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Experimental study of ethanol use in airplane engines

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This work evaluates and quantifies the environmental impact from the use of aviation gasoline blended with ethanol in aeronautical internal combustion engines. For this, a Lycoming IO-540-K1D5 engine has been used, working with different blends in order to measure performance characteristics and pollutant emissions of the system. The ecological efficiency concept is applied to evaluate the environmental impact by CO_2, SO_2, NO_x and Particulate Material (PM) emissions considering the influence of fuel conversion efficiency and different flight conditions. The tested flight conditions were takeoff and cruise at 10,000 ft. considering the measured thermal efficiency in each case, on the takeoff condition, the engine presents an ecological efficiency of 0.858 for gasoline and 0.914 for ethanol, and on the cruise condition, and the engine presents an ecological efficiency of 0.842 for gasoline and 0.924 for ethanol.

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A model for aero-elastic optimization of forward-swept composite wings

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Forward-swept wings can have some aerodynamic and stability advantageous over the back-swept wings. In addition, the rearward location of the main spar would lead to a more efficient interior arrangement with more usable space inside the passenger cabin. However, the large structural weights required to preclude aero-elastic divergence of forward-swept wings are unfavorable when compared to similar swept back designs. Thus, proper aero-elastic tailoring is necessary to lessen the severity of the aero-elastic divergence problem of such wing configuration. This research paper presents a model for aero-elastic optimization of an idealized, composite, swept, plate wing with high aspect ratio. The major aim is to enhance the wing aero-elastic performance and broaden its stability boundary without mass penalty. The objective function is measured by maximization of the critical flight speed at which wing divergence occurs, while maintaining the total structural mass at a constant value equals to that of a known baseline design. Variables include the fiber volume fraction, ply thickness and fiber orientation angle. The pre-assigned aerodynamic parameters that are not subject to change during the optimization process are chosen to be the wing projected area, aspect ratio, thickness and chord taper ratios. The optimization problem has been formulated as a nonlinear mathematical programming problem solved by invoking the MATLab optimization Toolbox routines, which implements the sequential quadratic programming method. Based on the analytical study by Terrence A Weisshaar, a simple plate-beam model has been derived and implemented for determining the elastic deformation of the wing structure and the modified strip theory for calculating the aerodynamic loads that arise from these deformations. This representation, together with classical lamination theory, allows the solution of the wing divergence problem using the exact governing differential equations and the transfer matrix method. Adequate scaling and normalization of the various parameters and variables are given in order to make the model valid for a variety of wing configurations and types of material of construction. A case study, including the optimization of a plate wing made of carbon-AS4/epoxy-3501-6 composites is presented, where trends for good designs having expanded aeroelastic stability boundary under the imposed mass constraint are discussed. Results have shown that the approach implemented in this work can be efficient in producing improved designs in a reasonable computer time. Actually, the proposed model has succeeded in arriving at the optimum solutions showing significant improvements in the needed design goal as compared with a reference or baseline design of the wing.

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