

PHYSICAL CONDITIONS OF CONSTANT SENSITIVITY OF LIQUID SOLUTIONS TO
PARTICLE TRACKS

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Thermodynamic methods are used to analyze the possibility of producing a region of continuous sensitivity to ions in a binary liquid solution. It is shown that such a region exists in solutions with limited solubility of the liquid components, and that it is possible to produce in it particle tracks consisting of excess matter released from the solution on the ions and having a large dielectric constant.

1. INTRODUCTION

IN 1957, Good proposed a bubble chamber of constant sensitivity^[1]. The gist of his idea is to produce artificially in a layer of gas-filled liquid distributions of the temperature and of the gas concentrations such that supersaturation is produced in a small region of the solution, sufficient to cause the solution to boil along the particle track. The very first experiment with a solution of CO₂ gas in acetone, methanol, and in other liquids, performed by Good, confirmed the correctness of his idea. However, these experiments revealed also serious shortcomings of such an instrument. Thus, by virtue of the high volatility of the gas dissolved in the liquid, the metastable region of the solution should be only in a weakly superheated state, which is insufficiently sensitive to fast particles and to γ quanta. For the same reason, the depth of the sensitive layer was also small and did not exceed 1 cm in the experiment. Finally, in the proposed version of the chamber, owing to the low density of the dissolved gas and to the slow rate of its diffusion in the liquid, the sensitive zone of the chamber could handle only a weak particle flux.

Subsequent investigations of a bubble chamber of constant sensitivity, performed by Kato^[2], did not improve its main characteristic greatly.

In this paper we analyzed a variant of a chamber, which also has constant sensitivity, but is based not on the boiling of a liquid, as in Good's chamber, but on the stratification of a binary liquid solution on longlived ions produced in the particle track. In such a chamber, in the metastable (supersaturating) region of the solution, the ions generate centers in which the solution becomes stratified into individual liquid components having different refractive indices. Obviously, such a chamber is the analog, from the point of view of the operating principle, of the gas diffusion chamber widely used in experimental physics. Just as in the diffusion chamber and in Good's chamber, in our version of the chamber the metastable region in the solution should be produced by creating in it a definite temperature gradient and a definite distribution of the concentration of the dissolved substance.

The possibility of stratification of a binary liquid solution in a metastable state by ions was demonstrated in^[3,4]. In turn, the possibility of ensuring prolonged

supersaturation of a solution in a definite temperature interval is well known from a number of investigations. Thus, already in 1898 Rothman^[5] succeeded in supercooling different solutions by 2° below the dew point for a long time. A similar result was obtained also in^[6,7].

Among the investigations of supercooling of solutions, a particular place is occupied, in light of the problem under consideration, by the work of Hermanie et al.^[8], in which solutions of 0.01–0.02% of water in liquid hydrocarbons were supercooled 5–10° below the stratification point. A further decrease of the temperature in the experiments led to a rapid separation of water from the solution, in the form of fog droplets. The authors of^[8] advanced the hypothesis that the formation of the fog in the supercooled liquid solution is connected with the effect of cosmic particles and γ rays on the solutions. This undoubtedly interesting guess, however, found theoretical justification or a special experimental verification neither in^[8] nor in any other investigations of solutions. The purpose of the present work was therefore a theoretical analysis of the possibility of artificially producing in a binary liquid solution conditions of constant sensitivity of the solution to stratification on ions.

2. FORMATION OF A STATIONARILY SUPER-SATURATED LAYER IN A LIQUID SOLUTION

We consider a vertical cylindrical vessel filled with a binary liquid solution. If definite temperature and concentrations are established in the solution on the ends of the vessel, then heat and solute fluxes will be produced along the cylinder^[9,10], namely:

$$\Pi_1 = -\rho D \text{grad } C_1 + \rho C_1 C_2 D_T \text{grad } T, \quad (1)$$

$$\Pi_2 = -\lambda \text{grad } T + \Pi_1 c_p T, \quad (2)$$

where Π_2 and Π_1 are respectively the per unit fluxes of heat and solute, ρ is the specific gravity of the solute, D and D_T are the coefficients of diffusion and thermal diffusion of the solute, C_1 and C_2 are the concentrations of the solute and of the solvent in the solution, T is the absolute temperature, λ is the coefficient of thermal conductivity of the solution, and c_p is the per unit specific heat of the solute.

