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SENSITIVITY ANALYSIS OF SUPERSONIC TURBINE TRAILING EDGES

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Turbine blades operating in transonic-supersonic regime develop a complex shock wave system at the trailing edge, a phenomenon that leads to unfavorable pressure perturbations downstream and can interact with other turbine stages[1]. Colder flow, bled from the high-pressure compressor, is often purged at the trailing edge to cool the thin blade edges, affecting the flow behavior and modulating the intensity and angle of the shock waves system. However, this purge flow can sometimes generate non-symmetrical configurations due to a pressure difference that is provoked by the injected flow[2]. In this work, a combination of RANS simulations and global stability analysis is employed to explain the physical reasons of this flow bifurcation. Stability analysis studies the growth or decay of perturbations superimposed upon a steady base flow, and has proven to be effective in the analysis of similar compressible and turbulent flows configurations[3]. The results of this study identify the physical global mode responsible of the non-symmetrical conditions as a function of the cooling flow purge intensity. The stability analysis results match the bifurcation predicted by RANS simulations, adding extra information about the underlying physical mechanisms. An anti-symmetrical global mode, related to the sudden geometrical expansion of the trailing edge slot, is identified as the main mechanism that forces the changes in the flow topology. Finally, a sensitivity analysis of the dominant global mode allows to identify those regions of the flow where a localized feedback will be more effective on the control of the instability.

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