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Investigation of the Field of Partial Pressures in a Diffusing Condensing Chamber

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THE distribution of supersaturations inside a diffusion chamber, and consequently the height and quality of the sensitive layer, depend on the temperature field and on the partial-pressure field. The temperature field inside a diffusion chamber was investigated in references 1 and 2. This communication describes a procedure and measurement results for the partial-pressure field.

A special instrument, namely an expansion diffusing chamber, was constructed to investigate the partial pressure field. The chamber is a glass-walled crylindrical container. The bottom of the chamber consists of two glass disks screwed together, and is cooled by liquid nitrogen, flowing through a spiral groove cut in the upper disk. The flow of nitrogen, and consequently the temperature of the bottom, are regulated by changing the pressure in a Dewar flask with a valve. The cover of the chamber is a brass plate with holes 7 mm in diameter distributed uniformly over the entire area. The brass plate is covered on the top with a rubber diaphragm which separates the working volume of the diffusion chamber from the volumes that connect with the atmosphere and with the vacuum system. The expansion is carried out in a container located above the working volume. A mercury manometer records the pressure in this container before the expansion and the common pressure in the system after the expansion. The degree of expansion is thus determined from the ratio of the pressures. The vapor source is the surface of ethyl alcohol filling a trough that is fastened to the upper cover. The diffusion chamber is filled with air at atmospheric pressure.

Generally speaking, the vapor partial pressure and temperature vary with the height within the volume of the diffusion chamber. Consequently, the cloud produced by the expansion does not form throughout the chamber, but only in those regions where the partial pressure exceeds a certain value. Knowing the temperature distribution and the degree of expansion, it is possible to determine the partial pressure of the vapor at the cross section where the boundary of a dense cloud produced by condensation on neutral or charged centers is located. By varying the degree of expansion, it is thus possible to determine the partial pressure field over the entire volume of the chamber.

The temperature inside the chamber is measured by a horizontally placed thermocouple, the height of which can be changed by means of a permanent magnet. The partial-pressure distribution obtained by the above method is shown in Fig. 1 (with the temperature distribution in the chamber being approximately as represented by curve 1 of Fig. 2).

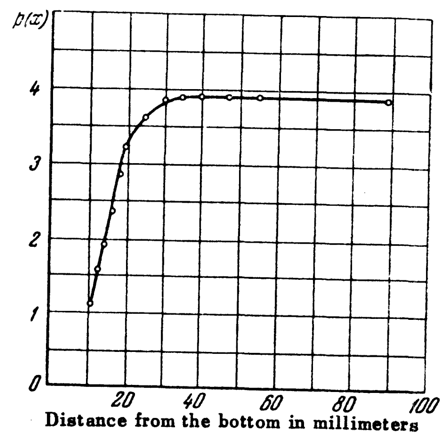

FIG. 1 Partial-pressure distribution in chamber. Height of sensitive layer is 15 mm.

The partial pressure is apparently constant over a considerable volume of the chamber, apparently because of the thorough mixing of the gas and the vapor. The fact that the temperature is constant in any horizontal cross section inside the chamber also indicates that the gas and vapor are thoroughly mixed.

To investigate the effect of the condensation on the partial pressure distribution, the chamber was irradiated inside with a gamma-ray source in such a way that, unlike in the preceding case, the expansion caused condensation on charged, rather than

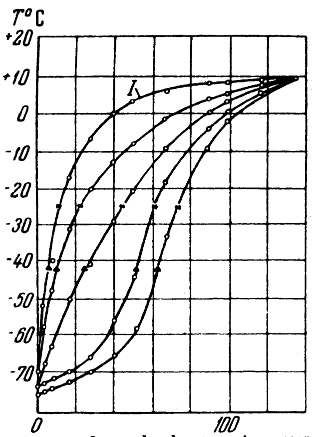

FIG. 2. Temperature distribution in chamber. Asterisks and triangles denote the temperatures of the upper boundary of the sensitive layer produced by a small and large number of condensation centers, respectively.

neutral, centers. Measurements have shown that the condensation on charged centers does not significantly affect the partial pressure distribution above the sensitive layer.

It was shown earlier[2] that the height of the sensitive layer changes with the temperature distribution inside the chamber. For any temperature distribution, the upper boundary of the sensitive layer can be established as being the section at which the temperature $T(x_0)$ has a value corresponding to the saturated vapor pressure $p_s(x_0) = p(x_0)/S_1$ where $p_s(x_0)$ is the pressure of the saturated vapor at a temperature $T(x_0)$, $p(x_0)$ is the partial pressure of the vapor at the upper boundary of the sensitive layer, and S_1 is the superstauration at which condensation on the ions begins. As was mentioned earlier, measurements performed by the expansion method show that the pressure $p(x_0)$ is constant over a considerable volume of the chamber. Therefore, if we assume that a change in the temperature distribution does not affect substantially the partial pressure of the vapor above the sensitive layer, the upper boundary of the sensitive layer (where the supersaturation equals S_1) should have the same temperature regardless of the temperature distributions. This deduction is easily verified experimentally. Figure 2 shows five different temperature distributions. The temperature at which condensation on the ions begins is marked with an asterisk on each curve. It is apparent that the upper boundary of the sensitive layer actually has an approximately constant temperature. Consequently, the assumption that in the region above the sensitive layer the partial pressure of the vapor does not change significantly with the temperature distribution is in agreement with the experimental data.

If the number of condensation centers inside the chamber increases (for example, when the chamber is irradiated by the gamma-ray source), the height of the sensitive layer decreases. The triangle on each temperature-distribution curve of Figure 2 designates the temperature of the upper boundary of the sensitive layer at which the ion concentration is thirteen times the initial concentration. It can be seen that the upper boundary of the sensitive layer remains at the same temperature as before for various temperature distributions. Decreasing the surface area of the evaporating liquid affects the variation in height of the sensitive layer in the same manner as increasing the ion concentration. The data given here shows that changing the condensation conditions over a wide range hardly affects the character of the partial pressure distribution above the sensitive layer.

In conclusion, I express my gratitude to M. S. Kozodaev and Professor M. F. Shirokov for interest in the work and for valuable comments.

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The Problem of the Generalization of the Statistical Theory of the Atom

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THE known non-relativistic Hellman equations, generalizing the statistical theory of the atom for the case of electron groupings by the orbital numbers[1], can be generalized by incorporating relativistic and spin-orbital corrections for energy. In connection with the attempts made to use statistical methods for the calculation of the density of distribution of nucleons in nuclei[2-4], the inclusion into these calculations of a term