

The Push for Eco-Friendly Airplanes

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Note: this is a preliminary exploration of a complex subject which is multifaceted in nature; we have collected articles which contribute to the understanding of the issues and we have contributed our own insights. This paper can be considered as work in progress. There are challenges; breakthroughs are possible.



(source: <https://www.aerotime.aero/paulius.jakutavicius/22692-green-flying-is-it-possible-to-implement>)

In 2014, prior to the Paris Conference of 2015 on Climate Change, ASUA in cooperation with WAFUNIF organized an international conference at the United Nations headquarters making an extensive review of what the major automobile manufacturers were doing to make automotive technologies more eco-friendly.

https://www.g-casa.com/conferences/prague15/pdf_paper/Owarish.pdf

Significant progress has been made since then regarding these technologies. Eco-friendly vehicles are practically in every country of the world. With the adoption of the Paris Treaty on Climate Change, there is even more impetus to get the countries of the world to do even more facilitating the adoption of eco-friendly vehicles.

All the stakeholders are urged to work together to make a significant difference:

- a) -Climate change video Video3 Owarish Frank:

Working Together - Final Version.m4v

- b) Major transformation of the world underway:

http://www.g-casa.com/conferences/brno/pdf_paper/Owarish.pdf

Now attention has to be given to the way airplanes are powered; so far, most airplanes use kerosene, that is, fuel-based technologies. There is experimentation going on but so far there has been no major breakthrough as yet and there is no incentive for airlines to change the way they operate as they simply follow what the manufacturers offer. This paper aims at giving the big push for the companies concerned to do more to adopt eco-friendly technologies with incentives by government entities to support research and development. MIT has been doing a fair amount of research on the broader subject of powering engines. The thinking is that the time has come to develop and adopt eco-friendly technologies for aircraft engines. It would be a good start by having these engines powered in a hybrid manner similar to what was done for automobile engines. Airplanes will have less weight to carry in terms of the amount of fuel; the batteries are heavy but not quite as that of fuel. This hybrid technology is safe as it has been used in cars for years. Similarly it is possible to have jet engines that run on hydrogen fuel cell or completely on electricity. The ROI has to be looked at over the medium and the long term.

The following article from Aero Magazine pretty much scout the terrain and the challenges:

Green Flying: is it possible to implement?

There is no doubt that aviation industry has a great impact on environment. Various Non-governmental organizations (NGO) worldwide are searching for the best ways to solve the issue of rapidly growing carbon dioxide emissions as the number of air passengers exceed every forecast. And not just NGOs, as aircraft manufacturers are carefully designing new engines and other solutions to reduce carbon emissions. However, the movement towards eco-friendly aviation is barely scratching the surface of the issue despite the effort. So, what is happening in the industry towards green flying initiative and what can actually be done on limited resources?

The biggest issues

Probably the biggest issue for green flying is the actual flying. People are constantly travelling by plane and it would be extremely difficult to persuade them that any other mean of transportation would be much more environmentally friendly. Mostly, because at this age time is money, and flying saves time. Besides that, travels by aircraft became a lot cheaper, especially with low-cost airlines when tickets for vacation can cost as low as 10 euro per person. However, what is the real cost of so many flights?

According to the International Air Transport Association (IATA), at the moment around 4 billion passenger seats are sold in civilian airliners every year. Meaning that nearly half of our population flies every year. It is predicted that by 2036 the number will double. Every year the number of air passengers grows by 5 percent. The irony – everyone worldwide is talking about carbon emissions and searches for the ways to minimize it but flies more than any year before.

Of course, one might say that aviation is just a very small player in carbon emission environment and it would not be wrong. Only 2 percent of global carbon emissions belong to aviation industry, however these 2 percent convert to 859 million tons, which still is a great issue in the worldwide context.

What are the solutions?

Some of the solutions to this ongoing and still rising issue are obvious. We should stop flying so frequently. But is it really a solution? Aircraft manufacturers are working daily to create engines that would use less aviation fuel and would be more efficient. However, knowing the aircraft fleet worldwide is not changing as soon as the new aircraft engines being released, these changes would not be implemented soon enough.

