Numerical Investigation on Strip Distortion Simulator for Generating Gas Turbine Engine Inlet Flow Distortion Patterns

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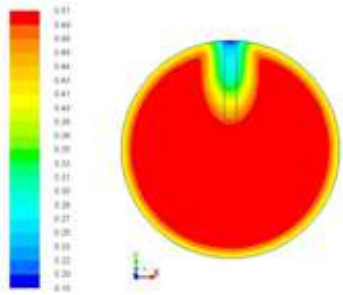
Keywords: Engine Inlet Distortion, Complex Flow Distortion, Flow Superposition, Method to Generate Distortion, Inverse Design

Abstract:

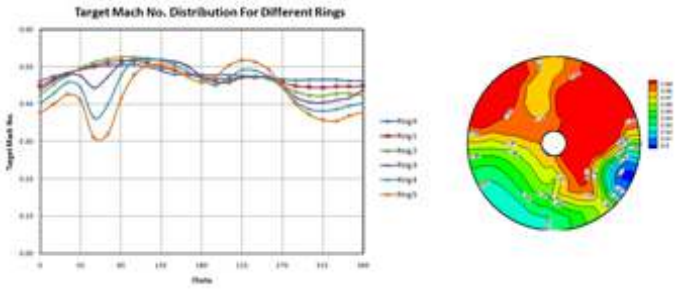
Engine inlet distortion creates great impact on the performance of the aircraft gas turbine engine. Study on the changes in performance of the engine due to distortion flow is essential and it requires a method to develop a distortion pattern so that engines can be tested subjected to this distortion. In the present thesis a methodology has been developed for generating a complex distortion pattern by using strips inserted radially in the flow duct. The strips are arranged in the duct in such a manner as to generate the target distortion pattern in a selected target plane.

The distorted flow field due to the presence of a strip was calculated by solving the Navier-Stokes equations. The distorted flow due to two strips in the target plane was constructed by superposing the solutions in this plane due to the individual strips, since superposition is known to be approximately valid. From the data bank created for distorted flows due to strips of different sizes, the target distorted flow field was constructed using multiple strips of chosen size and further verified by simulating the flow solving the Navier-Stokes equations.

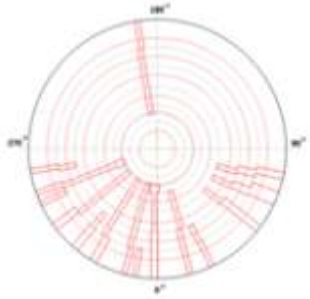
Once the strip arrangement for a target distortion flow is obtained by inverse design using superposition, the flow field is computed and the difference between the target Mach number and the computed distribution was calculated from Distortion Index (DI) and Distortion Coefficient (DC60). As shown in the below figure, DI for the target total pressure distribution is 0.1262 and for computed solution it is 0.1175. Based on DC60, the target distribution calculated is -0.198 and computed solution is -0.239. The difference in two flows as indicated by these two parameters can be further reduced by refining strip width and placing circumferential strips.



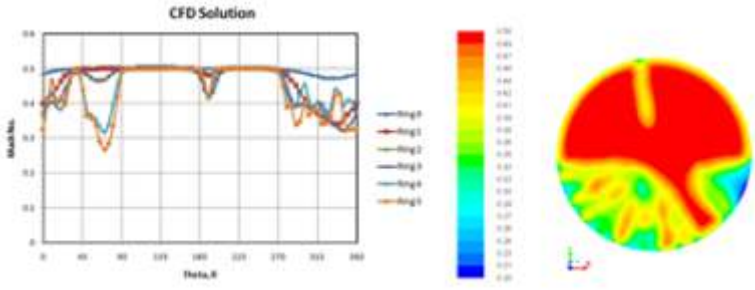
Mach number contours due to a single short strip 1-D upstream



Target Mach number distribution and corresponding normalised total pressure contours



Strip arrangement by superposition arrangement with contours



Computed Mach number distribution for designed strip