SURFACE TENSION OF VAPOUR PHASE NUCLEI IN OXYGEN–NITROGEN SOLUTIONS

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The decomposition of a homogeneous liquid phase, superheated beyond the phase equilibrium temperature, occurs as a result of the formation and the subsequent growth of critical bubbles. At high superheatings, the characteristic sizes of such bubbles are several nanometers. The properties of bubbles depend on their size.

We have investigated the kinetics of spontaneous nucleation in oxygen-nitrogen solutions in experiments measuring the expectation time for boiling-up [1]. Liquid volumes of 70–80 mm^3 were superheated in glass cells. Entry into the metastable region was accomplished by sharply reducing the pressure at fixed values of temperature and solution composition. Experiments were conducted on isobars of p = 0.5 and 1.0 MPa in the temperature range T = 106 – 138 K over the entire range of nitrogen concentrations x. From classical nucleation theory at a rate of $J = 10^7$ $m^{-3}s^{-1}$, using experimental data on the temperatures of attainable superheating, the surface tension σ at the critical bubble – solution boundary was determined.

The values of σ are compared with data on the surface tension of the solution at a flat interface σ_∞ [2]. The differential capillary rise method was used to determine σ_∞. Measurements were performed on an assembly of three glass capillaries. The surface tension of critical bubbles of pure liquids is 4–5% less than σ_∞ (x = 0). The ratio between σ and σ_∞ changes with changes in the solution composition. In the concentration range of 0.1–0.9, $\sigma > \sigma_\infty$. Near the equimolar composition, the discrepancy reaches 3-5%. It is assumed that it is associated with the curvature of the interface.

A similar relationship between σ and σ_∞ is given by the van der Waals capillarity theory [3]. However, according to this theory, the value of σ exceeds that of σ_∞ over a narrower concentration range and by a smaller amount. At T = 132 K, the maximum value of $(\sigma - \sigma_\infty)/\sigma_\infty$ is 0.3% for bubbles with a radius of 45 nm and a concentration of x = 0.73. The report also discusses some factors that can lead to changes in the surface tension of critical bubbles.

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