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Introduction of a Novel Parameter Model to Analyze the Geometric Variation of Airfoil Edges of Ex-In-Service Compressor Airfoils

Paul Voigt,
Matthias Voigt, Ronald Mailach
Technische Universität Dresden
Institute of Fluid Mechanics
Chair of Turbomachinery and Flight Propulsion
D-01062 Dresden, Germany
Email: paul.voigt@tu-dresden.de

Kimon Abu-Taa, Mirco Rostamian
Rolls-Royce Deutschland Ltd & Co KG
D-15827 Blankenfelde-Mahlow, Germany

The leading and trailing edge shapes of high pressure compressor (HPC) airfoils have a high impact on their aerodynamic performance. Typically, the shape of these airfoil edges are designed symmetrically as half circles or half ellipses. Due to manufacturing scatter and operational effects, the edges of real HPC airfoils deviate from the design intent. Especially the change in shape of the airfoil edges due to erosion can lead to a reduction of the aerodynamic efficiency and operability range.

This paper introduces a novel and intuitive parametrization approach to describe the occurring airfoil edge shapes. The introduced parametric model has been applied to a set of ex-in-service airfoils with a variety of airfoil edge shapes. For this purpose, just above 1000 of used HPC airfoils from different engines with different operational conditions and runtimes were digitized by means of a structured light 3D scanner. The high precision of the scanning system enables accurate capturing of the sensitive airfoil edge shapes.

Subsequently, the extracted parameters were used for a statistical evaluation of the leading edge shape geometry. The introduced parametric model is the basis of a prospective evaluation of the correlation between the geometric variation of airfoil edges and manufacturing scatter as well as engine operational condition.

Keywords: compressor airfoil wear, erosion, leading edge shape parametrization