Countering Aerodynamic Flow Separation: Tangentially Blowing across Wing Surfaces by Nozzle-Jet Activations to Delay Flow Separation and Improve Airflow Laminarity

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Steady airflow is essential for sound aerodynamic flight and stability. Separations in airflow around the wing destabilize the flow continuum and result in turbulent flow. Countering turbulence from an aerodynamic standpoint benefits the overall efficiency of flight. Approaching the goal of increased flow-quality is the standard goal throughout experimentation. The crux of this project is to study and counter the un-ideal flow separations at high angles of attack, and provide qualitative articulations with our hypothesis. This project first closely studied the flow-separation system over a test wing section under wind tunnel testing conditions. Later, we modelled a nozzle-jet which tangentially blew over the surface to counter scenarios which ‘desolidify’ the boundary layer. We first observed scenarios where the separation of aerodynamic steady flow was visible in the vicinity of the effective chord length of the airfoil: the scenario which destablises the continuum on the top of the wing. This scenario was controlled using a common NACA 2412 airfoil, and wind tunnel testing – the countering mechanism for the separation was activated under the same control parameters to test the effectiveness of the module. We captured images of the opaque gas stream (created by injecting a visualiser in the test section of the wind tunnel) of the high angle of attack conditions: with and without the tangential blowing. We compared the two fluid distribution images using computational software and found that the tangential blowing removed the turbulent swirl and eddy formation. i.e. the fluid flow particles were turbulently spaced at high angle of attack situations without the synthetic jet activated. However, it was more laminar when the tangential blowing jet was activated.

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