عنوان مقاله:

Effect of aging and manufacturing tolerances on multi-stage transonic axial compressor performance

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خلاصه مقاله:

The Axial compressor is an integrated part of a gas turbine. The central part of compressors is its blades. Blade aerodynamic has a significant effect on compressor performance. Because of the adverse pressure gradient in the compressor, any deviation in the blade profile has a significant influence on the flow field as well as the compressor performance. During the manufacturing and operation of a compressor, the blade profile may deviate from the nominal design. This deviation may happen within the manufacturing process, e.g., changing in stagger angle of the blade, changing in the maximum thickness of the blade profile or may occur in an operation process, e.g., increasing the blade surface roughness. By the way, these deviations affect the compressor performance. In this research, a numerical investigation is carried out to understand better the effects of geometry variability of the blades, including maximum thickness, blade surface roughness, and rotor blades stagger angle on the Transonic Axial compressor performance parameters, including the efficiency and pressure ratio. A CFD code, which solves the Reynolds-averaged Navier–Stokes equations, is employed to simulate the complicated 3D flow field of the axial compressor. The code is validated against experimental data for the axial compressor. The numerical result is in good agreement with the test dataand error at the design point for the efficiency was computed to be 0.3%, which shows high accuracy of the numerical method. Then, the effect of geometry variability on the axial compressor blade performance parameters is studied. Results show that increase in the surface roughness, blade thickness, and the rotor blades twist lowers the efficiency, pressure ratio and mass flow significantly in the compressor. Results show with a 10% increase of the blade installation angle at the design point, the mass flow rate decreases 1.93%, and the efficiency and pressure ratio decreases 0.35% and 1.8%, respectively. The blade surface roughness reduces the mass flow rate, total pressure ratio and efficiency of the compressor. The results show that imposing the roughness at the design point of the compressor, mass flow rate and efficiency is reduced 1.8% and 2.75 %, respectively. Meridional view of this compressor is shown in figure 1 in which the blade profiles for the first to fourth stages are DCA type [1].

کلمات کلیدی:

Transonic Axial Compressor, numerical simulation, Roughness, performance map, Stagger Angle, Efficiency, Twist