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INVESTIGATION OF INTERACTIONS BETWEEN SUCTION CHAMBER AND BOUNDARY LAYER OVER SUCTION WALLS USING DIRECT NUMERICAL SIMULATIONS

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For active boundary layer laminarization of commercial aircraft, appropriate suction surfaces have to be designed in order to reduce frictional drag. To investigate interactions between suction chamber, suction surface and boundary layer, Direct Numerical Simulations (DNS) of growing instabilities are carried out. The flow conditions are set according to wind tunnel tests conducted in the DNW-NWB subsonic wind tunnel in Braunschweig, Germany. The unsteady two-dimensional simulations cover a domain of the suction chamber, the porous surface with discrete slots in spanwise direction and the boundary layer. For these computations, the DLR flow solver FLOWer is used. It is a block structured code and used in its 4th order version. By the means of an initial condition, unstable Tollmien-Schlichting waves are introduced to the boundary layer flow and grow temporally during ongoing calculations. The growth rates of disturbances are evaluated in the boundary layer as well as in the suction chamber. In this way, the influences of slot dimensions such as the slot width and the suction sheet thickness are investigated. Besides qualitative observations of the effect, additional variations of the geometry allow the quantification of the acoustic impedance for each slot geometry [1]. A direct correlation is found between the acoustic impedance and additional Tollmien-Schlichting wave growth in unstable boundary layers. This holds for all geometries and all investigated boundary layer profiles, including a natural boundary layer and two cases with suction. All evaluated impedance values and growth rates coincide on a single curve. These findings can be used as a basis for modifications of Linear Stability Theory methods for transition prediction of suction walls at given porous properties by implementing an impedance boundary condition at porous surfaces.

REFERENCES

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