DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

Fuselage Tank Location Trade-Off for Passenger Aircraft Powered with Liquid Hydrogen

Task for a *Master Thesis*

Background

It seems to be advantageous, to store Liquid Hydrogen (LH2) in future passenger aircraft in the fuselage and to make the fuselage longer according to the required fuel volume. Two solutions are possible: 1.) a balanced aircraft configuration with one tank in the back of the fuselage and on tank aft of the cockpit, 2.) a less well balanced aircraft configuration (page 6) with two tanks (for redundancy) both in the back of the fuselage . In solution 1.) the integration of the forward tank outside of the pressure cabin (for safety reasons, due to possible hydrogen leakage into the cabin) is difficult. A discussion has been presented in a paper titled Assessment of Hydrogen Transport Aircraft. The paper seems to include the forward tank in the pressurized cabin, which may not be acceptable for safety reasons (see above). Furthermore, the larger CG shift and the larger horizontal tail size (for both tanks aft) is just quoted from a design tool, without going into any detail. Interestingly, the paper points in the Conclusions to the problem of landing gear integration with tanks aft. This seems to be very important to be investigated further. If requirements are held up not to have hydrogen tanks in the cabin (within the pressure seals), hydrogen aircraft may face (one way or another) more penalties compared to kerosene aircraft than apparent at first glance.

Task

Show how a best solution could be found. Estimate the increase in mass due to additional pressure bulk heads and similar additions related to the baseline. How does this translate to increased fuel consumption? In solution (2) the shift in CG location will be larger. Start with a simple calculation to show the CG shift from full to empty tank expressed in percent MAC. Look at the chapter Empennage Sizing from the Aircraft Design lecture notes. Estimate by what percentage the horizontal tail will be larger on a less well balanced aircraft configuration (2) compared to (1). How does this translate to mass and drag increase (and L/D reduction)? How does this translate to increased fuel consumption? Calculate with an Excel Table. Keep your calculations general, so that it is based on a set of input parameters. What is the better solution (1) or (2)?

The subtasks of your thesis are:

- Review the State of the Art in hydrogen passenger aircraft design with respect to fuselage tank layout proposals.
- Collect elements from conceptual aircraft design to build your methodology.
- Describe your Excel tool.
- Evaluate the tank layout solutions (1) and (2) as explained above and show which solution is superior.

The report has to be written in English based on German or international standards on report writing.