To solve Eq. (1), we take into account the fact that for liquid solutions $D_T \ll D$ ^[9] and $C_1 C_2 < 1$. There-

fore, at not too large values of grad T, the second term of (1) is much lower than the first term and can be neglected. For stationary diffusion, in the absence of stratification in the solution, we have

$$\operatorname{div} \Pi_1 = \operatorname{div} (\rho D \operatorname{grad} C) = 0, \quad (3)$$

where we drop the subscript 1 of C_1 . By virtue of the weak dependence of ρ and D on T and C in liquid solutions^[9,11] we can assume that $\rho = \text{const}$ and $D = \text{const}$. Therefore

$$\operatorname{div} \Pi_1 = \operatorname{div} \operatorname{grad} C = 0. \quad (4)$$

Let us solve this equation for the one-dimensional case, assuming that the diameter of the vessel is comparable with its height. We also assume that the Z axis of the coordinate system is directed along the cylinder axis, and the origin lies in the plane of the upper end of the vessel. Then we get from (4)

$$\frac{\partial \operatorname{grad} C}{\partial Z} = \frac{\partial^2 C}{\partial Z^2} = 0. \quad (5)$$

A solution of this equation is the linear function

$$C(Z) = C_0 - \frac{C_0 - C_L}{L} Z, \quad (6)$$

where C_0 and C_L are the concentrations of the solution at the beginning and the end of the vessel, and L is the length of the vessel. It follows from (1) and (6) that the flux of the matter in the solution is

$$\Pi_1 \cong -\rho D \operatorname{grad} C = \rho D \frac{C_0 - C_L}{L}. \quad (7)$$

To solve Eq. (2), we make the natural assumption that in a liquid solution λ and c_p do not depend on T or C . Then in the absence of heat sources in the volume of the solution, $\operatorname{div} \Pi_2 = 0$, or

$$-\lambda \frac{\partial^2 T}{\partial Z^2} + \Pi_1 c_p \frac{\partial T}{\partial Z} = 0. \quad (8)$$

An integral of this equation is the function

$$T(Z) = T_0 - \frac{T_0 - T_L}{1 - \exp(\Pi_1 c_p L / \lambda)} \left[1 - \exp\left(\frac{\Pi_1 c_p}{\lambda} Z\right) \right], \quad (9)$$

where T_0 and T_L is the temperature of the solution at the beginning and at the end of the cylinder. For a linear analysis, it is useful to introduce the notation

$$\psi_1 = \exp\left(\frac{\Pi_1 c_p}{\lambda} L\right), \quad \psi_2 = \exp\left(\frac{\Pi_1 c_p}{\lambda} Z\right). \quad (10)$$

It can be shown by numerical calculations that for weak liquid solutions the arguments of the exponentials in (10) are

$$\frac{\Pi_1 c_p}{\lambda} L \ll 1, \quad \frac{\Pi_1 c_p}{\lambda} Z \ll 1.$$

Therefore, if we are interested only in weak solutions, then ψ_1 and ψ_2 can be expanded in a Maclaurin series and the first two terms can be retained:

$$\psi_1 = 1 + \frac{\Pi_1 c_p}{\lambda} L, \quad \psi_2 = 1 + \frac{\Pi_1 c_p}{\lambda} Z. \quad (10')$$

Substitution of (10') in (9) leads in this case to linearization of the expression for $T(Z)$:

$$T(Z) = T_0 - \frac{T_0 - T_L}{L} Z. \quad (9')$$

The expression for the heat flux (2), when account is taken of (9) and (10), becomes

$$\Pi_2 = \Pi_1 \left(T_0 - \frac{T_0 - T_L}{1 - \psi_1} \right) c_p. \quad (11)$$

