Increasing Aerofoil Lift via Artificial Amplification of the Coanda Effect Using Heat

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The Coanda Effect is the tendency of fluid air molecules to remain attached to a convex surface. This effect is utilized on aerofoils, which rely on the attachment of air across the convex surface to accelerate the upper airflow, creating a pressure imbalance between the high-pressure air underneath the wing and the low-pressure air above the wing. However, the upper boundary layer of air (UBL) generally doesn't remain attached for the majority of the aerofoil surface, generally separating from the wing before reaching the trailing edge. Early UBL detachment results in a gap between the upper and lower boundary layers, forcing high/low-pressure air to mix, creating a turbulent flow of vortices behind the wing (drag). This research investigates the impact of a heated aerofoil surface on the attachment of the UBL. By constructing a replica of a NACA-4412 civilian-use aerofoil and wind tunnel, the airflow across a wing surface was captured and compared at 10oC and 45oC. The UBL traveling across the heated surface remained attached 28% further than it did when non-heated. Furthermore, the heated aerofoil saw a 64% reduction in the size of the area of drag behind the trailing edge. The significant reduction in drag was determined via a NACA-4412 drag-coefficient/angle-of-attack/boundary-layer separation model. The increase in UBL attachment at 45oC results in a decrease in drag coefficient from 0.6 to 0.2 (67%), decreasing negative acceleration of the aerofoil, thus requiring less thrust output by aircraft, ultimately minimizing fuel consumption in flight.

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