EXPERIMENTAL INVESTIGATION OF THE EFFECT OF DROPLETS ON COHERENT STRUCTURES OVER A OPEN, RECTANGULAR CAVITY

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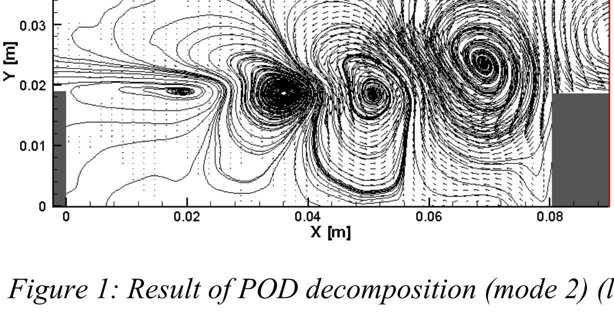
The purpose of the project was the investigation of two-phase flow and to find the effect of droplets on the continuous phase. This work is a continuation of the research started by Antonio De Lauretis (DC project in 2003) with using larger amount of droplets that expectably has a larger effect on the flow than in case of the previously mentioned DC project.

Post-processing of results is always a significant difficulty, thus in the present project a new post-processing method was implemented that is based on Proper Orthogonal Decomposition. With this method the two-phase flow results would have been expected to be analyzed. As POD is a very abstract mathematical decomposition, it was tested on synthetic flow fields to make a link between the modes of the decomposition and the physical phenomena. The tests and conclusions are detailed in the report.

A large database has been created for cavity flow by single phase PIV that consists of 10000 samples for further applications and tests for Re=9000 (based on the cavity depth).
Two-phase flow measurements have been carried out with high amount of droplets in the dispersed phase. The increased number of droplets introduced two new type of errors: the reflection on the surface of droplets increased significantly and the illumination of the tracer particles (seeding) decreased relatively which led to poor quality in PIV processing; the masking procedure to distinguish between the two-phases introduced a bias in the cross-correlation that led to false velocity vectors from PIV processing. The bias due to the presence of masks has been quantified in the report via several test cases.

To avoid the deficiencies of the masking process, two new concepts were proposed: a) Two-filter method at which both the tracer particles and the water droplets are filled by fluorescents that give different wavelengths thus providing the possibility to see them separately by using two different filters; b) Multi-peak method that uses the present configuration but distinguishes between the phases using the cross-correlation map (introduced by the author)

Results of the POD post processing can be seen in Figure 1. The most characteristic vortex shedding phenomena can be observed on mode 2 of the decomposition of flow field via POD with the most characteristic energetic vortex sizes. On the second picture the results of a conditional averaging based on POD can be seen where the convection velocity, the size of the characteristic vortices and the u'v' component of the Reynolds stress tensor can be seen. Bars indicate the rms of the convection velocity in a given location.



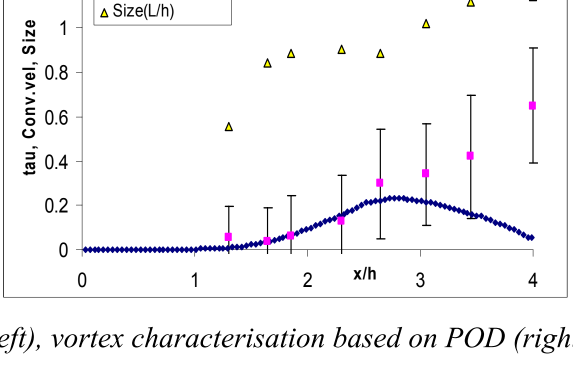


Figure 1: Result of POD decomposition (mode 2) (left), vortex characterisation based on POD (right)