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LETTER TO THE EDITOR

COMMENTS ON THOM'S PAPER "PRESSURE DROP DURING FORCED CIRCULATION BOILING OF WATER"

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IN A RECENT article Thom [1] compared a number of his derived values with those obtained previously [2] by the writer. Some care is, however, necessary in making this comparison as there is a difference in tube surface roughness between the two conditions compared.

The writer used the following equation to represent the Martinelli and Nelson [3] data for frictional pressure gradient during steam-water flow

$$\frac{\Delta P_{TPF}}{\Delta P_f} = (1 - x_m)^{2-n} + C_1 \left(\frac{v_g}{v_f}\right)^{1/2} \left(\frac{\mu_g}{\mu_L}\right)^{n/2} x_m^{(2-n)/2} (1 - x_m)^{(2-n)/2} + \left(\frac{v_g}{v_f}\right) \left(\frac{\mu_g}{\mu_L}\right)^n x_m^{2-n} \quad (1)$$

where C_1 is a function of pressure only, μ_g and μ_L are the absolute viscosities of vapour and liquid respectively, and n is the exponent in the relationship for friction factor

$$f = \frac{C_2}{Re^n}.$$

The other symbols are as used by Thom.

In reference 2, n was taken as 0·25 as a smooth tube surface was assumed; however in reference 1 a rough tube was used and the appropriate value of n is consequently zero. Equation (1) therefore becomes

$$\frac{\Delta P_{TPF}}{\Delta P_f} = (1 - x_m)^2 + C_1 \left(\frac{v_g}{v_f}\right)^{1/2} x_m (1 - x_m) + \left(\frac{v_g}{v_f}\right) x_m^2 \quad (2)$$

Examination of the experimentally derived figures given by Thom in his Table 5 indicates that

$$C_1 \simeq \left(\frac{v_g}{v_f}\right)^{1/2}, \quad (3)$$

hence equation (2) becomes

$$\frac{\Delta P_{TPF}}{\Delta P_f} = (1 - x_m)^2 + \frac{v_g}{v_f} \times x_m (1 - x_m) + \frac{v_g}{v_f} x_m^2 = (1 - x_m)^2 + \frac{v_g}{v_f} x_m. \quad (4)$$

This gives results little different from those given by the well-known "homogeneous flow" assumption which is

$$\frac{\Delta P_{TPF}}{\Delta P_f} = (1 - x_m) + \frac{v_g}{v_f} x_m. \quad (5)$$

The table compares the values of Thom with those obtained using equation (5). (The values in the table

Table 1. *Values of* $\Delta P_{TPF}/\Delta P_f$

Pressure (lb/in^2 abs)		Outlet quality by mass 0	0·02	0·2	0·5	0·8	1·0
250	Thom	1·0	3·22	20·6	49·4	78·7	98·86
	equation (5)	1·0	2·96	20·6	49·9	79·2	98·86
600	Thom	1·0	1·79	8·42	19·5	30·7	38·3
	equation (5)	1·0	1·75	8·46	19·6	30·8	38·3
1250	Thom	1·0	1·22	3·77	8·03	12·4	15·33
	equation (5)	1·0	1·29	3·87	8·17	12·5	15·33
2100	Thom	1·0	1·06	2·02	3·69	5·45	6·64
	equation (5)	1·0	1·11	2·13	3·82	5·52	6·64
3000	Thom	1·0	—	1·24	1·73	2·18	2·48
	equation (5)	1·0	—	1·30	1·74	2·18	2·48

obtained from equation (5), differ of course, from those from equation (1) with $n = 0{\cdot}25$ as used in reference 2.)

REFERENCES

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3. R. C. Martinelli and D. B. Nelson, Prediction of pressure drop during forced-circulation boiling of water, *Trans. Amer. Soc. Mech. Engrs* **70**, 695–702 (1948).

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AUTHOR'S REPLY

I congratulate Dr. Chisholm on bringing out his point. It should be noted, however, that his conclusion applies only to two-phase flow of water and steam along unheated tubes and does not apply to boiling conditions with steam generation. Nevertheless, the point is of practical interest and formed part of the research project at Cambridge. In that part of the programme the experimental two-phase pressure drop ratio for non-evaporating flow of water and steam along a horizontal unheated tube was plotted against (1) mass dryness fraction (2) equivalent void fraction. These results, over the pressure range 250–3000 psia, showed close agreement with simple homogeneous flow assumptions. It was noticeable, however, that in the mass dryness range 0·01–0·1 the observed two-phase frictional pressure drop tended to lie just above the homogeneous value at 250 psia and below it at 1250 and 2100 psia. Results at 600 psia agreed with homogeneous flow predictions. These small variations were incorporated in Table 5.

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