ON THE DIPOLE MOMENT OF TETRALIN.

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M. Puchalik has recently reported that tetralin (tetrahydronaphthalene) exhibits in benzene solutions considerable association, and a dipole moment of value $1.66 \times 10^{-18}$ e.s.u. Now, this value of moment is unusually high for a pure hydrocarbon. Experimental measurements have so far shown that with the exception of the unsymmetrically substituted acetylene hydrocarbons, investigated by Otto and Wenzke, almost the whole gamut of hydrocarbons of whatever shape and structure show moment values only between 0.5 to 0.0. Even here, the higher values are shown generally by unsymmetrically substituted ethylene compounds, and some benzene derivatives. More recently rather high values of moment have been reported by Svirbely, Albard and Warner for $d$-pinene and $d$-limonene: these values, however, require confirmation, particularly as the measurements have been carried out at extremely dilute solutions where the experimental errors have enormous effect on the calculated values of moment. It was, therefore, deemed necessary to check up the high value reported for the moment of tetralin and all the more so, as almost pure tetralin is available in commercial quantities and could be used as a solvent in dipole moment measurements.

**Experimental.**

The tetrahydronaphthalene used in these experiments was prepared from a "pure" stock, by drying over phosphorous pentoxide, and two successive slow fractional distillations in an all-glass apparatus under reduced pressure. The middle fraction boiling at a very steady temperature was collected for use: $d_4^{25\circ} = 0.9639$, $n_T^{25\circ} = 1.5382$.

The dielectric constant and density of the pure tetralin itself was measured initially, over the temperature range 10 to 40°, with the apparatus and methods described already. The experimental values together with the

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calculated values for the molecular polarisations are presented in Table I. It is at once evident from the low value for the dielectric constant, and the very slight decrease in molecular polarisation with temperature, that tetralin is a nearly non-polar liquid, whose molecules have a finite but small moment. For, experimental measurements on all definitely non-polar liquids have hitherto shown a small but finite rise in molecular polarisation values with temperature, a behaviour which is satisfactorily accounted for on the basis of the Raman-Krishnan theory of liquid structure. If it is assumed that the Debye equation can be directly applied to the polarisation values for the pure liquid state, the calculated value for the moment of tetralin comes out as $0.41 \times 10^{-18}$.

**Table I.**

**Pure Tetralin.**

<table>
<thead>
<tr>
<th>Temperature in °C</th>
<th>Dielectric constant ($\varepsilon$)</th>
<th>Density ($\rho$)</th>
<th>(P = \frac{\varepsilon - 1}{\varepsilon + 2} \frac{M}{\rho})</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.785</td>
<td>0.9760</td>
<td>50.51</td>
</tr>
<tr>
<td>20</td>
<td>2.756</td>
<td>0.9679</td>
<td>50.42</td>
</tr>
<tr>
<td>30</td>
<td>2.727</td>
<td>0.9599</td>
<td>50.30</td>
</tr>
<tr>
<td>40</td>
<td>2.697</td>
<td>0.9519</td>
<td>50.16</td>
</tr>
</tbody>
</table>

The difficulties in determining to the usual degree of accuracy moments of this order of magnitude by the method of dilute solutions have been discussed frequently in the literature. Thus, when the so-called "optical" method of calculating moment is employed, usually unsatisfactory results are obtained as there is no reliable method of determining the exact value of the induced or displacement polarisation. On the other hand when the method of temperature coefficient of molar polarisation is employed an increased accuracy, at least ten times in the dielectric constant and density values, is called for, or else the temperature range over which the molar polarisation is determined must be considerably enlarged. As in the present case benzene is

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