Authors' Closure

The authors welcome Dr. Stansby's comments and criticisms of their paper. A few closing comments will now be made.

Our apparent misinterpretation of the results in reference [5] was an unfortunate misprint, for which the authors are grateful to Dr. Stansby for pointing out. The statement should have ended "for an aspect ratio $L/D = 8$" instead of "and aspect ratio."

We are acutely aware of the limitations imposed by small aspect ratio cylinders, but saw no alternative which would permit an admittedly incomplete investigation of transcritical shedding patterns. The significant finding that transcritical flow patterns closely parallel subcritical flow patterns (even granted that only two forced end cells were observed) remains valid. To attribute the division of the shedding frequencies into a cellular pattern solely to the endplate effect would require further demonstration. Our tests clearly indicated a single spanwise shedding frequency at St = 0.165 in subcritical uniform flow and at St = 0.215 in transcritical uniform flow. No measurements were made near the center of the span to determine whether the shedding occurred in phase on both sides of the cylinder. Yet the evidence adduced by Dr. Stansby to infer that as β approaches zero, two end cells of the same frequency persist (as opposed to a single cell) does not seem compelling. If that were the case, the cell lengths should become equal as the limit is reached. However, Fig. 12 in reference [5] shows no change in the relative cell lengths of 5D and 3D with decreasing β. The implication is that there is either a discontinuity for very low values of β, when one spanwise cell suddenly appears (our contention), or the gradual transition to two cells of length 4D occurs at values of β smaller than examined in any investigation yet undertaken. In any case, the data on endplate cells versus shear flow cells remains inconclusive.

Subsequent tests employing the optimum endplate design for cylinders with an aspect ratio of 17 have been reported by the authors [16] and should help resolve some of the remaining questions about the relationship between roughness, shear parameter, and vortex shedding cell lengths for subcritical and critical Reynolds number flows. In addition, the authors have now examined results of tests on cylinders with aspect ratios of 27 and 48 in sheared flow and have determined that the strong cellular structure so evident at aspect ratios of 16 to 20 appears to break down, at least for subcritical flows in the range $2 \times 10^4 \leq Re \leq 1 \times 10^5$, for a given value of the shear parameter. Corroborating evidence for this phenomenon can be seen in similar tests performed elsewhere [(17)].

Additional References

16 Peltzer, R. D., and Rooney, D. M., "The Effect of Upstream Shear and Surface Roughness on the Vortex Shedding Patterns and Pressure Distributions Around a Circular Cylinder in Transitional Re Flows," VPI & SU Report VPI-Aero-110, Apr. 1980.

17 Peterka, J. A., Cermak, J. E., and Woo, H. G. C., "Experiments on the Behavior of Cables in a Linear Shear Flow," Colorado State University Progress Report, 19 May, 1980.

A Theoretical Model for the Transverse Impingement of Free Jets at Low Reynolds Number[1]

S. B. Friedman.[2] An engineering research should have, as a minimum, the objective of either explaining the underlying cause of some physical effect, or providing a model by which design can be reasonably performed.

The subject paper falls into the first of the above categories. The phenomena of the "backward-bending" jet is complex and, as well demonstrated in this paper, can be attributed to many causes. If there is any weakness in the conclusions it is that the relative importance of the various causes is not considered or discussed.

In the original work by Dr. Martin and myself, a very simple and workable design model was established, which accounted for better than 90 percent of the previously unexplained variation. A quick analysis and comparison of our work and this one shows little significant improvement in the predictive value using the newer model.

In conclusion, this work should be a valuable addition to the literature, considering both its content and methodology.

Authors' Closure

We would like to acknowledge the comments of Dr. Friedman and his interest in this research; a continuation of his initial experimental work.

The purpose of the theoretical study was to develop a more detailed understanding of the mechanism describing the phenomena of the "backward-bending" jet. That greater insight was achieved and greatly compliments the original intuitive modelling proposed by Dr. Friedman. It is therefore very satisfactory that the original empirical relationships can still be used effectively for design.

[1] By R. Winton and H. R. Martin, published in the December, 1980, issue of the JOURNAL OF FLUIDS ENGINEERING, Vol. 102, No. 4, pp. 510–518.

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