

Sensitivity Study on Aerodynamic Forcing Prediction in a Highly-Loaded Axial Turbine Stage

Authors: Müller T.R., Vogt D.M.

Affiliation: Institut für Thermische Strömungsmaschinen Uni Stuttgart, Germany

Keywords: aerodynamic forcing, unsteady convergence, scaling, rotor-stator interaction

Summary:

The prevention of aeromechanical problems is an important task in the design process of turbomachines. The interaction between the structure and the surrounding fluid flow can lead to forced vibrations and failures due to High-Cycle Fatigue (HCF). Therefore, a reliable prediction of the aerodynamic forcing is of great importance for all subsequent aeromechanical investigations.

The presented sensitivity study investigates a highly-loaded transonic axial turbine stage. A scaling technique has been applied to modify the stator geometry in order to achieve an integer stator-rotor blade count in an annulus section of the turbine stage. This modification enables a reduction of the numerical effort, while maintaining aerodynamic similarity. A FFT-analysis of the aerodynamic forcing on the rotor has been performed. The aerodynamic forcing on the rotor is mainly dependent on the rotor-stator interaction. Thus, the amplitude of the aerodynamic excitation force at the blade-passing frequency (BPF) has been used as a criterion for the evaluation of the unsteady convergence of the performed transient simulations. The sensitivity of the predicted aerodynamic forcing on the rotor to several important factors such as mesh size, time resolution, transient iteration loops and the applied turbulence model have been investigated within this study and will be discussed.