters and stringent requirements of aviation fuel. They also had no known detrimental effects on the engine. It has been shown that the different blends of biofuels could improve the overall efficiency of the plane, resulting in a fuel saving and a reduction in CO_2 emissions.

Sources of Bio-jet Fuels

While there are a number of different sources of biofuels, let's take a look at the sources that were used for the biofuel test flights.

Jatropha has been recently heralded as a potential crop for future fuel production. Jatropha oil comes from the jatropha curcas seed. It adapts to a wide range of climates and soils can grow in rock crevices and it is virtually resistant to drought.

Camelina, a flowering plant, can be grown on marginal lands and on lands unsuitable for food crops. It requires little water and can be used as a rotation crop for wheat. One third of the camelina seed is oil, which is then extracted and processed.

Algae have been flaunted as a potential solution to our energy problems. Their growth does not affect fresh water resources as they can be produced using ocean or waste water. They absorb more carbon dioxide through the photosynthesis process than any other plant. Algae growth does not impact upon food supplies. Algae should grow better if fed with excess carbon dioxide. Indeed, there have

been proposals in America to capture carbon dioxide from power plant emissions and use this in an algae bioreactor.

There has been huge interest in algae research recently. For example, Exxon Mobil has long been examining the potential to move to biofuels, particularly algae, realising the huge potential for reducing fossil fuel dependency. Plans were announced in July 2009 to invest up to $600 million in Synthetic Genomics, a bio-tech company with particular interest in biofuels.

Challenges/Issues

There are a plethora of issues regarding the widespread use of biofuels, few more publicised than the food versus fuel debate. As fuel prices rise, food prices would likely follow suit and hunger may become more prevalent. It is indisputable that certain crops such as corn grown for the production of ethanol are being diverted from the food market. In contrast, second and third generation biofuels do not impact upon food production.

Another issue regarding biofuels is the amount of land area required. In order to make a substantial impact, sufficiently large areas of land need to be used for the growth of bioenergy crops. Considerable research is taking place into developing bioenergy sources that give greater amounts of fuel than first generation crops. It is difficult to calculate exactly how much fuel a particular area of land can reliably produce. Yields vary from place to place and depend on soil nutrient content, the maturity of the crops and on the methods of energy extraction.

Although biofuel crops absorb carbon dioxide during growth, roughly the same amount of carbon dioxide is released when the fuel is burned. The real advantage, as regards carbon abatement, comes from the displacement of fossil fuels. Whether biofuels are mitigating carbon dioxide emissions or not depends on the method of production. If large areas need to be deforested to clear land for the growth of biofuels crops, or if more energy is being used to grow the crops and to produce the fuel than obtained from the fuel, then the biofuels are not reducing carbon dioxide emissions. The whole life-cycle of a biofuel needs to be considered.

Due to their chemical make-up, biofuels also have other emissions such as nitrous oxide. This poses further complex challenges as nitrous oxide is believed to have a more detrimental effect on the atmosphere than carbon dioxide. This is further reason to perform full life-cycle analyses.

Another pressing issue regarding biofuels is the amount of energy required to grow the crops and to derive the fuels. The energy used to plant and harvest the crops, to irrigate the land and to derive the fuels can be, particularly with first generation biofuels, considerably greater than the amount of energy obtained from the crops. Much of this required energy is from fossil fuels. With improved methods of energy extracted from the crops, second, third and fourth generation biofuels may require less energy to produce.

As with all developing technologies, there are considerable costs associated biofuel technology. The future of biofuels will be dependent upon significant investment of time, resources and money. Camelina, jatropha and algae are all in different stages of development. Although they show great potential, difficulties will present themselves when moving the processes to a commercial scale.

Conclusion

There is no single energy source going to solve our over reliance on fossil fuels in the aviation sector. We need to build up a portfolio. What that portfolio consists of remains to be seen. One thing is clear, however, first generation biofuels are not going to be the answer for aviation; they compete with food crops and require too much energy to produce. In the not too distant future, a number of blends of second and third generation biofuels may play a role in fuelling aircraft.

Researchers seem to differ over the potential for biofuels to resolve some of our energy issues. On the one side, some believe it may be difficult to justify the widespread introduction of bioenergy crop production as the high energy cost of production may exacerbate the very problem it set out to rectify. However, there are many who believe that producing biofuels correctly and sustainably can, and will, solve some of our problems. The most important thing going forward is that research and development continue and that guidelines are put in place to avoid widespread land clearing or deforestation. Wise, well-informed choices need to be taken if we are to obtain sustainability in the aviation sector.

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