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Hyperacoustic parameters of solutions at different temperatures

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***Abstract*---**A great contribution to the study of the liquid state can made by elucidating the nature of structural changes in liquid molecules at various state parameters. Optical methods will give us the opportunity to obtain more, complete information about nature of structural changes in molecules. One of these methods based on the study of the spectra of the Mandelstam-Brillouin scattering of light. Investigations of the spectra of Mandelstam-Brillouin scattering of light in solutions and the study of hyperacoustic parameters from them are another method for studying the molecular nature of intermolecular interactions in liquids. We have studied hyperacoustic parameters in a solution of aniline nitrobenzene at various concentrations and temperatures. As can be seen from the results obtained, with an increase in the proportion of aniline in the solution, an increase in the speed $\vartheta_{гз}$ and f_z frequency of hypersound and a decrease in the calculated value of the adiabatic compressibility - β_s. As can be seen from the data obtained, with an increase in the proportion of aniline in the solution, the hyperacoustic parameters change as a function of the viscosity described by formula (2). The change in these values can explained by a change in the structure and intermolecular interaction in the studied solutions with a change in the parameters of the state.

***Keywords*---**hyper sound, scattering, liquid, temperature, intermolecular interaction, absorption, frequency, solution, aniline, nitrobenzene, adiabatic compressibility.

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Introduction

The development of the molecular theory of the liquid state of matter contributes to the solution of applied problems in many branches of science and technology. However, the molecular theory of the liquid state of matter is far behind in its development from a similar theory of gases and solids. The study of the influence of intermolecular interaction on molecular light scattering, on hyperacoustic parameters, and on relaxation processes makes it possible to obtain the most correct information about the nature and structural changes during the transition of a liquid from a homogeneous to an inhomogeneous state. Acoustic studies of binary solutions in a wide range of concentration and temperature are of theoretical and applied importance. This is important from the point of view of the development of the molecular theory of the liquid state of matter, and with the ever-growing practical application of mixtures in a number of industries /1-4/.

We have studied the hyperacoustic and thermodynamic parameters in solutions of aniline + nitrobenzene at various concentrations and temperatures using the spectra of Mandelstam - Brillouin light scattering. To solve this problem, we used a spectral apparatus assembled on the basis of a Fabry-Pierrot interferometer with a dispersion region of 0.625 cm ^{2} . The excitation light source was a helium-neon laser with wavelength λ= 6328 A ^{0} . Thermal research was carried out in a special thermostat with an accuracy of maintaining the temperature 0.1 ^{0} FROM. Taking into account the tasks set, we studied the spectra of Mandelstam - Brillouin scattering of light and, using the displacement and half-width of the components, the hypersound propagation velocity was calculated using formula (1):

$$\vartheta_{\text{гз}} = \frac{\Delta\nu\cdot c\cdot\lambda}{2\cdot n\cdot sin\frac{\theta}{2}} \qquad (1)$$

Where, $\Delta\nu$ is the displacement of the Mandelstam-Brillouin component, c is the speed of light, λ is the wavelength of laser radiation, n is the refractive index of the studied liquid, $\theta$is the scattering angle. It has established that in solutions of aniline + nitrobenzene with an increase in the proportion of aniline in the mixture increases the speed of hypersound as viscosity. The relationship between viscosity and hypersound propagation velocity at a temperature of 293 K can expressed by the following expression /5/:

$$\vartheta_{\text{гз}} = \sum_{i=j}^{n} \vartheta_i \prod_{i\neq j} \frac{\eta-\eta_i}{\eta_i-\eta_j} \qquad (2)$$

Here, η_i и $\eta_j$are the viscosities at which the hypersonic velocity known ϑ_i, η is the viscosity at which the hypersound velocity is unknown. Calculation results ($\vartheta_{\text{гз}}$(η)) with a special program is shown in Fig. 1 and fig. 2

