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DEPENDENCE OF HYPERSOUND PROPAGATION SPEED ON MOLECULAR MASS AND TEMPERATURE

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Optical methods provide an opportunity to obtain comprehensive information about the structural changes in liquid molecules.

***Key words**: Hypersound, molecular mass, scattering, liquid, alcohols, temperature, pressure, spectrum, intermolecular interaction.*

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The molecular theory of the liquid state significantly lags behind the development of theories for gases and solids.
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A great contribution to the study of the liquid state can be made by clarifying the nature of structural changes in liquid molecules under different state parameters.

Optical methods provide an opportunity to obtain comprehensive information about the structural changes in liquid molecules.

The aim of this work is to study the manifestation of changes in structure and intermolecular interactions on the Mandelstam-Brillouin light scattering spectra and on hyperacoustic parameters at different state parameters.

Normal alcohols have been the subject of acoustic studies many times. However, the studies have mainly focused on ultra-acoustic parameters. Hyperacoustic parameters with state parameter variations have not been sufficiently

studied. In [1], the acoustic properties of a number of alcohols were studied in the temperature range of 180-293 K. It was shown that in strongly associated liquids, including normal alcohols, at frequencies up to 10 GHz, the structural relaxation mechanism predominates in sound absorption due to the redistribution of intermolecular hydrogen bonds.

A helium-neon (He-Ne) laser served as the light source.

The speed of hypersound is determined by the shift of the Mandelstam-Brillouin scattering spectrum with the formula:

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

Where, $\Delta\nu$is the displacement of the Mandelstam-Brillouin components (cm $^{-1}$), c is the speed of light, is the wavelength of laser radiation, $n$is the refractive index of the liquid, $\frac{\theta}{2}$is the scattering angle

In order to study the relationship between the sequential change of structure and hyperacoustic parameters, as well as the influence of complex formation through hydrogen bonding on them, ten normal alcohols were studied at different temperatures.

The increase in molecular weight of alcohols in the homologous series corresponds to an increase in hypersonic speed, which is nonlinear.

$$\vartheta_{\text{гз}} = \sum_{i=1}^{n} \vartheta_i \prod_{i \neq j} \frac{\mu - \mu_i}{\mu_1 - \mu_j} \qquad (2)$$

Where $\mu_1$and $\mu_j$are the molecular masses of alcohols with known hypersonic speeds, are the hypersonic speeds related to the molecular masses μ_1 and μ_j, ϑ_i is the hypersonic speed calculated from the Madelstam-Brillouin spectra, corresponding to molecular weight μ.

The results of measurements of the propagation speed of hypersound at different molar masses (μ) are shown in Fig. 1.

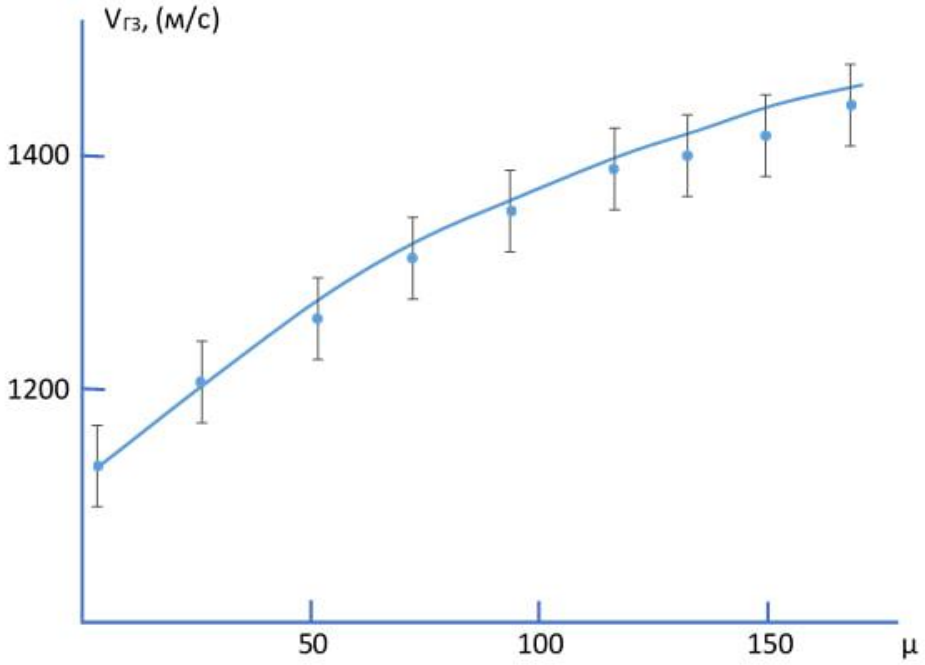

Fig. 1.
Dependence of the speed of hypersound on the molecular weight of a number of alcohols.

