Electric flying vehicles

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1 Introduction

Although the electric aircraft are a quite new concept, the first attempts were in 1970s. Since then, considerable advances have been made in order to overcome the environmental impact. The biggest challenge nowadays are still the batteries.

2 History

In the 1970s, experimenting with electric and solar power got a jump start [1]. Between 1967 and 1969, the Austrian Brditschka family created the first prototype. In 1973, the first aerodyne electrically powered aircraft could fly 300m above the ground during 14min. Then in the 80s, two French army officers, carried out a hydrogen powered aircraft with huge batteries (Ronald Berger [2] and Airspacemag [3].)
Even so, between 1974 and 1983 solar energy and energy achieved by pedaling was used satisfactorily. Kremer Prize and David Williams were the pioneers of creating this new way of human to fly.
Then, promoted by NASA, the industry of UAV (unscrewed aerial vehicle or drone) got a huge importance in the society of late 90s and beginning of the 2000s. Among others, the Helios broke records by getting an altitude not achieved until then, 29524m (in 2001).
In the past 15 years several numbers of notable electric flights takeoff have been seen, lasting 20 minutes to several days. Big companies as Airbus (2010) or Boeing (2008) had created their own electric light aircraft and started using lithium-ion batteries.
Although there are only mentioned electric aircraft, electric flying cars are also having great importance and incredible progress.

3 Today's challenges

Nowadays, it is being trying to turn everything into electric in order to reduce pollution, but there is a long path to go to finally achieve the 100 percent electric. One of the main problems is the energy density. The common fuel for the aircraft is kerosene that has an energetic density of $43MJ/kg$ while the energetic density of the Lithium-Ion batteries is only $1MJ/Kg$ [4]

One of the main flying factor is the weight of the aircraft. Clearly, if kerosene is used, less volume would be needed than using batteries. An increase in weight needs to increase the lift and so more power is needed. The power formula (after some basic calculations [5]):

$$P = \dot{m} \cdot V$$

$$\dot{m} = \rho \cdot L^2 \cdot V$$

$$P = (2 \cdot M^2 \cdot g^2)/(L^2 \cdot p \cdot V)$$

Where, "M" is the Mass of the aircraft, $\dot{m}$ is the mass-flow, ΔVz is the velocity, "g" is the gravity, "L" is the length of the aircraft, "p" is the density of the air and "V" is the velocity of the aircraft.

The power needed to fly should be minimized. Adding more mass in order to change the energy source to batteries, will increase the power needed. As an illustrative example, if the fuel of a conventional Airbus is substitute into batteries $(0.340kW/Kg)$[5], it will need 31 Tonnes of batteries for a seven hours flight. The average mass of an empty plane is around 12 tonnes what means that it will be needed 3 times the weight of the plane in batteries.

Another point to highlight, is the price of the fuel: The kerosene is around 2.23 per litre, so it would cost 330 to fill up an airplane. $554kWh$ of electricity costs about 0.17dollars per kWh, so it would cost 94 dollars to charge the airplane. Looking it this way batteries are much cheaper.

Likewise, in order to integrate batteries into the aircraft, a need to change the distribution of the batteries, higher voltages, aerodynamic considerations, wiring or new manufacturing techniques. Not only in the aircraft but the logistic also should be changed in order to be able to charge tones of batteries in a short time under any weather conditions.

4 The existing electric flying vehicles

Nowadays we already have some working electric flying vehicles, but the majority of them are only capable to flight short distances, and carry low weights. We have the example of the Alpha Electro [6], a 2-seat electric trainer with an endurance of 1 hour, and a 30 minutes reserve, which has certificates to fly in several countries.

The company H55 [7] has developed the "BRM Aero Energic". As the Alpha electro, it is a 2-seats trainer with a maximum endurance of 90 minutes and an energy cost per 1 hour flight of $US 7.00, incredibly cheap if it is compared with non-electric planes.

Fig. 1 Picture taken from [6]. An Alpha electro during a flight

Small electric flying vehicles are proven to be already working, but large commercial electric aircraft are still a challenge. As the BBC news [4] reported, the company Eviation [8] launched on July 2019 the the world's first commercial all-electric passenger aircraft: Alice. Designed to take 9 passengers at a cruise speed of 240 knots (around 440 km/h) and perform medium-range flights up to about 1500 km. This aircraft is expected to start its service in 2022. This is the largest electric aircraft nowadays and is yet far from a large 200 passengers prototype.

Is it to consider that the batteries are the major limitation for development of this electric devices. The need for a sufficient range to account for a power reserves and the ability to generate a full power on the take off. One important idea is that the batteries that have reached the end of their useful life for an aircraft could be repurposed in a similar manner rather than being discarded.

5 Future

In the next years the aviation sector is expected to have a huge growth [9]. In fact, by 2030s almost 200,000 flights per day are expected to take off and land all over the world. In order to face this change, sustainable solutions are considering. These propulsion systems are the ones in the spotlight: All electric, hybrid electrics and turbo-electric.

What is of interest on this topic is to know if companies are betting on using totally electric systems. It can be seen in the latest news [4], that many start-ups and big companies are involved in promoting the electrical propulsion systems and for it investing a large amount of money. For instance, Airbus, Rolls-Royce's, Siemens and Easy Jet which have a bunch of demonstration projects in development.

One of the most emerging start-ups is Wright Electric, founded in 2016. It is developing an airplane that uses battery energy for 2027. This electric airplane will have 180 seats and 500km of range. In 2018 they have evaluated the electric propulsion system. Big companies, such as Airbus [10] and Boeing, have their own future aircraft.

Other propulsion systems can be seen in development. For instance, there is one created by a Massachusetts Institute's research recently [11]. It is the first aircraft with an ion drive point and has earned comparisons to Wright brothers for its similarity in design. The propulsion system has no moving parts and it consist of thin wires strung horizontally creating a movement of ions between two electrodes (see Figure 2).

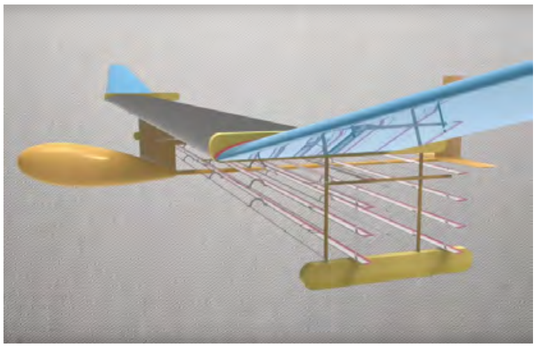

Fig. 2 Picture taken from [11]

At the same time models with jet engines are succeeding too (turbo-electric) based on distributed propulsion technology [5]. An American start-up company, Boom Technology, it is working on a supersonic air travel. Their target is to be able to fly from Los Angeles to Shanghai in 5 hours to be introduced in 2023.

6 Discussion and/or Conclusion

There is no doubt that it is a current and worrying issue. The expected demand of future mobility is increasing that much that something must be done. The problem is that, totally electric flying vehicles do not seem to be the solution to this problem, not at least the only one. Their capacity limitation it is a difficult problem to face. That's why another clean an more efficient alternatives are constantly appearing.

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