The other solution is to adapt current aircraft for biofuel. Some airlines are already flying with biofuel. In the past decade, aircraft are allowed to run with synthetic kerosene. ASTM International, the organization that sets standards on jet fuel, allowed having up to 50 percent of biofuel in jet tanks and by this day we already had around 143 thousand such flights. Yet again, this is an extremely small amount of scheduled flights as only in 2018 there were 39 million of them. There is also another issue being raised – if biofuel will be used, will there be an issue for food growing and using it for fuel rather than feeding people worldwide.

The most interesting suggestion is to use electricity instead of fuel. This solution is yet to be developed and is not used commonly at the moment. Only several test flight were done and most of them were on extremely small aircraft. Of course, using renewables are very appealing but the result at the moment is not satisfactory at all.

What else can be done?

It is really hard to say, what could be the universal truth for this rising issue. The development of new technologies will eventually serve to the purpose but at this time, it is best to adapt the older fleet to timely standards. The best way to do so is by upgrading the aircraft with spare parts that would help to minimize the consumption of jet fuel even in theoretical level. The reason behind this is that the fleet are not changing fast enough to be up to date with environmental standards and maybe even the smallest adaptations of the aircraft or its engines, while working hand-in-hand with manufacturers and standardization organizations would benefit to the cause.

“We understand that aviation industry is changing very slowly. It is enormous and even the slightest changes to the aircraft means a lot of finance. However, we must be flexible and responsible. There are many various regulations and new standards being developed every day. Even the smallest changes in the aircraft, physical or IT solutions, might change the efficiency of the aircraft and every player in the market should be willing to make their fleet as green as possible,” says Dainius Meilunas, CEO at Locatory.com, an aviation IT company, primarily acting as an aircraft parts locator.

<https://www.aerotime.aero/paulius.jakutavicius/22692-green-flying-is-it-possible-to-implement>

Jet engines and types of fuel used

According to Hunker, depending on the grade, jet fuel is basically highly refined kerosene. What is kerosene? It is a fuel that has been around for over a thousand years and is today consumed at a worldwide rate of 1.2 million barrels per day. People use it for heating, lighting and cooking. Because they contain the same classes of hydrocarbons, kerosene, jet fuel and diesel are similar products. When it comes to kerosene vs. diesel for your kerosene heater, many people report that either is suitable. They do notice a stronger odor when using diesel, which is due to the fact that it contains a wider variety of hydrocarbons.

In other words, kerosene is more highly refined than diesel, which means it has been processed at a higher temperature to remove more of the volatile compounds. The same difference exists between kerosene and jet fuel, which has been refined at even higher temperatures. The company that regulates petroleum products in India, Indian Oil, identifies jet fuel as **SKF**, which means "**superior kerosene fuel**."

Among the higher standards jet fuel has to meet are those for freezing point, flash point, viscosity, sulfur content and calorific value. In addition, it contains additives to help it burn more cleanly and efficiently as well as to prevent ice formation and corrosion.

Grades of Jet Fuel

- **Jet A**, which is the fuel that was widely used in Europe after World War II, is almost identical to kerosene. Its widespread use on the continent was due to the fact that it was more available than gasoline. Another grade in common use is Jet A-1. Together, these are the fuels used more commonly by commercial airliners.
- **Jet B and JP-4** ("JP" stands for jet propulsion) are mixtures of kerosene (30 percent) and gasoline (70 percent). They include a larger concentration of the light hydrocarbons and naphthas than Jet A, so they weigh less, which is a desirable characteristic for aviation. However, they have lower flash points and are more dangerous to handle. Because they have low freezing points, they are used for military purposes in the far north.

