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Vorticity Dynamics in Axial Compressor Flow Diagnosis and Design.[1] JIE-ZHI WU, Institute of Engineering Research, Peking University, Beijing; The University of Tennessee Space Institute, Tullahoma, TN, YAN-TAO YANG, HONG WU, QIU-SHI LI, FENG MAO, SHENG ZHOU, Institute of Engineering Research, Peking University, Beijing — It is well recognized that vorticity and vortical structures appear inevitably in viscous compressor flows and have strong influence on the compressor performance. But conventional analysis and design procedure cannot pinpoint the quantitative contribution of each individual vortical structure to the integrated performance of a compressor, such as the stagnation-pressure ratio and efficiency. We fill this gap by using the so-called derivative-moment transformation which has been successfully applied to external aerodynamics. We show that the compressor performance is mainly controlled by the radial distribution of azimuthal vorticity, of which an optimization in the through-flow design stage leads to a simple Abel equation of the second kind. Solving the equation yields desired circulation distribution that optimizes the blade geometry. The advantage of this new procedure is demonstrated by numerical examples, including the posterior performance check by 3-D Navier-Stokes simulation.

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