Experimental investigation of Flow-Induced Pulsations in successive deep axisymmetric cavities

J. Golliard[a] et Y. Aurégan[b]
[a]TNO, Stieltjesweg 1, 2628CK Delft, Pays-Bas
[b]LAUM, Université du Maine, Av O Messiaen, 72017 Le Mans Cedex, France
yves.auregan@univ-lemans.fr

CFA2014/347
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Earlier experimental and numerical studies provide insight in Flow-Induced Pulsations (FIPs) in a single shallow axisymmetric cavity in a pipe, and multiple shallow cavities. The focus was on the coupling of the shear-layer instability with plane waves in the pipe. This is representative of so-called "singing risers", the whistling of corrugated flexible pipes used for gas production and gas export from offshore platforms. On the other hand, a number of authors investigated FIPs occurring between flow-instabilities and the three- dimensional acoustic trapped modes in a single deep and/or narrow axisymmetric cavity.
The goal of the present study is to investigate FIPs generated in a large number of successive deep, narrow cavities. A series of 10 successive axi-symmetric cavities is installed in a pipe of inner diameter 30 mm. The upstream end of the pipe is anechoic, while the downstream end is a (unflanged) open to the atmosphere. The cavities are 35 mm deep and 7 mm wide, and are separated by disks of thickness 0.5 mm. A main flow is imposed through the main pipe, with air velocities up to 71 m/s (M~0.21).
Two main peaks of pulsations are observed, at two different frequencies, and at different Strouhal numbers. The first peak occurs around 1440 Hz, and is maximum for a Strouhal number of 0.42. The second peak occurs around 2400 Hz, with a maximum around a Strouhal number of 0.28. The first peak has an amplitude an order lower than the second leak. A preliminary analysis of the experimental data indicates that the first peak is most probably due to a plane-wave resonance in the main cavity. The second peak seems to be due to coupling with circumferential modes present in the successive cavities. The circumferential modes present modes shapes similar to Parker's modes, with alternated phase in successive cavities.