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Large-Eddy Simulation of a Turbine Stage with Rim Cavity

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Large-Eddy Simulations (LES) using a compressible, unstructured, finite-volume solver are conducted on a model of a turbine stage including two rotor blades, one nozzle guide vane, a rim seal and a rim cavity. The axial and rotational Reynolds numbers are $Re_\theta=1.3x10^6$ and $Re_x=2.2x10^6$. The mesh consists of 22 million nodes.

The numerical discretisation employs linear reconstructions of the primitive variables based on the Least-Squares approach of Barth [1]. The convective fluxes are approximated with the Riemann solver of Roe and the standard Smagorinsky model is adopted as the subgrid term. The linear reconstruction of the flow variables guarantees a third-order numerical dissipation proportional to the fourth spatial derivative. If the walls are resolved, the numerical dissipation in the near wall region can be an order of magnitude smaller than that associated with the Smagorinsky subgrid scale term [2].

A passive scalar equation is solved to measure the ingestion of annulus gas into the cavity. Validations are carried out against available experimental data and comparisons are made with both URANS models and LES models employing standard low-order schemes.
The analysis confirms that LES can provide a better prediction of gas ingestion through the rim seal, and suggests that the computational requirements needed could be alleviated by using high-order spatial discretisation schemes.

REFERENCES

[1] T. Barth, Recent developments in high order k-exact reconstruction on unstructured meshes. *AIAA Paper*., 93-0668, pp. 1-15, 1993.
[2] D. Amirante and N. Hills, Large-eddy simulations of wall bounded turbulent flows using unstructured linear reconstruction techniques. *ASME GT2014-26119*, 2014.