Numerical Prediction of the Impact of Non-Uniform Leading Edge Coatings On the Aerodynamic Performance of Compressor Airfoils.

Michael E. Elmstrom

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A computational fluid dynamic (CFD) investigation is presented that provides predictions of the aerodynamic impact of uniform and non-uniform coatings applied to the leading edge of a compressor airfoil in a cascade. Using a NACA 65(12)10 airfoil, coating profiles of varying leading edge non-uniformity were added. This non-uniformity is typical of that expected due to fluid being drawn away from the leading edge during the coating process. The CFD code, RVCQ3D, is a steady, quasi-three-dimensional Reynolds Averaged Navier-Stokes (RANS) solver. A k-omega turbulence model was used for the Reynolds' Stress closure. The code predicted that these changes in leading edge shape can lead to alternating pressure gradients in the first few percent of chord that create small separation bubbles and possibly early transition to turbulence. The change in total pressure loss and trailing edge deviation are presented as a function of the coating non-uniformity parameter. Results are presented for six leading edge profiles over a range of incidences and inlet Mach numbers from 0.6 to 0.8. Reynolds number was 600,000 and free-stream turbulence was 6%. A two-dimensional map is provided that shows the allowable degree of coating non-uniformity as a function of incidence and inlet Mach number.

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