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Title

Optimized Active Flow Separation Control in the Slat-cut Region Using Low Duty Cycle Pulsed Jets.

Authors

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Abstract

The design of UHBR (Ultra High Bypass Ratio) engines require a leading-edge slat cut-out to maintain a clearance between the nacelle and the ground. During the take-off and landing, when the slats are expanded, the lift force is undermined not only by the missing slat and the geometry changes in the cut-out area, but it is noticeably affected by a local separation observed backward the cut-out at high angles of attack. The effect of an active flow control (AFC) by pulsed jets on a separated flow developed at high angle of attack of a DLR-F15 Wing model is investigated experimentally in a wind tunnel and numerically simulated using ANSYS FLUENT. A swept wing model of a chord of 0.34 m and length of 3.33 chords, in a landing configuration, is considered. A built-in Pulsed Jet Actuator (PJA) module enables 88 nozzles controlled by solenoid valves embedded in the wing model to control the flow separation. The PJA module is designed to control each valves independently in duty cycle, frequency and starting time relative to the first valve. Oil visualizations as well as force measurements and pressure distribution are conducted to examine the effect of the AFC on the separation developed at high angle of attack of the wing model. It is shown that the lift coefficient is governed mainly by the dimensionless frequency F^+ of the pulsing, the pulsing duty cycle *DC* and the velocity ratio *Vr*. The impact of the momentum coefficient C_μ on the lift improvement is examined. It is observed that at low angle of attack, in the linear region of the lift curve, the lift coefficient increases with the momentum coefficient C_μ for angle of attack $\alpha < 8°$. However, at maximum lift coefficient Cl_{max}, the AFC by pulsed jets shows a dramatic increase of the lift. It is found that reducing the duty cycle and the frequency F^+ of the pulses are remarkably improving the lift coefficient. In addition, the effect of the momentum coefficient C_μ on the stall angle is analyzed.

References

[1] Schloesser, P, Soudakov, V., Bauer, M., and Wild, J. "Active Separation Control at the Pylon-Wing Junction of a Real-Scale Model." *AIAA Journal*, 2018, pp. 1–10. https://doi.org/10.2514/1.J057345.
[2] Stalewski, W., and Stryczniewicz, W. "Computational and Experimental Studies on Flow-Separation Control via Blowing-Suction Devices." *2018 Flow Control Conference*, 2018. https://doi.org/10.2514/6.2018-3687.
[3] Ben Steinfurth, Julien Weiss "Efficiency Enhancement in Active Separation Control Through Optimizing the Duty Cycle of Pulsed Jets" *AIAA Journal*, Vol. 60, No. 12, 2022, pp. 6566-6580. https://arc.aiaa.org/doi/full/10.2514/1.J061667.