Journal of turbomachinery

Optimization of nonaxisymmetric endwall contours for the rotor of a low speed, 1½ -stage research turbine with unshrouded blades—optimization and experimental validation

Snedden, Glen
Council for Scientific and Industrial Research
Pretoria, 0001, South Africa
Email: gsnedden@csir.co.za

Abstract

This paper presents the predicted, as well as final experimental results for the design of an automatically optimized non-axisymmetric endwall and as such, attempts to close the loop between design and practice, providing additional information to other groups involved in the design of endwall contours. The contours designed in this investigation were manufactured using the direct laser sintering rapid prototyping method and installed and tested in the low-speed, 112-stage turbine at the CSIR's test turbine facility (TTF) in Pretoria, South Africa. Steady-state 5-hole pressure probe traverses were used to characterize the performance and flow profiles upstream, immediately downstream and in a quasi-"mixed-out" sense downstream of the rotor. In addition to the datum (annular) case, both the computed as well as experimental results were compared to the corresponding results generated for a "generically" contoured rotor which was originally designed for a linear cascade test case, but one which used the same blade profile to the current case. The results show that in general both sets of contours performed well, although the added emphasis on flow correction for the contours produced in this investigation resulted in slightly worse performance in terms of loss at the rotor exit (X3) but greatly improved performance in terms of the efficiency and flow angles at the "mixed-out" (X4) measurement plane.