We now return to Eq. (6). It describes the distribu-

tion of the concentration of the solution over the depth of the vessel. However, to determine the supersaturation zone it is necessary to have one more equation that determines the boundary of the total saturation of the solution as a function of the temperature $T(Z)$. It is at present impossible to obtain such an equation theoretically. We therefore use an empirical rule, from which it follows that for weak solutions the boundary stratification curve can be described in terms of the coordinates C and T by the following equation:

$$C_n = A + BT, \quad (12)$$

where A and B are constant coefficients fitted experimentally to the experimental stratification curve of the solution. Combining (9), (10), and (12), we obtain an equation for the boundary saturation curve

$$C_b = A + B \left[T_0 - \frac{T_0 - T_L}{1 - \psi_1} (1 - \psi_2) \right]. \quad (13)$$

The supersaturation zone of the solution can be determined as the difference between the actual concentration of the solution and its saturated value, i.e., as the difference between (6) and (13):

$$\Delta C = (6) - (13) = C_0 - \frac{C_0 - C_L}{L} Z - C_n. \quad (14)$$

It is obvious that positive values of ΔC will correspond to the supersaturated-solution zone, and negative ones to the unsaturated zone.

3. WIDTH OF THE ZONE SENSITIVE TO STRATIFICATION ON IONS

We shall agree to define as the upper limit of the sensitivity zone that limit which is determined by the start of formation of viable stratification nuclei on the ions; similarly, the lower limit corresponds to intense formation of stratification of centers on concentration fluctuations.

To determine the upper limit of the zone, we use a conclusion arrived at in^[3], from which it follows that the critical supersaturation of the solution ΔC_c , corresponding to the start of the appearance of stable nuclei on the ions, can be determined from the equation

$$\Delta C_c = \frac{3}{2} \frac{MC_b}{\rho RT} \left(\frac{4\pi\sigma^4}{(ze)^2} \frac{\epsilon\epsilon_2}{\epsilon_2 - \epsilon} \right)^{1/3}, \quad (15)$$

where M and ρ are the molecular weight and density of the dissolved matter, σ is the surface tension on the boundary between the nucleus and the solution, ze is the charge of the ion in which the drop is produced in the solution, and ϵ and ϵ_2 are respectively the dielectric constants of the solution and of the drop. It is obvious that the coordinates Z_1 , corresponding to the upper limit of the sensitivity zone, should be determined from the condition $\Delta C = \Delta C_c$, where ΔC is taken from (14) and ΔC_c from (15). Solving this equation, we obtain

$$Z_1 = L \frac{C_0 - C_n}{C_0 - C_L} - \frac{3}{2} \frac{ML}{\rho RT} \frac{C_n}{C_0 - C_L} \left(\frac{4\pi\sigma^4}{(ze)^2} \frac{\epsilon\epsilon_2}{\epsilon_2 - \epsilon} \right)^{1/3}. \quad (16)$$

In Eq. (15) T and C_b are functions of Z_1 , i.e., this is a transcendental equation and can be solved graphically or numerically if the coefficients are specified. However, this equation can be greatly simplified by

leaving out from the expressions for T and C_b the term $(T_0 - T_L)(1 - \psi_2)/(1 - \psi_1)$ and retaining only T_0 . Such an approximation is admissible, since $T_0 \sim T_L$, $\psi_1 \sim \psi_2$, and consequently $T_0 \ll (T_0 - T_L)(1 - \psi_2)/(1 - \psi_1)$. The inaccuracy of this approximation can be partially compensated for by introducing into (16) in place of T_0 the quantity $\bar{T} = (T_0 + T_L)/2$. Taking these simplifications into account, Eq. (16) can be written in the form

$$Z_1 = \frac{3}{2} \frac{M}{\rho RT} \frac{A + B\bar{T}}{\text{grad } C} \left(\frac{4\pi\sigma^4}{(ze)^2} \frac{\varepsilon\varepsilon_2}{\varepsilon_2 - \varepsilon} \right)^{1/2} - \frac{C_0 - A - B\bar{T}}{\text{grad } C}. \quad (17)$$

