Numerical Investigation of Active Flow Blowing on a Wing with Conventional and Non-Conventional Flaps

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Introduction
This study investigated the time-dependent effects of active trailing edge blowing over airfoils with deflected flaps. Active Trailing Edge (TE) blowing is an Active Flow Control (AFC) technique consisting of ejecting high velocity flow over the aft section of an airfoil. The TE of an airfoil usually contains a high-lift device called a flap which can move dynamically and is most often used in aircraft take-off and landing. Computational Fluid Dynamics (CFD) is utilized to investigate the effects of Active blowing on the deflected flaps, through generation of velocity contours, separation location, and vorticity identification. This work is to be published, along with PIV results, in AIAA SciTech 2021 conference [1].

Conceptual Framework
TE blowing has two benefits: a decrease in drag and an increase in lift, though these do occur most effectively at different regimes. This study focused on both regimes using a NACA 0012 planform with two types of flaps: the conventional flap and the Dual Radius Flaps (DRF) and utilized commercial CFD software ANSYS FLUENT to solve the flow over the body generating velocity contours, separation locations, and vorticity generation. DRF flaps feature a curved top surface, the curvature is obtained from two arcs with differing radii. DRF flaps are followed by a number which connotates the ratio between the second and first radii, further information can be found in Kanistras et al. [2] DRF flaps were augmented in accordance with Kanistras et al. [2], chord values were also changed accordingly. The computational domain (Fig.1) is entirely structured and features a y+<1 on all surfaces except of the injector lip. Turbulence was modeled with K-ω SST Transition over the computational domain in Fig. 1.

Key Findings/Results
Several sets of data were compiled, and velocity contours generated. Over 100 sets of data have currently been generated and the most significant results are shown in Figures 2, 3, and 5. These represent 3 different flap types at blowing and non-blowing cases. The different flap types are conventional flap and DRF 2 and DRF 10, here the numeral depicts the ratio between the second and first radii. The induced blowing reattaches the flow and eliminates the trailing edge vortices.

Impact
TE blowing can significantly reduce take-off and landing time which reduces the necessary length of runways like those on aircraft carriers and reduces the noise of aircraft in urban areas. The other mode of TE blowing has the capability of making aircraft more efficient, ‘greener’, aircraft possibly allowing for electric aircraft, but this has not been accessed.

References

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