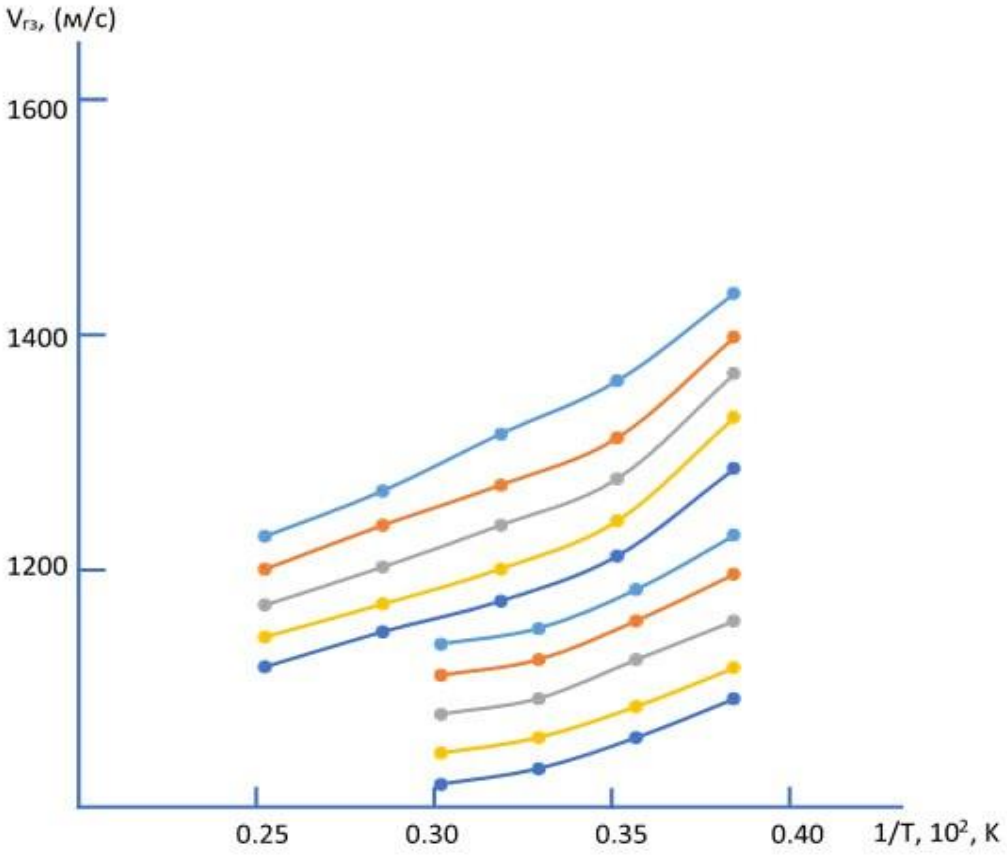

Fig. 2.

Dependence of the hypersonic speed of a number of alcohols on temperature. As the temperature increases, the hypersound speed decreases (Fig. 2). This decrease is qualitatively the same in all alcohols, and the tendency is that the higher the temperature, the closer the hypersound speeds in these alcohols. The dispersion value for the first members of the homologous series is small, however, for higher members there is a tendency to increase

As we know, aliphatic alcohols are typical representatives of associated liquids with intermolecular hydrogen bonds. An increase in pressure leads to an increase in the number of H-bonds. This is consistent with Le Chatelier's principle / 2 /, according to which H-bonds reduce the volume occupied by molecules, therefore their formation is facilitated by those processes that lead to a decrease in the volume per molecule / 3 /.

An increase in temperature, on the contrary, leads to the destruction of associates. The results of experiments showed that with an increase in temperature, the speed of hypersound in normal alcohols decreases nonlinearly, and at high temperatures, the ends of the curves of the dependence $\vartheta_{\text{гз}}$on T at 450 K approach each other. It can be concluded that at high temperatures and pressures, the quantitative difference in the speed of hypersound in normal alcohols tends to decrease. We associate such a tendency in the case of an increase in temperature with the destruction of the probability of the formation of H-bonds.

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