To determine the lower limit of the sensitivity zone, which is characterized by a large frequency of spontaneous generation of stable stratification centers, we use the fundamental Becker-Doring kinetic equation^[12] for the rate of heterogeneous formation of critical nuclei:

$$I^* = \frac{N^* S^* \beta}{\sqrt{2\pi kT}} \sqrt{\frac{\Delta\Phi^*}{3n^*}}. \quad (18)$$

In this expression, I^* denotes the number of stratification nuclei with critical dimensions produced per second in cm^3 of supersaturated solution, $S^* = 4\pi r^{*2}$ is the surface area of the nucleus of radius r^* , β is the number of collisions of the molecules of the dissolved substance from a unit surface of the nucleus per second, $\Delta\Phi^*$ is the maximum change of the thermodynamic potential of the supersaturated solution when a nucleus of critical dimension is produced in it, n^* is the number of molecules in the nucleus, and N^* is the average number of nuclei of critical dimension in 1 cm^3 of the solution, which are in statistical equilibrium with the number N of solute molecules in the same volume.

The quantity N^* can be represented by the well known Boltzmann formula

$$N^* = N \exp(-\Delta\Phi^*/kT). \quad (19)$$

For a binary solution, $\Delta\Phi^*$ is the maximum of the following function (see^[3]):

$$\Delta\Phi = -\frac{4\pi}{3} \frac{\rho}{M} RT \frac{\Delta C}{C_b} r^3 + 4\pi r^2 \sigma. \quad (20)$$

We have used here the same notation as in (15). For nuclei of critical dimension there should be satisfied the extremal condition

$$\left. \frac{\partial \Delta\Phi}{\partial r} \right|_{r=r^*} = 0. \quad (21)$$

It follows therefore from (20) and (21) that

$$r^* = 2\sigma \left(\frac{\rho}{M} RT \frac{\Delta C^*}{C_b} \right)^{-1}. \quad (22)$$

Substituting now (22) in (20), we obtain the sought expression for $\Delta\Phi^*$:

$$\Delta\Phi^* = \frac{16}{3} \pi \sigma^3 \left(\frac{\rho}{M} RT \frac{\Delta C^*}{C_b} \right)^{-2}. \quad (23)$$

The quantity n^* , which enters in (18), can be determined by starting from the volume of the nucleus, the molecular weight, and the density of the substance in the nucleus. Without presenting the simple calculations here, we write down

$$n^* = \frac{32\pi}{3} N_0 \frac{\rho}{M} \sigma^3 \left(\frac{\rho}{M} RT \frac{\Delta C^*}{C_b} \right)^{-3}, \quad (24)$$

where N_0 is Avogadro's constant.

It is easy to determine also the quantity N , which enters in (19):

$$N = N_0 \frac{\rho_2}{M_2} C_b, \quad (25)$$

where ρ_2 and M_2 are the density and molecular weight of the solvent.

The factor β in (18) is still unknown. Its explicit form is easiest to establish from the well known law of diffusion transport of matter in the solution. It follows from it, in particular, that the flux of impurity molecules in the solution through an area ΔS normal to a given direction, in a time Δt , is

$$\Delta N = \frac{1}{6} N \bar{u} \Delta S \Delta t, \quad (26)$$

where \bar{u} is the average thermal velocity of the impurity molecules in the solution. By definition, $\beta = \Delta N / \Delta S \Delta t$, and therefore