ϑ, m/s

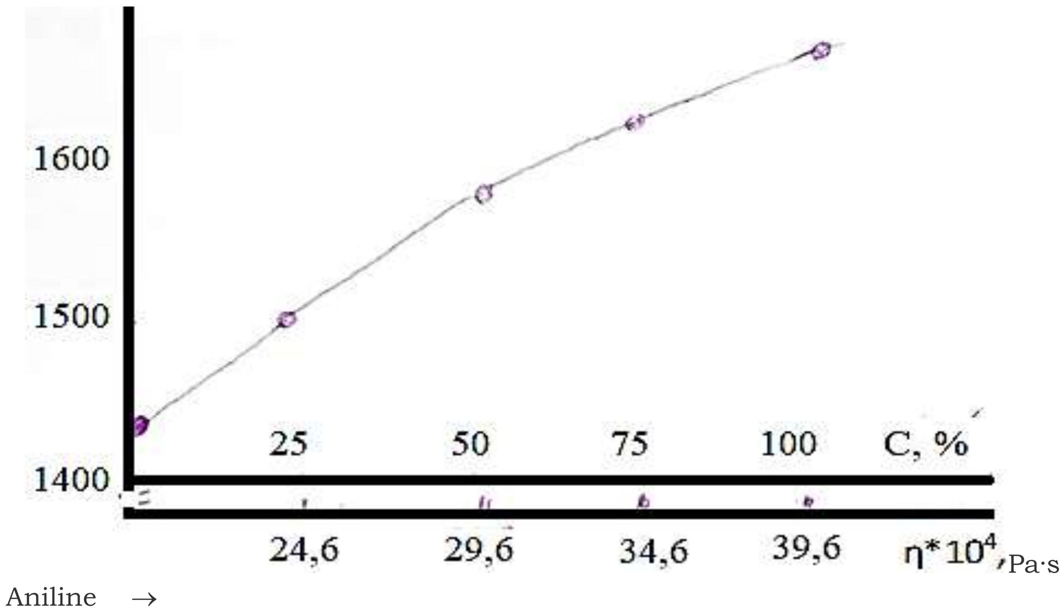
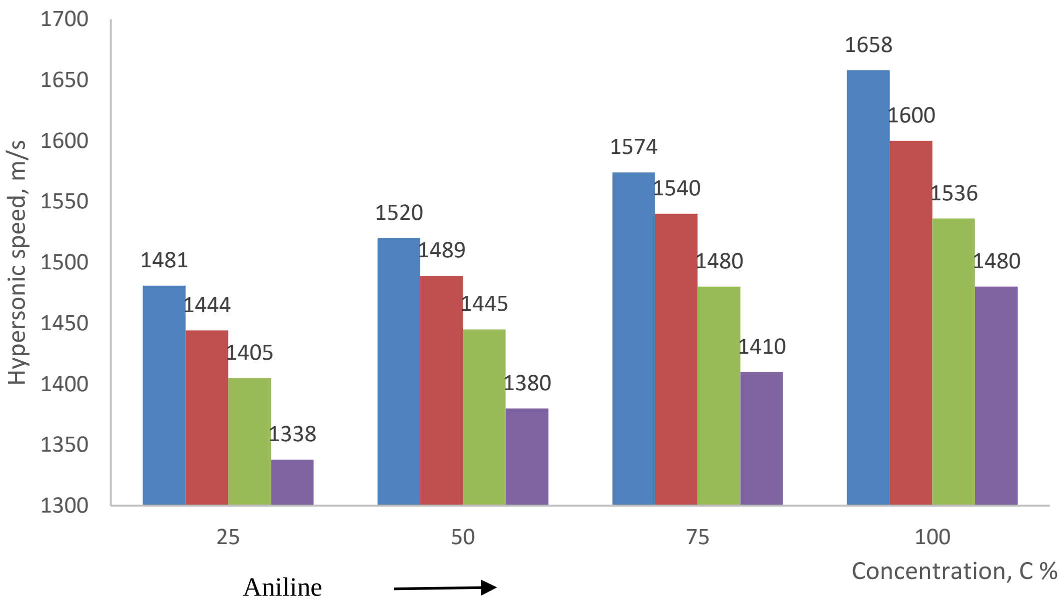


Fig.1



Rice. 2

Table 1 shows the results of measuring hyperacoustic thermodynamic parameters in solutions of nitrobenzene + aniline in ratios of 1.0:0.0; 0.75:0.25; 0.50:0.50; 0.25:0.75; 0.0:1.0 at various temperatures. As can be seen from the results obtained, with an increase in temperature in solutions, the hypersound velocity ($\vartheta_{гз}$) and the frequency f_z of hyper sound decrease, and the adiabatic compressibility calculated by the formula $\beta s = 1/\rho\, \vartheta_{гз}^2$ increases. As we have already noted, the relationship between the speed of hypersound propagation and concentration characterized by a change in viscosity. Hyperacoustic parameters of nitrobenzene (X_1) + aniline (X_2) solutions at different temperatures and concentrations.

T, K	$X_1:X_2$	$\vartheta_{гз}$, m/s	f_{gz}, 10^9 Hz	βs, 10^{11} Pa $^{-1}$
293	1.0:0.0	1435	4.9	40
	0.75:0.25	1481	5.2	38
	0.50:0.50	1520	5.5	37
	0.25:0.75	1574	5.8	36
	0.0:1.0	1658	6.1	34
323	1.0:0.0	1400	4.7	42
	0.75:0.25	1444	5.1	39
	0.50:0.50	1489	5.4	37
	0.25:0.75	1 540	5.7	36
	0.0:1.0	1600	5.9	35
348	1.0:0.0	1370	4.5	44
	0.75:0.25	1405	4.8	41
	0.50:0.50	1445	5.1	39
	0.25:0.75	1480	5.5	38
	0.0:1.0	1536	5.7	36
373	1.0:0.0	1307	4.3	46
	0.75:0.25	1338	4.7	44
	0.50:0.50	1380	4.9	41
	0.25:0.75	1410	5.1	38
	0.0:1.0	1480	5.5	37

In thermal studies, these relationships are also preserved. As the temperature rises, the viscosity of the liquid and, accordingly, the speed and frequency of hypersound decrease, while the adiabatic compressibility increases. As can be seen from the data obtained, with an increase in the proportion of aniline in the solution, the hyperacoustic parameters change as a function of the viscosity described by formula (2). The change in these values can explained by a change in the structure and intermolecular interaction in the studied solutions with a change in the parameters of the state.

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