6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Numerical Simulation of Resonators under Grazing Flow using Block-Structured Cartesian-Mesh CFD

Tsubasa Iwafune*[1], Daisuke Sasaki[2], Hidemi Toh[2], Tatsuya Ishii[3]

[1] Kanazawa Institute of Technology Graduate School, 3-1 Yatsukaho, b1325463@planet.kanazawa-it.ac.jp

[2] Kanazawa Institute of Technology, 3-1 Yatsukaho, dsasaki@neptune.kanazawa-it.ac.jp

[3] Kanazawa Institute of Technology, 7-1 Ogigaoka, htoh@neptune.kanazawa-it.ac.jp

[4] Institute of Aeronautical Technology, 7-44-1 Jindaiji-Higashi, ishii.tatsuya@jaxa.jp

Key Words: *Acoustic liner, Cartesian mesh, Grazing Flow, CFD*

An acoustic liner is applied to engine nacelle to reduce the fan noise of jet engine. The acoustic liner is a panel which is structured with the porous face sheet and a lot of resonators designed based on the Helmholtz resonance. However, the practical performance of sound absorption in flight is difficult to be predicted because the influence of flows to the sound absorption is unclear. The sound absorption correlates with the changes of tiny vortices. It is difficult to observe vortices around resonators in the experiment because the changes of the phenomenon of the resonator are too small. Therefore, "Computational Fluid Dynamics (CFD)" is a promising approach to investigate the flow phenomena. In our past study, simple-shape model of the liner was analysed to understand the fundamental characteristics.

This study investigates the validity of the Block-Structured Cartesian-mesh CFD (BCM) for numerical flow simulation of resonators in Grazing Flow through the comparison with the past results[1] and also the influence of multiple cells to flows. BCM has benefits to reduce numerical viscosity by the orthogonality of the mesh and the employment of higher order accurate scheme. Thus, it is effective way to observe tiny flow phenomenon of complex or real-world shapes[2]. In this study, we analysed single-cell model which has only a resonator for verification and multiple-cell model which has several resonators in a row. The shape of those resonators are set as identical.

In the results, the BCM's results show good agreement with Tam's results. Therefore, BCM is proved to have enough computational accuracy for the case. In addition, the periodic pressure change in single/multiple resonators is visualized. The frequency of that pressure change of single-cell model is different from that frequency of multiple-cell model, although shapes of their cells are same. The frequency of pressure change in the resonator depends on velocity of a flowfield and shape of the resonator. However, the frequency changes due to the interaction of pressure changes of adjacent resonators. It will affect the acoustic absorptivity of the acoustic liner. In addition, the result shows the amplitude of the pressure wave is high enough to cause the self-noise of the acoustic liner.

REFERENCES

[1] C. K. W. Tam, H. Ju, M. G. Jones, Numerical Simulation of a Slit Resonator in a Grazing Flow., 44th AIAA Aeroacoustics Science Meeting and Exhibit, AIAA paper 2006-799, 2006.

[2] D. Sasaki, K. Nakahashi, Rapid Large-Scale Cartesian Meshing for Aerodynamic Computation., 29th Congress of the International Council of the Aeroacoustical Science, ICAS 2014-0842, 2014.