$$\beta = \frac{1}{6} N \bar{u}. \quad (27)$$

In turn, from the equation for the diffusion coefficient $D = \bar{u}l/3$ we get

$$\bar{u} = 3D/l, \quad (28)$$

where l is the mean free path of the impurity molecules in the solution. For liquid solutions, l can be identified with the intermolecular distance δ . Substituting (28) in (27) and putting $l = \delta$, we obtain

$$\beta = \frac{1}{2} ND / \delta. \quad (29)$$

Gathering now Eqs. (18)–(29) and making simple transformations, we obtain a final formula for the frequency of the fluctuation generation of stratification centers with critical dimensions:

$$I^* = \left(N_0 C_b \frac{\rho_2 M}{\rho M_2} \frac{\sigma}{RT} \right)^2 \frac{D}{\delta} \sqrt{\frac{16\pi}{3} \left(\frac{\Delta C^*}{C_b} \right)^{-3/2}} \times \exp \left[-\frac{16\pi\sigma^3}{3kT} \left(\frac{\rho}{M} RT \frac{\Delta C^*}{C_b} \right)^{-2} \right]. \quad (30)$$

As a criterion for the establishment of the lower limit of the sensitivity zone we can choose $I^* = 1 \text{ cm}^{-3} \text{ Sec}^{-1}$.

For an exact solution of our problem, namely the determination of the lower limit of the sensitivity zone, it is necessary to solve first Eq. (30) for ΔC^* , equate ΔC^* to ΔC (from (14)), and then solve the resultant equation for Z_2 . However, such a plan of successive transformations cannot be realized, since Eq. (30) is transcendental. The problem can be solved only numerically or graphically. This circumstance will be illustrated below using as an example the determination of the width of the sensitivity zone in two liquid solutions.

4. GROWTH RATE OF THE DROPS IN THE SOLUTION AND THE TIME OF THEIR REMOVAL FROM THE SENSITIVITY ZONE

The transition of the nucleus into a transcritical region in a supersaturated solution will be accompanied by an unlimited growth of this nucleus as a result of the excess matter released from the solution. The rate of such a growth can be described by Hazen's approximate equation^[13]

$$r = \left(2D \frac{\rho_c - \rho_n}{\rho} t \right)^{1/2}, \quad (31)$$

where ρ is the density of the nucleus (henceforth referred to as the drop); ρ_c is the partial density of the matter dissolved in the supersaturated solution; ρ_n is the density of the same substance in the saturated solution; r is the radius of the drop and t is the time of its growth.

Assuming for liquids D equal to 10^{-5} cm² sec⁻¹, $\rho_c = 0.1\rho$, and $\rho_n = 0.05\rho$, as is usually the case for weak solutions, and using Eq. (31), we obtain the time necessary for the drops to grow from the critical dimension to a visible dimension $\sim 5 \times 10^{-4}$ cm. Calculations by means of formula (31) yield $t \approx 0.2$ sec.

The drop produced in the solutions will descend under the influence of the gravity in accordance with the Stokes law (we assume that the specific gravity on the drops is larger than the specific gravity of the solution):

$$u = \frac{2r^2g(\rho - \rho')(\eta' + \eta)}{9\eta'(2\eta' + 3\eta)}, \quad (32)$$

where u is the rate of the descent, g the acceleration due to gravity, ρ and η are the density and the viscosity of the liquid forming the drop, and ρ' and η' are the density and viscosity of the solvent. Using in (32) the value of r^2 from (31), we get

$$u = \frac{4D(\rho_c - \rho_n)g(\rho - \rho')(\eta' + \eta)}{9\rho\eta'(2\eta' + 3\eta)} t. \quad (33)$$

