DEVELOPMENT OF A METHODOLOGY FOR THE NOISE PREDICTION OF A ROTATING OBJECT

László Nagy, Hungary
Supervisors: J. Anthoine, P. Rambaud, J. Christophe

The aim of this study was to develop a methodology for the noise prediction related to the rotation of an object in a pipe. The chosen hybrid method consists of two well separated steps. The unsteady, three-dimensional, incompressible aerodynamic flow field is first computed using the LES module of the FLUENT 6.3. The unsteady pressure fluctuations on the solid surface(s) are extracted from the first step to be post-processed in the acoustic solver SYSNOISE 5.6. This solver computes the noise at a receiver positioned in the far-field through the Curle's analogy.

In the chosen method for rotating in FLUENT an interface is positioned between the fixed part and the rotating part of the mesh which includes the rotating object. To determine the influence of the interface on the flow and acoustic results, computations were made for an empty pipe (without object) with standing wall. Respectively at two different positions were investigated and compared to the reference case which uses fixed mesh (J. Christophe, DC Report 2006). The comparison of these three computations showed that an interface at 99%D_{wall} has a slight influence on the flow field, especially the pressure field near the wall. Further analysis is required to explain that influence. On the other hand, the case with the interface at 50%D_{wall} showed good agreement with the reference case. The acoustic results, obtained from SYSNOISE, showed however that the three configurations provide the same noise level in the far-field, even when the interface is positioned close to the wall although this configuration was not expected to provide correct results from the flow field deviations.

After these computations performed with an empty pipe, a rotating cylinder [10%D_{wall}, 5%D_{wall}, 32%D_{wall}] has been added within the pipe. The flow field has been checked by looking at time averaged quantities within the wake and Q iso-surface of the coherent structures (Figure 1). The acoustic computations showed an increase of the noise level compared to the case without object in the pipe, even though only the wall pressure distribution was exported into SYSNOISE (Figure 2). A Ffowcs-Williams and Hawkings method should be developed to allow computing also the noise from the unsteady pressure on the surface of the rotating object. Without it, the noise propagation is underestimated. A comparison between the FW-H module implemented in FLUENT and SYSNOISE showed that the FLUENT module overestimated the noise prediction at the same far-field position.

As concluding remark, it was proved that, under far-field assumption, the noise level due to the interface is negligible compared to the radiated noise when a rotating object is present inside the duct. This method can then be applied for the determination of the noise level radiated from a ducted fan.

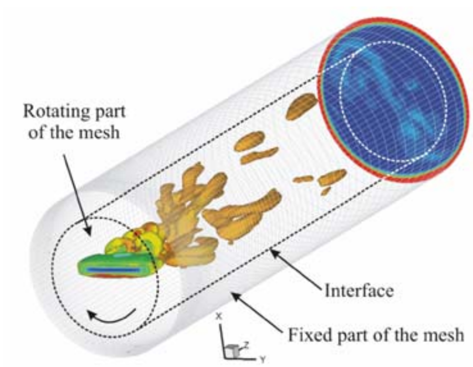

Figure 1: The Q=1500 iso-surface behind the square rod rotating object positioned of 50%L_{pipe} in a pipe

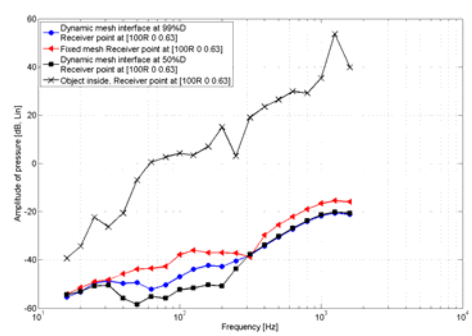

Figure 2: Comparison of noise propagation in far-field using SYSNOISE solver