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Discussion

A. J. Healey[4]

The authors present an interesting experimental study designed to indicate limitations of application of a well-established theory. The paper, however, leaves one to believe that it is possible to model a fluid line junction as a constant pressure junction. The experimental condition chosen to illustrate the point was that of a junction with approximately equal length branches. With two junctions in the network, however, such good correlation is not possible.[5,6] It would appear that a more exact model of a junction is necessary particularly when significant phase differences may occur between the flows in the branches.

Finally, equation (5) may yield an averaged resistance where a zero mean flow is maintained through the orifice but it does not represent the incremental resistance of the orifice. The incremental slope of equation (6) is given by

$$\frac{d(\Delta P)}{dQ_m} = \frac{\rho Q_m}{(A_0 K)^2} = \sqrt{\frac{2\rho \Delta P}{(A_0 K)^2}}$$

which is two times the value used by the authors in equations (6). The difference would have small effect on the results with low mean flows because the terminating resistance is small anyway, but this may account for some of the discrepancy observed in Fig. 10 for the response of P_{r_3} which was associated with an orifice diameter one half of the branch diameter. The experimental results definitely show more dissipation than the authors predict.

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Authors' Closure

The authors wish to thank Dr. Healey for his discussion of the paper. The authors agree that a more exact model of a junction is necessary and do not wish to mislead the reader into believing that the simplified model will work under all conditions. On the other hand, the authors believe it is useful to illustrate conditions where the simplified model can be used.

With regard to the orifice resistance with mean flow in the line, it is appropriate to use the incremental or linearized a-c value of the orifice resistance in these small-signal dynamic calculations. Assuming incompressible flow and that the orifice area and flow coefficient are constant, the incremental or linearized a-c value of the orifice resistance $Z_0(\text{ac})$ is twice the d-c resistance of the orifice $Z_0(\text{dc})$. For the conditions of Fig. 9, however, the theoretical curves are approximately the same whether the a-c or d-c value of the orifice resistance is used. For the conditions of Fig. 10, the theoretical curves are affected somewhat by the difference between the a-c and d-c values. Fig. 11 has been included to illustrate this difference. The experimental results of Fig. 10 are also included to again illustrate the larger dissipation than predicted by the laminar theory.

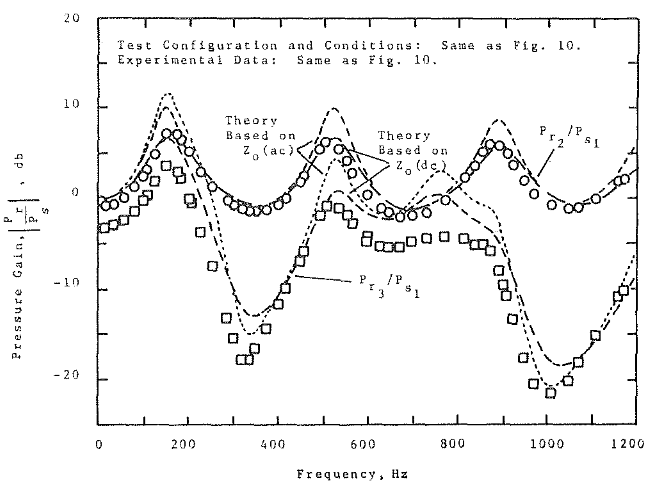

Fig. 11 Effect of orifice resistance on theoretical pressure gain

