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Effect of Volute Tongue Shape and Position on Performance of Turbo Machinery Compressor

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Abstract : This paper proposes a numerical study of volute tongue design, which affects the centrifugal compressor operating range and pressure recovery. Increased efficiency has been the traditional importance of compressor design. However, the increased operating range has become important in an age of ever-increasing productivity and energy costs in the turbomachinery industry. Efficiency and overall operating range are the two most important parameters studied to evaluate the aerodynamic performance of centrifugal compressor. Volute is one of the components that have significant effect on these two parameters. Choice of volute tongue geometry has major role in compressor performance, also affects performance map. The author evaluates the trade-off on using pull-back tongue geometry on centrifugal compressor performance. In present paper, three different tongue positions and shapes are discussed. These designs are compared in terms of pressure recovery coefficient, pressure loss coefficient, and stable operating range. The detailed flow structures for various volute geometries and pull back angle near tongue are studied extensively to explore the fluid behavior. The viscous Navier-Stokes equations are used to simulate the flow inside the volute. The numerical calculations are compared with thermodynamic 1-D calculations. Author concludes that the increment in compression ratio accompanies with more uniform pressure distribution in the modified tongue shape and location, a uniform static pressure around the circumferential which build a more uniform flow in the impeller and diffuser. Also, the blockage at the tongue of the volute was causing circumferentially nonuniformed pressure along the volute. This nonuniformity may lead impeller and diffuser to operate unstably. However, it is not the volute that directly controls the stall.

Keywords : centrifugal compressor volute, tongue geometry, pull-back, compressor performance, flow instability
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