is discontinuous. Hence, the dimension of the zone of appreciable change in potential energy is equal to zero ($a = 0$), and condition (2) is hopelessly infringed, for now

$$2mEa^2/\hbar^2 \equiv 0.$$

This abstract case (equivalent to an infinitely large value of the quantum constant) is devoid of physical meaning in relation to the processes considered.

REFERENCES

1. O. Knake and I. N. Stranskii, UFN, no. 2, 1959.
2. B. Pol, Raketnaya tekhnika, no. 9, 1962.
3. N. N. Kochurova, IFZh, no. 3, 1964.
4. L. D. Landau and E. M. Lifschitz, Quantum Mechanics [in Russian], Fizmatgiz, 1963.
5. V. G. Levich, Yu. A. Vdovin, and V. A. Myamlin, Course in Theoretical Physics [in Russian], 2, Fizmatgiz, 1962.

2 October 1964

Krzhizhanovsk Power Engineering Institute, Moscow

UDC 536.423.4

ON THE CALCULATION OF THE CONDENSATION COEFFICIENT

N. N. Kochurova

Inzhenerno-Fizicheskii Zhurnal, Vol. 8, No. 6, pp. 822-823, 1965

In the theory of evaporation the condensation coefficient f is equal to the ratio of the number of condensing molecules to the total number of vapor molecules striking the surface of the condensate. Theoretical and experimental studies of the condensation coefficient [1-3] show that it is determined by the change in the energy state of molecules during phase transition and on the purity of the surface of the condensed phase.

The basic idea of reference [3] consists in the application of the solution of the "barrier problem" of quantum mechanics to the calculation of the condensation coefficient.

In this formulation of the problem, the difficulties of constructing a model of the process that fully corresponds with reality are reduced to determining the height and shape of the barrier. The first of these is determined by the activation energy (which is not always equal to the heat of vaporization), the second comprises determination of the barrier width.

For a clean surface of the condensed phase, the condensation coefficient is determined by the change in the energy state of the molecules during phase transition.

Collision of vapor molecules with condensate and the possibility of reflection of the incident vapor molecules are determined by the transmission and reflection processes at the boundary between two regions of different potential. Here, in each specific case of a barrier of a certain shape and width and also for different relationships between the total energy and the height of barrier, it is necessary to use the corresponding solution of the Schroedinger equation.

Reference [3] presents an example of calculation of the condensation coefficient in the case when the activation energy is equal to the heat of vaporization and the total energy is greater than the height of the barrier. In this case the condensation coefficient is treated as the probability of molecules crossing the boundary between regions of different potential. The manifestation of the quantum effect (nonzero reflection) is then determined by the width of the transition region. Increase in the width of the transition region causes the reflection to tend to zero.

Since the question of the shape of the barrier is a topic of special investigation for each substance, in order to estimate condensation coefficient in the first approximation the width of the transition region was assumed equal to zero. With the above assumptions (activation energy equal to the heat of vaporization and width of transition region equal to zero) the condensation coefficient was calculated for a number of substances at different temperatures. The values of the condensation coefficient were found to be close to one and exactly equal to one at the critical temperature.

When the width of the transition region is taken into account, the condensation coefficient will tend to one. This result corresponds to the value $f = 1$ obtained in Hertzfeld's classical examination of the problem [4] and by a number of other authors [1, 2]. Moreover, experimental determinations of the condensation coefficient, in conditions close to the conditions of the assumed model, also give values close to one [6].

The unexpectedness of the absence of a quantum constant, mentioned in [7], is only apparent, as may be seen from [5]. The reasoning in [7] concerning infringement of the inequality $2mEa^2/\hbar^2 \ll 1$ in the case of zero width of transition region reduces to the assertion that, in fact, $a \neq 0$. Obviously, however, this is not an obstacle to the use of the proposed model for estimating the condensation coefficient. As is known, quantum mechanics can be used to solve problems of the type in question and includes the classical and the specifically quantum description of the process. Thus, the remarks in [7] about the "strangeness" of the proposed method are not justified.

NOTATION

$\hbar = h/2\pi$, where h – Planck's constant; k – Boltzmann's constant; a – spatial scale of appreciable change in the force field; E – energy; m – molecular mass.

REFERENCES

1. O. Knake and I. N. Stranskii, UFN, no. 2, 1959.
2. A. N. Nesmeyanov, Saturated Vapor Pressures of the Chemical Elements [in Russian], Izd. AN SSSR, 1961.
3. N. N. Kochurova, IFZh, no. 3, 1964.
4. Hertzfeld, Kinetische Teorie der Wärme, Braunschweig, 229, 1925.
5. L. D. Landau and E. M. Lifschitz, Quantum Mechanics [in Russian], Fizmatgiz, 1963.
6. V. I. Subbotin, M. N. Ivanovskii, V. P. Sorokin, and B. A. Chulkov, Teplofizika vysokikh temperatur, no. 4, 1964.
7. D. A. Labuntsov, IFZh [Journal of Engineering Physics], no. 6, 1965.

1 February 1965