Abstract

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Design optimization of a centrifugal compressor vaneless diffuser

Centrifugal compressors are used in many heat pumps and refrigeration systems. Radial vaneless diffuser is a principal component in these compressors. Therefore, the present research aims at improving the centrifugal compressor performance by optimizing the design of the radial vaneless diffuser. Two radial vaneless diffuser geometries were proposed, investigated and numerically optimized. The optimization aimed at minimizing the diffuser loss coefficient and maximizing the pressure coefficient. Simulations were performed by solving the Reynolds averaged Navier–Stokes equation under 2D axisymmetric condition. A genetic optimization algorithm was implemented in order to conclude the optimum diffuser geometry. 2D axisymmetric simulations with air and R134a as working fluids showed that the optimized geometry reduced the diffuser loss coefficient by up to 10% and increased the pressure coefficient by up to 3.8%. Additional 3D simulations with an impeller located before the diffuser were performed. These 3D simulations showed that the optimized diffuser geometry reduced the diffuser loss coefficient by up to 4.7% and increased the pressure coefficient by up to 6.6% under jet-wake and swirl flow conditions.