Let us now estimate, by way of an example, the value of u for drops produced in a solution of methyl alcohol in hexane at room temperature. From the published handbook data we have $\rho - \rho' = 0.12$ g-cm⁻³, $\eta = 6 \times 10^{-3}$, and $\eta' = 3 \times 10^{-3}$ g-cm⁻¹ sec⁻¹. Substituting in (33) these data and the data for ρ_c , ρ_n , ρ , and D , which we used above in the calculation of t , we get

$$u = 3 \cdot 10^{-3} t \text{ (cm/sec)}. \quad (34)$$

The path S covered by the descending drops in a time t is $S = (\frac{3}{2}) 10^{-3} t^2$ (cm-sec). It follows therefore that the natural escape of drops from a sensitivity zone several centimeters deep should occur within several dozen seconds. In Eq. (31) we did not take into account the additional growth of the drop due to its displacement from the depleted layers of the solution to the more and more saturated layers. Allowance for this circumstance should lead to a stronger dependence of the drop growth rate on the time and, consequently, to a decrease of their stay in the sensitive zone of the solution.

5. PARTICULAR APPLICATIONS OF THIS THEORY

As illustrations of the premises developed here concerning the width of the sensitivity zone and the fluxes of the heat and solute in the solutions, let us consider two-component solutions of methyl alcohol in hexane and of water in benzene. These solutions were chosen because of the availability of more complete information concerning their stratification and concerning their pure components. These solutions are also of interest in that they consist of components with large hydrogen contents.

a) Methyl alcohol-hexane. We assume the length L of the cylinder filled with the solution to be 12 cm. Let the region of the working temperatures extend from 20

to 46°C, i.e., we assume for the upper part of the cylinder $T_0 = 319^\circ\text{K}$, and for the lower one $T = 283^\circ\text{K}$. Inside this temperature range, the solution is characterized by a stratification curve^[14]. We assume also that the following weight concentrations on the methyl alcohol in the hexane are maintained at the ends of the cylinder: $C_0 = 0.19$ and $C_L = 0.07$. Then, as follows from the stratification curve^[14], the drops produced in the solution will consist of 0.6 molar parts of methyl alcohol and 0.4 parts of hexane. The dielectric constants of the solution and of the drops, calculated from the partial values of the dielectric constants of the pure components, are $\epsilon = 2.14$ and $\epsilon_2 = 12$. The surface tension σ on the boundary between the drops and the solution, obtained in accordance with Antonov's rule, is 2 dyne-cm⁻¹. We use also the following tabulated data: $M = 32$ and $M_2 = 86.18$ g-mole⁻¹, $\rho = 0.82$ and $\rho_2 = 0.66$ g-cm⁻³, $\lambda = 0.13$ W-m⁻¹ deg⁻¹, $c_p = 0.6$ cal-g⁻¹ deg⁻¹, $D = 10^{-5}$ cm² sec⁻¹, and $\delta = 2.5 \times 10^{-8}$ cm.

Substitution of these data into formula (7) yields for the solute flux a value $\Pi_1 = 8 \times 10^{-8}$ g-cm⁻² sec⁻¹. It follows therefore that $\Pi_1 c_p / \lambda = 1.5 \times 10^{-4}$ cm⁻¹. The smallness of this quantity makes it possible to use in subsequent calculations the formula (9') in lieu of (9).

The heat flux obtained from formula (11) is 6.5×10^{-4} cal-cm⁻² sec⁻¹. The results of other calculations (the distribution of the temperature and of the concentration in the solution) are plotted in Fig. 1. The straight lines 1 and 2, in accordance with formulas (9) and (6), represent the changes of the temperature and of the concentration with depth of the solution. Curve 3 is the boundary of the saturated solution C_b . This curve is based on the experimental data borrowed from the paper of Chernova^[14]. The region contained

