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THE VELOCITY OF PROPAGATION AND ATTENUATION OF ULTRASOUND IN METHYLPYRIDINES

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The results of measurements of c and α/f^2 as functions of temperature for five methylpyridines: β- and γ-picolines and 2.4, 2.5 and 3.5 lutidines are given.

1. Introduction

Investigations of the propagation velocity of an ultrasonic wave on α-picoline as a function of temperature [1] have shown that the functional dependence $c(T)$ is linear, but with two regions of linearity. Above 293 K the temperature coefficient of the velocity of ultrasound is -4.9 m s^{-1}deg^{-1}, but -3.9 below this temperature. This gives evidence for the existance of an additional "phase" transition (of an association-disassociation type or of a defreezing-freezing of the internal motions of the molecules) between the melting and solidification points.

Previous investigations indicated that in other methylpyridines similar transitions should be observed. In the region of the transitions, the liquids should exhibit relaxation properties.

The purpose of this paper is to describe measurements on a number of methylsubstitute pyridines in which relaxation regions might have been found. Measurements were made of the propagation velocity c and the ultrasound attenuation coefficient α as functions of temperature for five compounds: β- and γ-picolines and 2.4, 2.5 and 3.5 — lutidines.

2. Apparatus

The experimental results for c and α were obtained using an ultrasonic phase pulse interferometer type UI12 [2] at a frequency of 12 MHz. Temperature stabilization was maintained by means of a temperature regulator, type 650-UNIPAN with a platinum sensing device type 210 s 3 wire — 100 ohm, to an accuracy ± 0.05 K.

3. Results of the measurements

Fig. 1 represents the relationship between the attenuation coefficient divided by the frequency squared and the temperature, over the temperature range 280-330 K for γ-picoline. The value of this coefficient is initially constant and then rises with increasing temperature. For the same liquid the relation between the propagation velocity and the temperature is shown in Fig. 2.

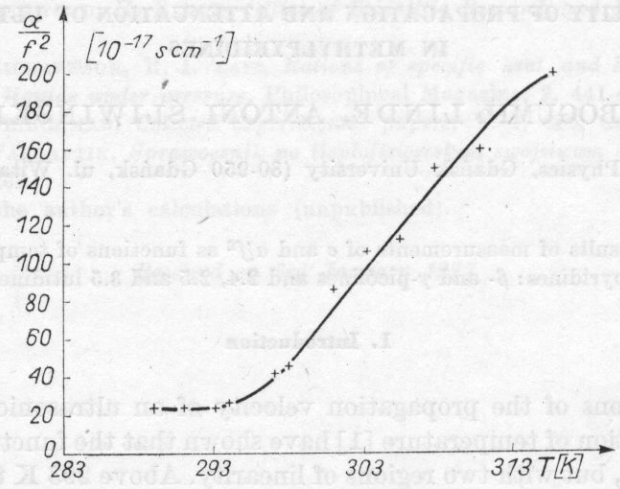

Fig. 1. The dependence of α/f^2 on temperature for γ-picoline at a frequency of 12 MHz

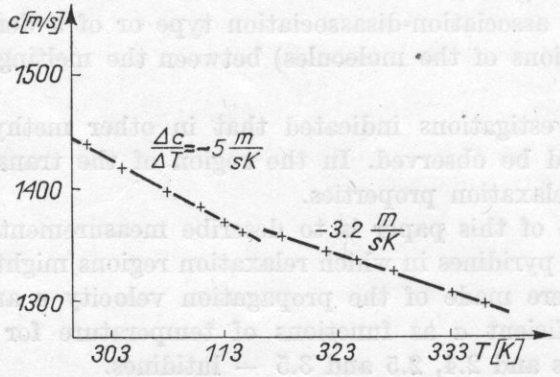

Fig. 2. The dependence of the ultrasonic propagation velocity c, on temperature for γ-picoline at a frequency of 12 MHz (the corresponding temperature coefficients of the ultrasonic velocity are given above the straight segments)

At about 315 K there is a region in which the curve has a marked change of gradient.