- **JP-5** is also known as high-flash-point kerosene. It is safer to handle than even Jet A and is required for aircraft aboard aircraft carriers as well as for presidential fleet aircraft. Its composition includes approximately 53 percent C₉ to C₁₆ liquid paraffins (hydrocarbons) with the rest made up of cycloparaffins, aromatics and olefins.
- **JP-8** is a 100 percent kerosene blend and is an acceptable substitute for diesel fuel. It is the fuel most widely used for military aircraft, and its use is expected to continue until 2025. Unlike JP-4, which feels like a solvent to the touch, JP-8 feels somewhat thick and oily.

Source: <https://www.hunker.com/12003828/the-differences-between-kerosene-jet-fuel>

Observation

The real issue is not to reduce the number of air travel but rather to look at the technologies use to propel jet engine. However, even if newer technologies are used, there is still the problem of replacing the air planes in use for which by the way efforts are being made to improve fuel efficiency, essentially done by replacing parts of the engine.

Can jet engines function on electricity?

According to The New Scientist, traditional jet engines create thrust by mixing compressed air with fuel and igniting it. The burning mixture expands rapidly and is blasted out of the back of the engine, pushing it forward.

Instead of fuel, plasma jet engines use electricity to generate electromagnetic fields. These compress and excite a gas, such as air or argon, into a plasma – a hot, dense ionised state similar to that inside a fusion reactor or star.

Plasma engines have been stuck in the lab for the past decade or so. And research on them has largely been limited to the idea of propelling satellites once in space.

Berkant Göksel at the Technical University of Berlin and his team now want to fit plasma engines to planes. “We want to develop a system that can operate above an altitude of 30 kilometers where standard jet engines cannot go,” he says. These could even take passengers to the edge of the atmosphere and beyond.

The challenge was to develop an air-breathing plasma propulsion engine that could be used for take-off as well as high-altitude flying.

Plasma jet engines tend to be designed to work in a vacuum or the low pressures found high in the atmosphere, where they would need to carry a gas supply. But now Göksel’s team has tested one that can operate on air at a pressure of one atmosphere (*Journal of Physics Conference Series*, doi.org/b66g). “We are the first to produce fast and powerful plasma jets at ground level,” says Göksel. “These jets of plasma can reach speeds of up to 20 kilometres a second.”

The team used a rapid stream of nanosecond-long electric discharges to fire up the propulsion mixture. A similar technique is used in pulse detonation combustion engines, making them more efficient than standard fuel-powered engines.

It's the first time anyone has applied pulse detonation to plasma thrusters. Jason Cassibry at the University of Alabama in Huntsville is impressed. "It could greatly extend the range of any aircraft and lower the operational cost," he says.

But there are several hurdles to overcome before the technology can propel an actual plane. For a start, the team tested mini thrusters 80 millimeters long, and a commercial airliner would need some 10,000 of them to fly, which makes the current design too complex for aircraft of that size. Göksel's team plans to target smaller planes and airships for now. Between 100 and 1000 thrusters would be enough for a small plane, which the team thinks is feasible.

Read more: <https://www.newscientist.com/article/mg23431264-500-plasma-jet-engines-that-could-take-you-from-the-ground-to-space/#ixzz5zyfSqVY>

Observation: there is thus great expectation but also real challenges.

The use of battery for generating electricity

Battery is relatively heavy but is a real possibility. There are many factors to consider generating the thrust needed. Hybrid technology is another possibility.

Case study: Airbus

A complex hybrid-electric flight demonstrator

The E-Fan X is a complex hybrid-electric aircraft demonstrator. In the test aircraft, one of the four jet engines will be replaced by a 2MW electric motor, which is roughly equivalent to that of 10 medium-sized cars. The electric propulsion unit is powered by a power-generation system and battery. When high power is required—at take-off, for example—the generator and battery supply energy together.

Smarter air travel for all

If the aviation industry is to achieve its goal of a 75% reduction in CO₂ in new aircraft by 2050, future technologies in electric mobility must be accelerated. The E-Fan X should achieve significant fuel savings. Our goal is to mature the technology, performance, safety and reliability, thereby accelerating progress on hybrid-electric technology. We also aim to establish the requirements for future certification of electric-powered commercial aircraft.

