

VISCOSITY OF HYDROGEN ISOTOPE SOLUTIONS

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The viscosity of hydrogen isotope solutions is measured. The viscosity coefficients are found to be smaller than their additive values. It is moreover found that the deviation of the viscosity coefficients from additivity depends on the mass of the solution components.

We have previously reported measurements of the viscosity of H₂-D₂ solutions^[1]. With the aid of a capillary viscosity meter described in^[2], we measured the viscosity of H₂-HD and HD-D₂ solutions in the entire region of concentrations at temperatures from 15 to 20.4°K. In all the investigated solutions, the dependence of the viscosity coefficients on the concentration had the same character. If we assume that the viscosity coefficient of the mixture is an additive quantity, i.e., $\eta = \eta_1x_1 + \eta_2x_2$ (where η is the viscosity coefficient of the mixture, η_1 and η_2 the viscosity coefficients of the components, and x_1 and x_2 are the concentrations of the latter), then the experimental values of the viscosity coefficients for these systems are smaller than additive at all temperatures and in the entire range of concentrations. The table lists the values of the viscosity coefficients for these systems for two isotherms: T = 18.8°K and T = 20.3°K.

To estimate the deviation of the viscosity coefficients of the solutions from their additive value we can use the relative difference of these coefficients $\Delta\eta/\eta$, where $\Delta\eta = \eta - \eta_{\text{exp}}$. Figure 1 shows the dependence of $\Delta\eta/\eta$ on the concentration for all the investigated systems. As can be seen from the figure, the deviation from additivity is asymmetrical with respect to the concentration. It increases with decreasing temperature. In addition, it turns

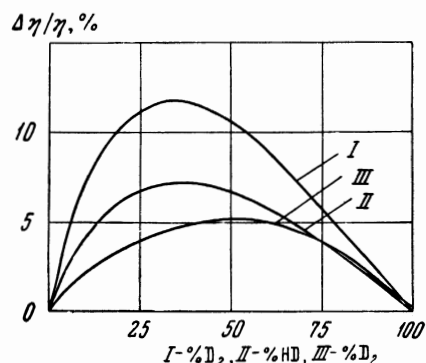


FIG. 1. Relative excess viscosity vs. concentration for the following systems: I - H₂-D₂, II - H₂-HD, III - HD-D₂ at a temperature 18.8°K.

out that the relative difference of the viscosity coefficients of the solutions is connected with the masses of the components, and increases with increasing mass difference of the isotopes making up the solution. At the maximum at T = 18.8°K it is equal to 11.5, 7.0, and 5.1% for the systems H₂-D₂, H₂-HD and HD-D₂, respectively.

It is also natural to compare the quantity $\Delta\eta/\eta$ with the relative mass difference $\Delta m/m_{\text{av}}$ of the isotopes, where $\Delta m = m_1 - m_2$. Figure 2 shows this relation. Its plot is a straight line extending to the origin. In addition, we plotted $\Delta\eta/\eta$ against m_h/m_l , where m_h and m_l are the masses of the

Viscosity of mixtures of hydrogen isotopes (averaged values of η , 10⁻⁶ cgs units)

Mixture	T°, K	Concentration of second component, molar %					
		0	20	40	60	80	100
H ₂ - D ₂ {	18.8	143	181	230	290	360	434
	20.3	128	160	200	248	303	358
H ₂ - HD {	18.8	143	156	175	199	227	260
	20.3	128	140	157	176	198	225
HD - D ₂ {	18.8	260	284	312	343	383	434
	20.3	225	241	262	289	320	358

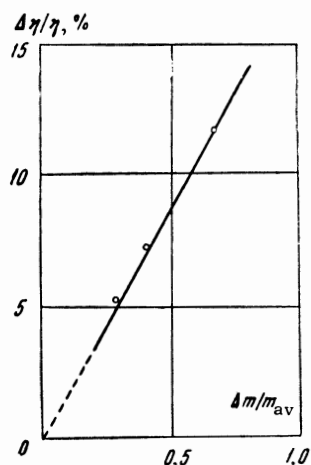


FIG. 2. Relative excess viscosity vs. relative isotope mass difference.

heavy and light components, respectively. This plot is a continuous curve which extends to unity value of m_h/m_l . A connection is thus observed for both cases between the masses of the solution components and the deviation of the viscosity coefficients from additivity.

¹N. S. Rudenko and V. G. Konareva, ZhFKh (Journal of Physical Chemistry) 38, 2700 (1964).

²N. S. Rudenko and V. G. Konareva, *ibid* 37, 2761 (1963).

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