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Numerical simulation of flow past an oscillating rod-airfoil configuration

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Description of the configuration

The rod-airfoil configuration is a good simplification for wake-body interaction noise modelling. Many investigations have been carried out and the flow structures and radiated noise has been reproduced well [2]. However, when the wake-body system encounters a gust or the engine undergoes a surge, the interaction flow structure and the radiated far-field noise characters will be changed. To the knowledge of authors, there are few literatures taking this realistic factor into account.

In our studies, the rod-airfoil are submitted to forced transverse oscillation to imitate the effect of a gust or a surge. The oscillation frequency is close to Strouhal number of flow around a stationary rod-airfoil at the same Reynolds number. We will focus on the flow structure and the far-field noise differences between the oscillation case and the stationary one.

The Improved Delayed Detached Eddy Simulation (IDDES) is used to simulate the flow structure and noise source, and the porous FW-H solver is used to attain the far-field noise. The 5th order WENO interpolation and Roe scheme with an adaptive dissipation factor are employed in the simulation. This configuration is placed in a uniform airflow with Mach number Ma = 0.21 and Reynolds number based on the rod diameter Re = 48000. The simulations are implemented in completely 3D, using the same mesh, where the domains extend over 3.0d in the spanwise direction. The point number of the mesh is about nine millions.

Preliminary results

The preliminary results have been obtained. Firstly, as a validation, results of stationary rod-airfoil configuration is examined. The pressure coefficient and streamwise velocity spectra are well consistent with those of the experiments, as illustrated in **Fig. 1** and **Fig. 2**.

Fig. 3 show that the forced oscillation reorganizes the wake, bring it closer to a lower Reynolds number flow. This flow character has been observed in previous investigation on the oscillating cylinders at low

Reynold number [4]. However, the mechanism is still unclear, especially at high Reynolds number.

Further analysis of the oscillation effect on flow structure and far-field noise will be given in the full script.

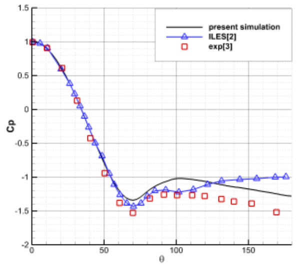

Fig. 1 Comparison of pressure coefficients on rod-surface between present simulation and the existing literatures

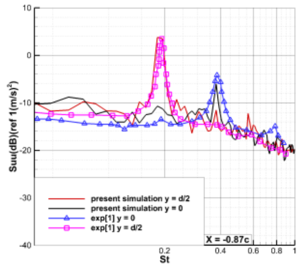

Fig. 2 Comparison of streamwise velocity spectra between present simulation and the experiment.

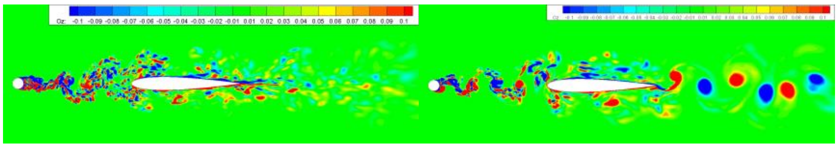

Fig. 3 Comparison of the spanwise vortices between the stationary configuration and oscillating one (left: stationary; right: oscillating

References

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