The future of fuel cells in civil aircraft?

**Fuel cells** could have several efficiency-enhancing applications in civil aircraft according to new tests in the laboratory and on research aircraft. As well as providing auxiliary and emergency power, the by-products of fuel cells could have useful applications, for example, the water produced could be used for toilets and cooling.

According to the Intergovernmental Panel on Climate Change (IPCC) reports, air transport is currently responsible for about 2 per cent of global CO₂ emissions and this figure will probably rise to 3.5 per cent with increasing air traffic. There is increasing pressure on aircraft manufacturers to improve the efficiency of their aircrafts and lower their environmental impact and in recent years aircraft systems have become increasingly powered by electricity. Fuel cells are an attractive source of this electricity.

The study explored the possible applications for fuel cells in civil aircraft and tested their feasibility. They identified a number of potential functions.

Firstly, a hydrogen-based fuel cell system could replace or enhance the Auxiliary Power Unit (APU), which provides the power for aircraft systems on the ground, most importantly for the main engine start and taxiing. Currently the APU has a low energy efficiency of only 20 per cent and is responsible for a significant amount of nitric oxide and carbon monoxide emissions, as well as noise pollution. A fuel cell system could also perform the role of the emergency power system which generates electricity in the case of engine failure in flight.

Fuel cells could provide some of the power needed for cruising. Currently this is provided by the main engines and the efficiency of the energy supply is estimated to be 30-40 per cent. Fuel cells can reach 50 per cent electrical efficiency i.e. half of the energy content of the hydrogen is converted into electricity and the remaining half is converted into heat. However this does not take into account the energy needed to produce the hydrogen which may bias the comparison between fuel cells and current power supplies on aircraft.

The waste products of fuel cells could play additional roles on aircraft. A fuel cell system for a large aircraft would produce about 50 litres of water per hour, which could be used for toilets and air conditioning, thereby reducing the amount of water that needs to be loaded on the aircraft. Fuel cell exhaust, which consists of oxygen depleted air, could be used to extinguish and prevent fires. This would reduce the need for current emergency systems which require carrying nitrogen tanks on board to replace air in partly-empty fuel tanks with inert nitrogen which then prevents the ignition of fuel vapour.

Already a fuel system to produce emergency power has been integrated into a research aircraft and has proved robust in all tests. A fuel cell system has also been tested in a high-tech motor glider aircraft in which it provided 25 kW of electrical power. It was the world’s first piloted aircraft capable of taking off using only power from fuel cells and operated in a straight line at an electrical efficiency level of 52 per cent.

However, other potential functions identified in the study have not yet been tested in ‘real-life’ situations. The researchers plan to test the multiple functions of fuel cells on-board, for example, their ability to provide some power at the same time as delivering water and oxygen depleted air for on-board functions. For this the researchers are developing a flexible aircraft platform in which the different components can be changed and tested. They will also test the performance of a fuel cell in delivering the power for taxiing on the ground.


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