THE MODELLING OF A MULTI TEST SECTION CLOSED LOOP WIND TUNNEL

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ABSTRACT

The R4 closed-loop compressor rig at the von Karman Institute for Fluid Dynamics (VKI) was recently revamped into a versatile and modular facility featuring multiple test sections. During the initial commissioning of the rig, it was found that the facility could not achieve the target performance, necessitating further investigation. Consequently, a comprehensive thermodynamic model of the facility was developed. The model revealed a previously undocumented self-throttling phenomenon arising from the mixing of different streams within a constant-volume plenum.

This paper presents the developed model, providing a detailed description of its structure, the mathematical formulation adopted for each component, and the underlying assumptions and limitations. The model is then used to illustrate the aforementioned self-throttling phenomenon and to support the corrective measures implemented in the facility. The numerical results are systematically validated against experimental data.

The proposed model represents a valuable tool for the future development and design of closed-loop, multistream test facilities.