From the results of [1] it follows that for H₂O and D₂O molecules at temperatures below the melting point, the values of the entropy of activation of electrical relaxation $\Delta S_T$ vary. At the same value of the heat of activation $\Delta U_T$, $\Delta S_T$ is greater for H₂O than for D₂O. This can be explained by the difference in the inertial properties of the H₂O and D₂O molecules, since rotation in the electrical field of the dipole associated with a polar molecule leads to a larger change in the ordering in the arrangement of the molecules and, consequently, to a larger change in the entropy in the lighter H₂O molecules. It was found that the difference in the inertial properties of H₂O and D₂O can be used to determine the degree of interaction of adsorbed molecules with one another and with the crystal lattice of the adsorbent.

**Experimental Method**

The adsorption of H₂O and D₂O molecules was studied on brand G0B-Ts-202-125 NaA zeolites. The zeolite powder was subjected to pressing and vacuum treatment for 20 h at 350°C and a pressure < 10⁻⁵ mm Hg. To reduce the influence of effect near the electrodes, the electrodes of the measuring condenser were coated with a layer of gold. The measurements were performed in the frequency range 10²-10⁷ Hz and in the temperature interval from 20 to -45°C. The filling of the zeolite with water was conducted in successive doses, corresponding to a content of from 1 to 5 water molecules in the large cavity of the zeolite. After repeated dehydration of the zeolite, the zeolite was filled with D₂O in the same way.

Figures 1 and 2 give the dependence of the factor of dielectric losses $\varepsilon''$ on the frequency $f$ in a logarithmic scale for adsorbed normal water and adsorbed heavy water. Considering the linear nature of the dependence of the low frequency losses, due to through conduction, on the frequency, we can graphically determine the contributions to $\varepsilon''$ due to relaxation of dipoles and to through conduction. The position of the maximum losses found in this way is close to the value obtained for H₂O adsorbed on unpressed zeolite at somewhat greater degrees of filling [2] and was associated with the relaxation of polar molecules of adsorbed water.

**Discussion of Results**

The relationship between the molecular relaxation time $\tau$ of the process of polarization in an electric field, the heat of activation $\Delta U_T$, and the entropy of activation $\Delta S_T$ of this process is given by the Eyring formula [3]

$$\frac{1}{\tau} = KT/h \cdot \exp \frac{\Delta S_J}{R} \cdot \exp \left(-\frac{\Delta U_J}{RT}\right)$$

where $K$ is Boltzmann's constant; $h$ is Planck's constant; $T$ is the temperature, °K; and $R$ is the universal gas constant.

Fig. 1. Dependence of the loss factor $\varepsilon''$ on the frequency $f$ for adsorbed normal water on NaA zeolite. Filling 16%: 1) $20^\circ$; 2) $-16^\circ$; 3) $-25^\circ$; 4) $-45^\circ$. Curves 5-8) the same at 4% filling.

Fig. 2. Dependence of the loss factor $\varepsilon''$ on the frequency $f$ for adsorbed heavy water on NaA zeolite. Filling 16%: 1) $20^\circ$; 2) $-16^\circ$; 3) $-25^\circ$; 4) $-45^\circ$. Curves 5-8) the same at 4% filling.

**Table 1. Values of $\Delta S_T H_2O/\Delta S_T D_2O$ at Various Temperatures and Fillings $a, %$**

<table>
<thead>
<tr>
<th>a, %</th>
<th>Temperature °C</th>
<th>-16</th>
<th>-16</th>
<th>-25</th>
<th>-35</th>
</tr>
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<tr>
<td>4</td>
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<td>1</td>
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<tr>
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<td>1</td>
<td>1</td>
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<td>1,08</td>
<td>1,1</td>
<td>1,1</td>
<td>1,42</td>
</tr>
</tbody>
</table>

Since in the case of relaxation of adsorbed $H_2O$ and $D_2O$ molecules, the $\Delta U_T$ obtained is the same, while $1/\tau$ can be set equal to the frequency at which the maximum losses are observed, the ratio $\log f_{max H_2O}/\log f_{max D_2O} = \Delta S_T H_2O/\Delta S_T D_2O$.

From Table 1 it is evident that the ratio $\Delta S_T H_2O/\Delta S_T D_2O = 1$ for a filling corresponding to approximately one adsorbed molecule per large cavity of the zeolite. Consequently, at this filling there is practically no interaction between adsorbed molecules, and there is chiefly an interaction of adsorbed molecules with the crystal lattice of the adsorbent. In the presence of two adsorbed molecules per cavity, evidently a weak interaction appears between molecules, but the interaction of the molecules with the lattice remains stronger. In the case of four molecules per cavity, the interaction between molecules becomes more perceptible, and the value of $\Delta S_T H_2O/\Delta S_T D_2O$ increases. It should be noted that the sensitivity of the method proves to be greater at low temperatures.

The absolute values of $\Delta S_T$ for $H_2O$ for pressed zeolite proved to be substantially smaller than for unpressed zeolite as a result of the reduction of the influence of heterogeneity [2]. However, the nature of the dependence of $\Delta S_T$ on the filling with water is the same in pressed and unpressed zeolites. When the degree of filling is reduced, $\Delta S_T$ decreases rapidly, beginning with a degree of filling corresponding to three molecules per cavity, and becomes very small. Thus, the interaction of adsorbed molecules with one another becomes appreciable only at degrees of filling corresponding to more than three molecules per large cavity of the zeolite. Rotation of the dipole associated with the adsorbed molecule in an electric field at low degrees of filling cannot cause any appreciable change in the entropy of the crystal lattice, in connection with the high degree of its ordering. It was shown in [4] that the change in the differential molar entropy of $H_2O$ molecules on NaA zeolite as a function of the degree of filling is almost constant at low degrees of filling, while at degrees of filling corresponding to more than three molecules per cavity, it increases sharply. This result is in good agreement with our data.

The results obtained can be explained if we assume that the first adsorbed water molecules are arranged in the eight-membered entrance windows into the large cavities and are strongly bound to the crystal lattice of the adsorbent by electrostatic forces [2, 5]. Therefore, the passage of the adsorbed water molecule into the activated state is not accompanied by any significant change in the arrangement of the other molecules. In this case the molecules are bonded to a greater degree to the adsorbent than to one another. Then the small change in the value of $\Delta S_T$ and the value of $\Delta S_T H_2O/\Delta S_T D_2O$ close to one are understandable.

In the case of large degrees of filling (> 3 molecules per zeolite cavity), the molecules are adsorbed close to the six-membered windows into the small cavities. In this case the molecules are found to be bonded to the crystal lattice of the adsorbent to a lower degree and to one another to a greater degree than in the preceding case. This also leads to an increase in the value of $\Delta S_T$ and in the ratio $\Delta S_T H_2O/\Delta S_T D_2O$. 1419