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Computational Analysis of the Scaling Effects on the Performance of an Axial Compressor

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Abstract : The miniaturization of gas turbines promises many advantages. Miniature gas turbines can be used for local power generation or the propulsion of small aircraft, such as UAV and MAV. However, experience shows that the miniaturization of conventional gas turbines, which are optimized at their current large size, leads to a substantial loss of efficiency and performance at smaller scales. This may be due to a number of factors, such as the Reynolds-number effect, the increased heat transfer, and manufacturing tolerances. In the present work, we focus on computational investigations of the Reynolds number effect and the wall heat transfer on the performance of axial compressor during its size change. The NASA stage 35 compressors are selected as the configuration in this study and Computational Fluid Dynamics (CFD) is used to carry out the miniaturization process and simulations. We perform parameter studies on the effect of Reynolds number and wall thermal conditions. Our results indicate a decrease of efficiency, if the compressor is miniaturized based on its original geometry due to the increase of viscous effects. The increased heat transfer through wall has only a small effect and will actually benefit compressor performance based on our study.

Keywords : axial compressor, CFD, heat transfer, miniature gas turbines, Reynolds number
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