21 - Transatlantic Hydrogen Seagoing Aircraft

Humankind must manage their resources more responsibly to assure the survival of future generations. With the ever-increasing amount of flights, aviation plays a significant role in achieving a sustainable future. This role cannot be fulfilled by the prevalent strategy of only improving the efficiency of conventional engines. Therefore, the proposed Design Synthesis Exercise (DSE) was to develop a zero-emission, 10000 km range, 500 passengers and 500 km/h, hydrogen powered blend of seaplane and airship. This concept was found to be impossible, due to its enormous size, thus the DSE was reformulated to achieving competitive zero-emission transatlantic flight having relative freedom to optimize for the number of passengers and cruise speed.

Mission Objective

The mission objective is to provide a sustainable, transatlantic air travel alternative to present-day civil aviation, competitive in payload capacity, travel time, ticket price, safety and reliability.

System Design

An exploration of the feasibility of a fast hydrogen sea-going airship was carried out, comparing different compression ratios of the gaseous hydrogen and also liquid hydrogen. The conclusion of this investigation was that cryogenic liquid hydrogen is the best option, due to the extremely large volume that storing the hydrogen in a gaseous state would require. This volume creates such large drag that the hydrogen propulsion is not viable and achieving the required velocities is economically unfeasible.

The final concept is therefore a cryogenic liquid green-hydrogen aircraft that is optimized to be economically competitive with current transatlantic flight. Its range is 8,000 km and the cruise speed is 720 km/h, while carrying 1,500 passengers at a cruise altitude of 4 km. It is powered using hydrogen fuel cells, which generate the electricity required by all systems of the aircraft. The water vapour created is liquefied and mostly expelled to the atmosphere, making it greenhouse gas emission-free. Furthermore, highly reliable tanks and refueling systems will be used to avoid harmful hydrogen leakage. The aircraft is propelled by a series of fans that are placed on top of the wing and are powered by electric motors.

The main dimensions of the aircraft compared to the Airbus A380, the world's largest passenger airliner, are a length of about 1.4 times the A380, about 1.5 times its wingspan and about twice its maximum take-off weight.

Due to the large size of the aircraft, sea-based operations are required. Already existing ports will be used as bases for the seaport infrastructure. The aircraft will use its fan propulsion for taxiing on water and docking. To ensure stability and maneuverability on water the bottom of the aircraft will be based on a standard NACA TN 2481 hull.

Estimating that 25% of the market share would be occupied by this aircraft and a ticket price of a flight being $600 makes it competitive with current standards. The aircraft is not only appealing for airlines due to its profitability, but also due to the added value brought by its sustainable nature.

The Aircraft is a step forward in achieving long-range, zero-emission aviation, allowing airlines and passengers to play a larger role in the green energy transition. As a group, we hope that this project contributes to the survival of future generations and opens a door to pursue innovative green aviation alternatives.