Technical specifications

Generator: power generator system

Electrical supply system: 3000V DC electrical distribution

Engine: one of four engines is replaced with an electrical motor

Energy storage: high power battery pack

<https://www.airbus.com/innovation/future-technology/electric-flight/e-fan-x.html#specifications>

Fly Your Ideas Competition: Airbus also has a competition for innovation

At the dawn of a new era in aerospace, with Fly Your Ideas, Airbus offers a unique opportunity for students worldwide to activate their pioneering spirit and innovate for the future. With support from Airbus, teams will tackle global challenges, harnessing the latest digital tools and technologies to create a safer, cleaner, better connected world.

Conclusion

Experimental Aircraft Info provides a comprehensive picture of efforts going on for aircraft hybrid propulsion.

<https://www.experimentalaircraft.info/homebuilt-aircraft/electric-aircraft-engines-2.php>

Hybrid aircrafts:

https://www.bing.com/search?q=hybrid+engine+for+aircraft&form=EDNTHT&mkt=en-us&httpsmsn=1&msnews=1&rec_search=1&plvar=0&refig=c889ee2952cd44fb8247281ae89b69ba&sp=-1&pq=hybrid+engine+for+aircraft&sc=1-26&qsn=&sk=&cvid=c889ee2952cd44fb8247281ae89b69ba

MIT delivers green airplane designs to NASA

<https://thefutureofthings.com/4285-mit-delivers-green-airplane-designs-to-nasa/>

<http://news.mit.edu/2010/nplus3-0517>

Appendix

<https://www.telegraph.co.uk/business/2016/07/31/what-the-green-airplane-of-the-future-could-look-like/>

The following are excerpts, full article available at the link above:

The green airplane of the future will tackle some of aviation's biggest environmental challenges including fuel efficiency, noise and plane washing.

New developments in technology will make it quieter, cleaner and cheaper, allowing it to fly more frequently and burn less fuel.

And it is taking off in Brazil after the Rio 2016 Olympics.

The Embraer E170 is the prototype unveiled by Boeing and its Brazilian manufacturers in the latest phase of its ecoDemonstrator programme to develop sustainable solutions and reduce the environmental impact of air travel.

The aircraft will test five new technologies that could improve performance during 14 to 20 test flights at the end of August.

“As leaders in the sector, Boeing and Embraer have the unique opportunity to invest in tests and in technologies that stimulate the development of aviation,” says John Tracy, chief technology officer for Boeing.

Among the advances is the use of Brazilian biofuel, comprising 10pc bio-kerosene and 90pc fossil kerosene. All test flights will use the eco-friendly substitute.

“Many airlines around the world use biofuels fuels on regularly scheduled commercial flights. The age of biofuels is already with us,” Dr Tracy says.

“Our job is to make sure that we give them the best products that can create the most value for them and allow them to have the most efficient operations in the world.”

The Boeing vice president said the aviation industry had made an “incredible advance” on fuel efficiency but that fuel remained airlines’ biggest expense, leading to constant demand for improvement.

Studies have suggested that biofuels emit 50pc to 80pc less carbon and the findings from the ecoDemonstrator could help airlines meet new global standards for carbon emissions.

But while both Boeing and Embraer engineers believe they will eventually see planes running on 100pc biofuel, there is no single short-term solution.

“Our work is to make sure there are many options because here in Brazil, sugar cane might be a very good choice but in other places around the world, there might be no sugar cane but maybe there’s some local crop that’s sustainable that doesn’t negatively impact the food or water supply,” Dr Tracy adds.

“The biofuels that we’re developing are what we call ‘drop-in fuels’, and they can be used in existing engines, in existing airplanes.

“We believe that one per cent of aviation fuel can be replaced by biofuel and we’re talking about 10 conversion technologies. As the production volumes go up, we are very confident that the price will be in the right range to allow the airlines to have economically viable, environmentally-friendly solutions.”