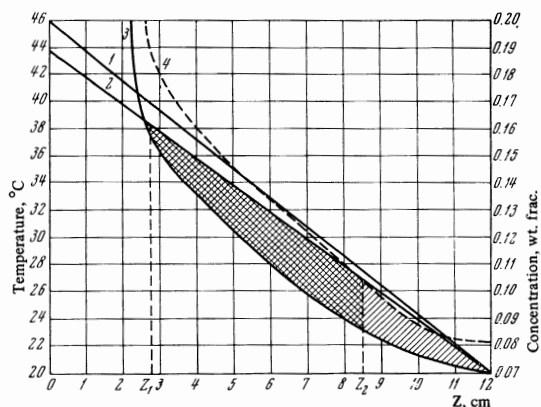


FIG. 1. Distribution of the temperature and of the concentration of methyl alcohol in hexane over the depth of the solution. 1 - Temperature, 2 - concentration, 3 - saturation limit, 4 - admissible supersaturation limit. The sensitivity zone is doubly cross-hatched, and the supersaturation zone is shaded.

between the line 2 and the curve 3 is the region of the supersaturated solution. The part of this region lying between the point Z_1 and Z_2 is the sensitivity zone of the solution. In this zone, the ions are active centers of stratification of the solution.

The upper limit of the sensitivity zone Z_1 was obtained by graphically solving the equation $\Delta C_c = C - C_b$,

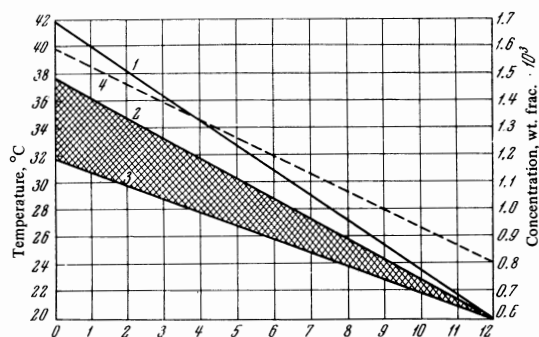


FIG. 2. The same as Fig. 1, but for a solution of water in benzene.

where the values for C and C_b were taken from the curves of Fig. 1, and ΔC_C was calculated from formula (15). The position of the lower boundary Z_2 was determined with the aid of formula (30), in which I^* was assumed equal to $1 \text{ cm}^{-3} \text{ sec}^{-1}$ and $T = (T_0 + T_L)/2$. The condition $\Delta C^* \leq C_b/5$ on the boundary position was first obtained from formula (30), and then the plots of Fig. 1 were used to determine the coordinate Z_2 for which C_b and $\Delta C = C - C_b$ satisfied the given condition.

Curve 4 represents the limit of the admissible concentration of the solution, and its coordinates were determined from the limiting formula

$$C = C_b + \Delta C^* = 1,2C_b$$

It is seen from the figure that in a solution of methyl alcohol in hexane, at the chosen initial conditions, the width of the sensitivity zone is about 6 cm. It is obvious that the sensitivity zone can be greatly broadened by suitably optimizing the quantities T_0 , T_L , C_0 , C_L , and L .

b) Water-benzene. For this solution we assume $L = 12 \text{ cm}$, $T_0 = 350^\circ \text{K}$, $T_L = 293^\circ \text{K}$, $C_0 = 1.5 \times 10^{-3}$, and $C_L = 0.6 \times 10^{-3}$. We omit the calculation details, since they duplicate the first case. We note only that from (15) it follows that $\Delta C^* \leq C_b/3$.

The results of all the calculations are plotted in Fig. 2. The data for the construction of the saturation boundary C_b were taken from the paper by Englin^[15]. Just as in the preceding case, the straight line 4 limits from above the admissible concentration of the solution. To construct this line, we use the limiting equation $C = C_b + \Delta C^* = 4C_b/3$. It is seen from Fig. 2 that in a solution of water in benzene the sensitivity zone extends over the entire depth of the vessel.

An examination of these two particular examples

shows that in the liquid solution it is possible to maintain continuously a supersaturated state sufficient for the formation of fog on the ions.

The formulas obtained in the paper lead to the conclusion that the operating principle of gas-diffusion track chambers can be transferred in its totality to liquid chambers filled with binary solutions. The depth of the sensitivity layer in such chambers can extend over the entire depth of the solution.

This investigation may serve as the basis for the development of liquid track chambers of continuous sensitivity.

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