Several special cases where the hemispherical emissivity may be expressed in simple forms are:

(a) $(S/R) \to 0$ (location A in Fig. 1): When $(S/R) \to 0$, equation (3) reduces to:

$$\epsilon = 1 - 2E_3(KS) \qquad (4)$$

(b) Hemispherical gas (location B in Fig. 1): For a hemispherical gas volume $[(S/R) = 1]$, equation (1) may be integrated to give:

$$= 1 - e^{-KS} \qquad (5)$$

This expression can be also found in reference [4].

(c) Spherical gas (location C in Fig. 1): For a body situated at the inner surface of a spherical gas envelope $[(S/R) = 2]$, the emissivity as found from equation (1) is

$$\epsilon = 1 - \frac{1}{2(KR)^2}\left[1 - (1 + 2KR)\, e^{-2KR}\right] \qquad (6)$$

Equation (6) was also derived by Schmidt [5]. For optically thin gas, $KR \ll 1$, equation (6) is reduced to

$$\epsilon = \frac{4}{3}KR \qquad (7)$$

Equation (7) was also given in references [4] and [6].

(d) Body outside of gas volume (location D in Fig. 1): When a body is located outside of the hot gas volume, the emissivity may be computed from:

$$\epsilon_o = \left(\frac{R}{L}\right)^2 \left\{1 - \frac{1}{2(KR)^2}\left[1 - (1 + 2KR)\, e^{-2KR}\right]\right\} \qquad (8)$$

where the subscript o indicates that the body is located outside of the gas volume $[(R/L) \leqslant 1)$.

Incident thermal radiation

With Fig. 1, the calculation of thermal radiation becomes very simple. For a given gas dimension (R), surface location (S), and radiation property (K), one can read the emissivity ϵ directly from Fig. 1. The incident thermal radiation from the gas body at a temperature T to a surface is simply $q = \epsilon\sigma T^4$.

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COMMENTS ON THE PREDICTION OF PRESSURE DROP DURING FORCED CIRCULATION BOILING OF WATER

J. R. S. Thom, *Int. J. Heat Mass Transfer* **7**, 709–724 (1964)

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NOMENCLATURE

G,	mass velocity (lb/ft^2 s);
v_g,	specific volume of gas phase (ft^3/lb);
v_l,	specific volume of liquid phase (ft^3/lb);
$\bar{X}_a$,	fraction of cross section occupied by gas phase;
X_m,	weight fraction gas in mixture;
α,	specific volume ratio (v_g/v_l);
γ,	dimensionless slip factor;
σ,	slip ratio (α/γ).

J. R. S. Thom has recently proposed correlations for prediction of pressure drop for the circulation of boiling water [1]. He proposes to fit curves of the type

$$\bar{X}_a = \frac{\gamma \,.\, X_m}{1 + X_m(\gamma - 1)} \qquad (1)$$

by using a slip factor γ which is a constant at any given pressure. This simplifying assumption would be expected to have limited application and should be used with knowledge of these limitations.

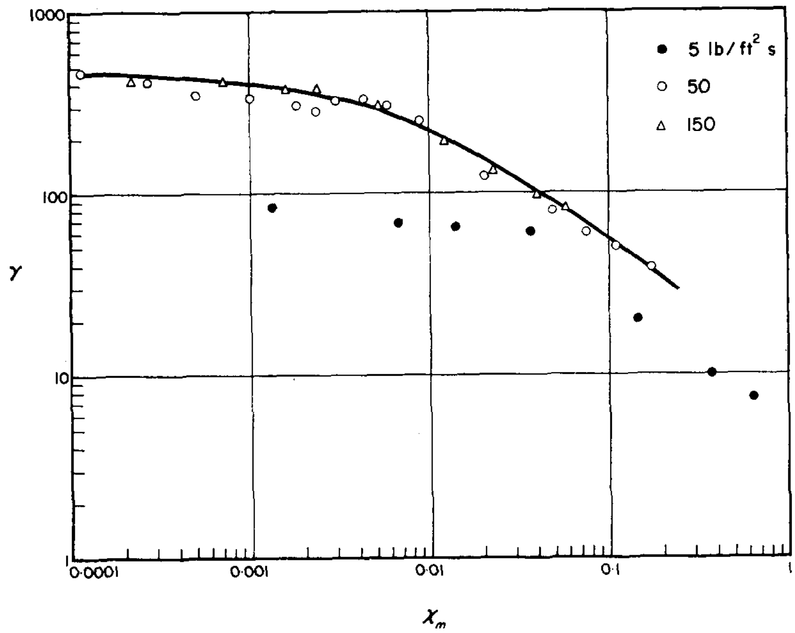

FIG. 1. Air–water data.

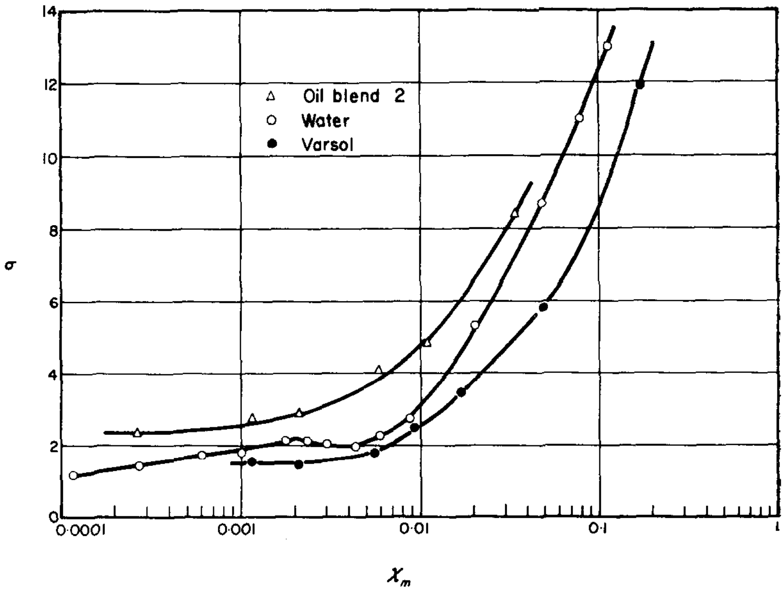

FIG. 2. Air–liquid systems at $G = 50\ \text{lb/ft}^2\text{s}$.

Figure 1 shows Hughmark data [2] for the air–water system with a 1-in pipe at atmospheric pressure. Data for three different mass velocities are shown. The data at mass velocities of 50 and 150 lb/ft^2 s indicate a region of X_m from 0·0001 to 0·006 that could be assumed to be constant. Similarly, the data for a mass velocity of 5 lb/ft^2 s indicate a region of X_m that is relatively constant; however, this slip factor is about 20 per cent of that at the higher mass velocities.

Figure 2 shows Hughmark data for the slip ratio σ of three air–liquid systems at a mass velocity of 50 lb/ft^2 s. It is apparent that σ can be assumed constant for only a limited range of X_m and that σ is not defined by X_m alone.

The simplifying assumption of a constant slip factor or a constant slip ratio at a given pressure may be applicable to specific design conditions, but it should be recognized that these terms are not constants.

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