THE ELECTRIC SENFTLEBEN EFFECT IN A GAS WITH OPTICALLY ACTIVE MOLECULES

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The change of the thermal conductivity in an electric field of the polar gas C_4H_9OH with optically active molecules has been observed experimentally. It is shown that the relative change in the thermal conductivity depends on the field (E = 0–450 V/cm) and the pressure (p = 0.17–2.54 mm Hg) through the ratio E/p. In the range of values E/p from 0 to 65 V/cm-mm Hg, the effect is positive and has a maximum. For E/p > 65 V/cm-mm Hg, the effect changes sign and approaches saturation with increase in the ratio E/p.

THE behavior of the transport coefficients in monatomic gases in magnetic and electric fields is connected with the symmetry properties of the scattering probability of the molecules.[1] In view of the fact that molecules of the type of optical isomers do not have a plane and a center of symmetry,[2] the selection rules for the matrix elements of the collision operator of such molecules will be determined only by their symmetry relative to time reversal. Therefore a study of the effect of external fields on the thermal conductivity of a gas consisting of optically active molecules presents undoubted interest. As a result of the experiment that we carried out, it has been found that the behavior of the thermal conductivity of a polar gas of secondary butyl alcohol (C_4H_9OH, dipole moment d = 1.6 Debye) in an external electric field is significantly different from that usually observed in polar gases (the electrical Senftleben effect). The molecules of this gas under study are optically active.

The results are set forth below of an experimental investigation of the thermal conductivity of the gas C_4H_9OH in an electric field E up to 450 V/cm and in the pressure range p = 0.17–2.54 mm Hg. The experiments were carried out on apparatus similar to that described in[3].

The measured quantity is the relative change in the thermal conductivity

$$\varepsilon = (\varepsilon_{\parallel} + \varepsilon_{\perp})/2,$$

where $\epsilon_{\parallel}$ and $\epsilon_{\perp}$ are the values of ϵ under conditions for which the field is parallel and perpendicular to the temperature gradient. The absolute values of ϵ were found as a result of calibration measurements on the Senftleben effect in NF_3.[4]

The figure shows the experimental dependence of ϵ on E/p for the gas studied. It is seen from the drawing that, within the limits of error of measurement ($\lesssim 15\%$), ϵ depends on the field E and the pressure p through the ratio E/p. For small E/p, the value of ϵ is positive and upon increase of this ratio, ϵ passes through a maximum ($\epsilon_{max} = +0.32 \times 10^{-5}$) for E/p = 30 V/cm-mm Hg. At E/p = 65 V/cm-mm Hg, ϵ changes sign.

It should be noted that the dependence $\epsilon = \varphi(E/p)$ for the gas C_4H_9OH is similar to the dependence of the relative change in the thermal conductivity in an electric field which takes place in the case of the anomalous Senftleben effect[3] in the gas CH_3CN. Theoretical consideration of this effect will be published later.

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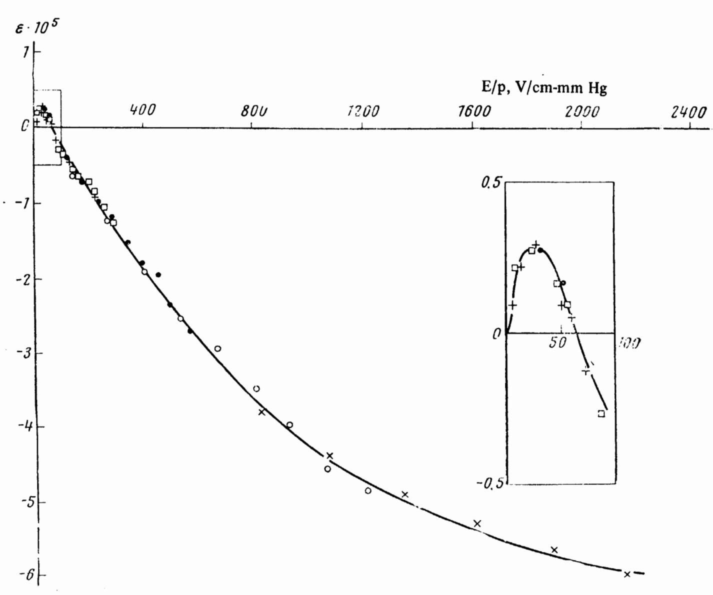

Dependence of ϵ on E/p for C_4H_9OH gas. The experimental points correspond to the following pressures (in mm Hg): ○–0.17, ●–0.80, □–1.63, +–2.54.

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