Contribution of conformal antennas towards sustainable aircraft

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ABSTRACT

The protection of the environment and reduction of the footprint of the air transport is very important task nowadays. Growing air traffic also significantly contributes to the emissions and noise, which is increasingly important in particular in the vicinity of busy airfields. Very important message which has been declared by politicians is about 2% reduction in fuel consumption (and thus reducing CO and NOx emissions) for aviation by 2021, and then by 2% per year until 2050 [1]. Many procedures and new technologies have to be applied to achieve this ambitious goal. Among other, replacing of the protruding communication antennas by integrated one with the aircraft surface, can be used to fulfil the defined requirements [2, 3]. The structurally integrated antennas cause less additional drag, noise and turbulence in comparison with classical protruding antennas. It also reduces the maintenance costs and operational delays avoiding collisions of protruding parts by collisions with airport cargo vehicles. The European project ACASIAS [4] addresses, among others, the topic of integrated antennas and their effect on aerodynamic performances and environment. The VHF antennas can be integrated into the fuselage panels or winglet’s surface [3]. This paper is focusing on the evaluation of the aerodynamic effect of the integrated antenna with the aircraft fuselage and its influence on the weight and additional fuel needs.

The effect of the antennas inside the radome in different locations along the upper part of the fuselage has been evaluated by CFD method on two aircraft scales. The NASA Common Research Model (CRM) [5], representing a modern wide body airliner, and a smaller Fokker 100 have been used during this study. CRM is based on a transonic transport configuration designed to fly at a cruise Mach number, M=0.85 at design lift coefficient CL=0.5. It consists of wing, body, nacelles, pylon and tail. This configuration was selected because of it is close to the real configuration of airliners. Fokker 100 aircraft represents medium-sized, short-range aircraft. Two types of radome’s shape were calculated, Panasonic and new GoGo-Ku, respectively. The new GoGo-Ku radome is better from the drag point of view in comparison with the Panasonic one. The results of drag increment of CRM have been compared with baseline configuration without radome. From the results it is evident that the best location of the radome is in the rear part of the fuselage. On the other hand, the overwing location of the radome is the worst from the same perspective. The drag increment is from 0.07% (for the best location) to 0.76% (corresponding to the overwing location). The aerodynamic drag penalty and additional weight of fuel needed due to the drag of the radome have been calculated be means of two approaches. The first one is based on the constant value of the gliding ratio during the flight. This method corresponds to the aerodynamic part of the penalty only. The second method is based on calculation of the additional fuel needed to carry the radome itself and due to the snow ball effect also some more fuel to carry the additional fuel. This method takes into account the flight profile and the ratios between particular parts of the flight, namely take-off, cruise, approach and landing, more

precisely. The weight penalty is from 160kg to 1 700kg, corresponding to the rear and overwing location, repsectively. The values of the drag increment caused by the presence of the radome will be used for further evaluation of the CO2 and NOx emissions.

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