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LETTER TO THE EDITORS

ON THE CONDENSATION COEFFICIENT OF WATER ESTIMATED FROM HEAT-TRANSFER MEASUREMENTS DURING DROPWISE CONDENSATION

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In their recent paper [1] published in this Journal Tanner, Pope, Potter and West report on heat-transfer measurements during both dropwise and filmwise condensation at steam pressures in the range 0·0267–0·101 bar. From the dropwise results the authors conclude the condensation coefficient for water to be $\geqslant 0{\cdot}1$. This conclusion is deduced from simple kinetic theory assuming the measured temperature difference to be the interfacial temperature drop which arises from molecular matter transfer resistance.

The magnitude of condensation coefficient which is indicated by the results of filmwise experiments carried out by Tanner *et al.* under identical conditions of steam pressure, heat flux and geometry of apparatus is investigated.

Assuming, as Tanner *et al.* propose, the condensation coefficient to be indeed as low as 0·1 at a pressure of 0·0267 bar a significant thermal resistance arises at the interface which is represented by the surface of film in contact with the bulk vapour phase. This interfacial temperature jump ΔT_i deduced from simple kinetic theory is calculated to be approximately:

$$\Delta T_i \sim 0{\cdot}231 \times 10^{-4}\,\mathrm{degC\,m^2/W} \times q \tag{1}$$

where q is heat flux.

The average temperature drop across the film according the Nusselt model ΔT_{Nu} at a steam pressure of 0·0267 bar and a plate height of 0·019 m is given by:

$$\Delta T_{Nu} = \left(\frac{q}{2{\cdot}145 \times 10^4\,\mathrm{W/m^2(degC)^{\frac{3}{4}}}}\right)^{\frac{4}{3}}. \tag{2}$$

Hence the overall temperature difference in filmwise condensation at 0·0267 bar and a condensation coefficient of 0·1 is obtained by:

$$\underset{\alpha=0\cdot1}{\Delta T} = \Delta T_i + \Delta T_{Nu}. \tag{3}$$

In Fig. 1, equation (3) is represented by the dotted curve and equation (2) by the solid one. The two curves are compared with the corresponding set of filmwise results at 0·0267 bar which have been taken from Fig. 9 in the paper of Tanner *et al.* Obviously these measurements do not agree with the dotted curve as should be expected when the condensation coefficient is believed to be as low as 0·1. However, it is apparent that the measured ΔT-values agree well with the Nusselt correlation which does not include any interfacial temperature drop. Hence it is evident that the filmwise results of Tanner *et al.* imply a much greater value of condensation coefficient than has been estimated from dropwise experiments.

Taking the condensation coefficient to be unity the inter-

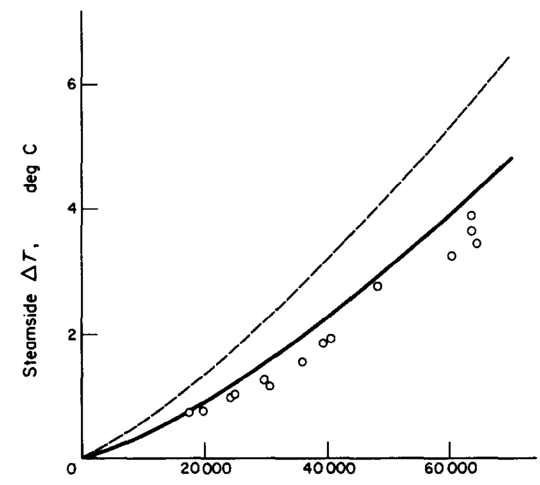

FIG. 1. Comparison of filmwise results of Tanner *et al.* [1] at 0·0267 bar (o) with Nusselt correlation (————) and Nusselt correlation incorporating interfacial kinetic resistance corresponding to condensation coefficient 0·1 (– – – –).

facial temperature difference is of the order 10^{-1} degC and may be neglected in the range under consideration. Therefore the Nusselt correlation represented by the solid curve is approximately valid for the condensation coefficient of unity. Thus the filmwise results of Tanner *et al.* at low steam pressure indicate that no significant interfacial thermal resistance can be detected and consequently the condensation coefficient for water should be close to unity.

These conclusions from the filmwise experiments of Tanner *et al.* are in good agreement with the findings of several other recent workers on this field such as [2] and [3].

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