Similar results for the temperature dependencies of α/f^2 and c for 2.5 lutidine are shown in Figs. 3 and 4.

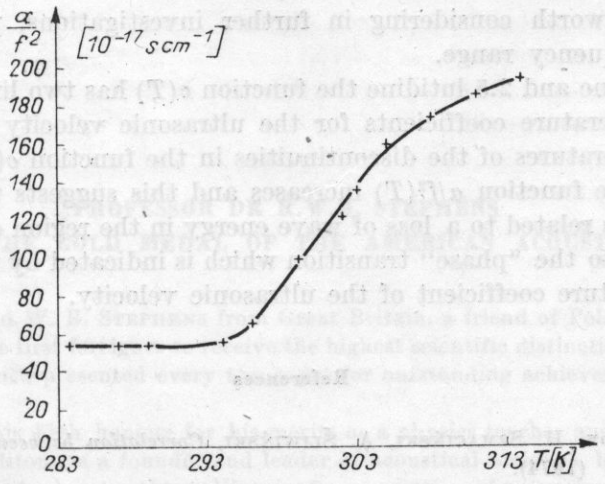

Fig. 3. The dependence of α/f^2 on temperature for 2.5 lutidine at $f = 12$ MHz

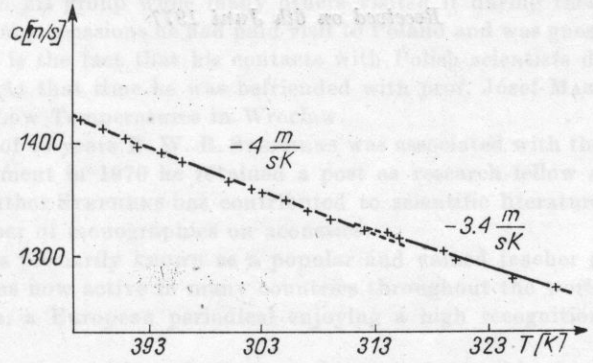

Fig. 4. The dependence of the ultrasonic propagation velocity on temperature for 2.5 lutidine for $f = 12$ MHz (the corresponding temperature coefficients of the ultrasonic velocity are given above the straight segments).

For the other liquids tested no changes in the inclination of the curve $c(T)$ were observed; the velocity coefficients for β-picoline; 2.4 and 2.5 — lutidine being -3.8 ms^{-1} deg^{-1}, -3.7 ms^{-1} and -4.6 ms^{-1} deg^{-1}, respectively.

The measurement errors for the velocity of ultrasound did not exceed 4 ms^{-1} while that for the attenuation coefficient was no more than 5 %.

4. Discussion and results

For all the above-mentioned liquids the graphical representation of the function $\alpha/f^2(T)$ indicates the existence of a relaxation region (for γ-picoline and 2.5 lutidine the representations are shown in Figs. 1 and 3). These dependen-

cies are thus worth considering in further investigations, particularly over a broader frequency range.

In γ-picoline and 2.5 lutidine the function $c(T)$ has two linear ranges, with different temperature coefficients for the ultrasonic velocity (Figs. 2 and 4).

The temperatures of the discontinuities in the function $c(T)$ are in the regions where the function $\alpha/f^2(T)$ increases and this suggests that the increase of absorption is related to a loss of wave energy in the region of the relaxation, corresponding to the "phase" transition which is indicated by the discontinuity in the temperature coefficient of the ultrasonic velocity.

References

[1] B. LINDE, H. SZMACIŃSKI, A. ŚLIWIŃSKI, *Correlation between ...*, Acta Physica Polonica, A46, 5 (1974).

[2] J. WEHR, *The measurement of the velocity and attenuation of ultrasonic waves* [in Polish], PWN, Warszawa 1972.

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