

Study of the Effect of the Contra-Rotating Component on the Performance of the Centrifugal Compressor

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Abstract : This article presents a study of the effect of a contra-rotating component on the efficiency of centrifugal compressors. A contra-rotating centrifugal compressor (CRCC) is constructed using two independent rotors, rotating in the opposite direction and replacing the single rotor of a conventional centrifugal compressor (REF). To respect the geometrical parameters of the REF one, two rotors of the CRCC are designed, based on a single rotor geometry, using the hub and shroud length ratio parameter of the meridional contour. Firstly, the first rotor is designed by choosing a value of length ratio. Then, the second rotor is calculated to be adapted to the fluid flow of the first rotor according aerodynamics principles. In this study, four values of length ratios 0.3, 0.4, 0.5, and 0.6 are used to create four configurations CF1, CF2, CF3, and CF4 respectively. For comparison purpose, the circumferential velocity at the outlet of the REF and the CRCC are preserved, which means that the single rotor of the REF and the second rotor of the CRCC rotate with the same speed of 16000rpm. The speed of the first rotor in this case is chosen to be equal to the speed of the second rotor. The CFD simulation is conducted to compare the performance of the CRCC and the REF with the same boundary conditions. The results show that the configuration with a higher length ratio gives higher pressure rise. However, its efficiency is lower. An investigation over the entire operating range shows that the CF1 is the best configuration in this case. In addition, the CRCC can improve the pressure rise as well as the efficiency by changing the speed of each rotor independently. The results of changing the first rotor speed show with a 130% speed increase, the pressure ratio rises of 8.7% while the efficiency remains stable at the flow rate of the design operating point.

Keywords : centrifugal compressor, contra-rotating, interaction rotor, vacuum

Conference Title : ICTFD 2019 : International Conference on Turbomachinery and Fluid Dynamics

Conference Location : New York, United States

Conference Dates : June 04-05, 2019