EFFECT OF THE PRESSURE OF AN EXTRANEOUS GAS ON EVAPORATION IN ENCLOSED CONTAINERS

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The results of an experimental investigation of the evaporation of nitrogen tetroxide in enclosed cylindrical containers in a nitrogen medium at elevated pressure are given.

Evaporation from the free surface of a liquid in enclosed containers at normal pressure has been investigated in several papers ([1, 2], etc.).

Nitrogen tetroxide offers promise as the working medium in turbines, the coolant in gas-cooled reactors [3], and as one of the widely used liquid oxidizers for rocket motors [4].

The experimental device described in [5] was constructed for investigating evaporation in enclosed containers. The basic elements of the device are the stainless steel operating vessels with a diameter of 100 mm and heights of 300, 600, and 1200 mm, which are placed alternately in the test section. The experiments were performed in a constant-temperature bath. The temperature data units consisted of thermistors connected to measuring bridge circuits. The pressure measuring system in the operating vessels consisted of two differential pressure gauges, connected in parallel through dividing containers, potentiometric data units for measuring the pressure drop, and a comparison vessel.

The experimental results are in qualitative agreement with the concepts of evaporation and of the effect of the free volume height above the liquid surface, the temperature, and the pressure on the evaporation process. The quantitative data are given in Fig. 1, which also shows the curve obtained in [6]. This curve has been confirmed by experimental data at normal pressure [7]. Winkelman's dependence of the diffusion coefficient on the temperature and pressure was used for processing the experimental data. Analyzing the experimental data, we reach the conclusion that the theoretical curve also holds for an inert extraneous gas at elevated pressures. Our data make it possible to calculate the pressure rise under different

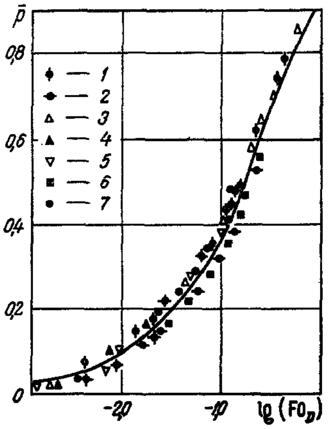

Fig. 1. Experimental data on the evaporation of nitrogen tetroxide in nitrogen. For each series of points the temperature, the height of the gas cushion above the liquid surface, and the nitrogen pressure are equal to, respectively: 1) 34.5°C; 28.8 cm; 3.01 gauge atm; 2) 33°C; 112 cm; 2.23 gauge atm; 3) 33°C; 54.5 cm; 2.32 gauge atm; 4) 35°C; 55.2 cm; 3.38 gauge atm; 5) 34°C; 57.4 cm; 4.96 gauge atm; 6) 22.7°C; 56.6 cm; 1.12 gauge atm; 7) 19.7°C; 55.8 cm; 2.98 gauge atm.

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sets of conditions in enclosed containers of power plants, while they also support the results obtained in [8] at elevated pressures.

NOTATION

$\bar{P} = P/P_s$, P, and P_s, relative pressure, present pressure, and saturated vapor pressure, respectively; $Fo_D = D\tau/l^2$, diffusion Fourier number; D, diffusion coefficient; l, height of gas above the liquid surface; τ, time.

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AN EXPRESSION FOR THE GROWTH MODULUS OF VAPOR BUBBLES AT THE BOILING POINT

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An expression is proposed for the growth modulus of a vapor bubble when its radius varies in an arbitrary manner with time.

1. A considerable number of theoretical papers have been devoted to the growth laws of vapor bubbles at the boiling point [1-8]. All lead to the equation

$$R = \beta(0.5)\,\tau^{0.5}, \tag{1}$$

which is true for most of the period of growth of the vapor bubble on the heating surface. If we exclude cases of extremely low pressures, Eq. (1) may be treated as an approximate theoretical law for the growth of vapor bubbles at the boiling point.

The growth modulus $\beta(0.5)$ of a vapor bubble is, in general, expressed by the following equation:

$$\beta(0.5) = c_\beta \left(\frac{\lambda \Delta T}{L\rho'' a}\right)^{n_\beta} a^{0.5} = c_\beta\, \mathrm{Ja}^{n_\beta} a^{0.5}, \tag{2}$$

where n_β lies in the range $0.5 \leqslant n_\beta \leqslant 1$, while c_β = const (in some papers c_β is defined as a function of the physical properties of the heater and test liquid [5] but this is not particularly important for subsequent analysis).

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