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Technical Comments

Brief discussion of previous investigations in the aerospace sciences and technical comments on papers published in the Journal of Aircraft *are presented in this special department. Entries must be restricted to a maximum of 1000 words, or the equivalent of one* Journal *page including formulas and figures. A discussion will be published as quickly as possible after receipt of the manuscript. Neither the AIAA nor its editors are responsible for the opinions expressed by the correspondents. Authors will be invited to reply promptly.*

Reply by the Authors to H. Wong's Comment on "Effect of Nozzle Cavity on Resonance in Large SRM: Theoretical Modelling"

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THE authors appreciate the interesting discussion proposed by H. Wong[1] and wish to thank him for raising these interesting questions concerning our paper.[2] We agree on certain points but are critical of some of the arguments in his discussion.

The effect of the deviation of the trajectory of the vortex from a path to the acoustical flow is a quite significant effect. This effect might even be more important than predicted by the model proposed by Wong. Further research on the vortex path should be undertaken to provide a more quantitative prediction.

As the velocity is varied continuously in our experiments, by modifying the nozzle opening, the maximum pulsation should correspond to a zero phase shift between the vortex passage and the acoustic oscillation of the cavity. We scan the full range of phases. Furthermore, as long as the time of flight of the vortex across the opening of the cavity remains short compared to the oscillation period, the integrated phase effect will remain small. If the residence time of the vortex was comparable to an oscillation period, one would have a very significant averaging out of the source. Hence we think that the correction by an order of magnitude as a result of phase lag is not fully justified, unless one can argue that the time of flight is of the order of an oscillation period.

Although we agree that viscothermal losses are probably negligible for a nonporous wall, in our experiment the porous wall through which the flow is injected at the forward end might induce additional acoustical losses. Those have been excluded from our analysis. In fact the numerical calculation carried out by Anthoine et al.[3] does predict amplitudes that are significantly larger than those found in our experiments.

An additional loss of energy that was neglected is the vortex shedding at the diaphragm. This will not only play a role in the scale model experiment, but in the actual situation, as stressed by Wong, such effect could be coupled to vibroacoustical and flow-induced vibration losses.

In view of these points, we conclude that our estimated vortex strength and the fact that we concentrate our vortex into a line vortex might be very significant sources of overestimation of the energy production. The same effect has been observed by Bruggeman et al.[4] in the case of self-sustained oscillations of closed side-branch resonators. The spatial distribution of the vorticity would in that particular case explain the fact that the single line vortex model overestimated pulsation levels by about a factor of three.

References

[1] Wong, H., "Comment on "Effect of Nozzle Cavity on Resonance in Large SRM: Theoretical Modeling," *Journal of Propulsion and Power*, Vol. 20, No. 6, 2004, pp. 1133, 1134.

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[3] Anthoine, J., Buchlin, J.-M., and Guéry, J.-F., "Effect of Nozzle Cavity on Resonance in Large SRM: Numerical Simulation," *Journal of Propulsion and Power*, Vol. 19, No. 3, 2003, pp. 374–384.

[4] Bruggeman, J. C., Hirschberg, A., van Dongen, M. E. H., and Wijnands, A. P. J., "Self-Sustained Aero-Acoustic Pulsations in Gas Transport Systems: Experimental Study of the Influence of Closed Side Branches," *Journal of Sound and Vibrations*, Vol. 150, No. 3, 1991, pp. 371–393.

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