APPENDIX 2: Proof that measured friction factor is a linear function of perimeter ratio

From Eq (5) of Appendix 1:

$$\frac{f}{f_1}=\frac{P_R}{P}\left[\left(\frac{n-1}{n}\right)^2+\frac{2n-2}{n^2}\frac{V_2}{V_1}+\frac{1}{n^2}\frac{V_3}{V_1}\right]^{-2}$$

which reduces to:

$$\frac{f}{f_1}=\frac{P_R}{P}\left(1-\frac{2}{n}X+\frac{1}{n^2}Y\right)^{-2}$$

where $X=1-V_2/V_1$ and $Y=2(1-V_2/V_1)-(1-V_3/V_1)$. Binomial expansion gives:

$$f/f_1=\frac{P_R}{P}\left[1+\frac{4}{n}X+\frac{2}{n^2}(6X^2-Y)+\frac{4}{n^3}(8X^3-3XY)+\cdots\right]$$

Values of X and Y supplied by the data in Table 7 show that the cubic term in n is negligible and the quadratic term is quite small. Even for $n=2$ it is less than 1% in all cases. Therefore:

$$f/f_1=\frac{P_R}{P}\left[1+\frac{4}{n}X\right]$$

$$=\frac{P_R}{P}\left[1+\frac{\pi}{p/D}\left(1-\frac{V_2}{V_1}\right)\left(\frac{P}{P_R}-1\right)\right]$$

using Eq (4). Therefore:

$$f=a+b\frac{P_R}{P}$$

where:

$$a=\frac{f_1\pi}{p/D}\left(1-\frac{V_2}{V_1}\right)$$

and

$$b=f_1\left[1-\frac{\pi}{p/D}\left(1-\frac{V_2}{V_1}\right)\right]$$

where V_2/V_1 and f_1 are constant for a given value of p/D.

BOOK REVIEW

Flow Visualization III

Ed. W-J Yang

This volume is a collection of papers presented at the Third International Symposium on Flow Visualization, held in Michigan in September 1983. Like the two previous collections in this series, this one contains a wealth of information pertinent to the techniques for rendering flows visible and the applications thereof.

I found it particularly useful by virtue of its international orientation. Recent international developments in this field, particularly by the Japanese, are well represented here even though they do not often appear in the usual American and European archival journals.

The volume also serves to indicate what are the current directions of the state-of-the-art in flow visualization. Thus, while traditional methods and applications are well represented, substantial sections are also devoted to such topics as laser-based techniques, image processing, computer-generated graphics, and biomedical applications.

The volume contains 157 papers of which seven are invited lectures. The major categories of flow visualization applications covered are: separated flows, vortices and wakes, supersonic flows and shock waves, jets, internal flows, stratified and boundary layer flows, rheology, ships and waves, aerodynamocs, atmospherics and oceanography, fluid machinery, heat transfer, and combustion. The high quality of the published illustrations is especially noteworthy.

In summary, this book is a valuable resource for anyone who practices flow visualization in particular, as well as for the fluid mechanics community in general.

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