

(as well as their total volume) is related to the relative viscosity of the dispersion. The mean pore radius ( $\bar{r}$ ) should be, in fact, an inverse measure of the particle-particle interference. Experimental results obtained on a very wide range of powders differing in mineral type and fineness have shown that this idea is promising. The accompanying graph shows the correlation obtained between  $\log \eta_{r-1}$  (at 15° C. and at a single shear stress) and  $C_v/\bar{r}$ , where the liquid phase consisted of a bitumen of substantially Newtonian flow characteristics with viscosity at 15° C. of  $2.72 \times 10^4$  poises. Forty-five different systems are plotted in the graph, and include sixteen different powders (seven different mineral types). The values of  $\bar{r}$  range from 0.4  $\mu$  to 4  $\mu$ .

So far, the method has only been applied to systems having solid concentrations high enough to enable the same degree of powder packing to be achieved in the dry state for the purpose of measuring  $\bar{r}$ . The possibilities of extrapolating to lower concentrations are still being examined. A detailed account of this work is being prepared for publication elsewhere.

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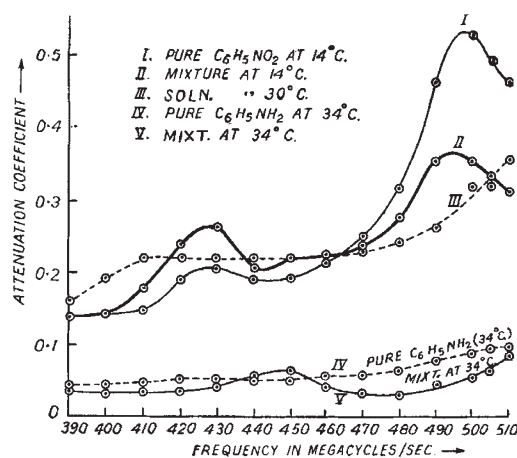
<sup>1</sup> Rigden, P. J., *J. Soc. Chem. Indust.*, **66**, (9), 299 (1947).

<sup>2</sup> Rigden, P. J., *J. Soc. Chem. Indust.*, **66** (4), 130 (1947); *Nature*, **167**, 268 (1946).

### Nature of Grouping of Molecules in Opalescent Binary Liquid Mixtures

It is well known that certain binary mixtures of organic liquids show opalescence at suitable temperatures. It was first shown by Krishnan<sup>1</sup> that the value of the factor of depolarization of the light scattered transversely by such a mixture with the incident light vector horizontal is different from unity, and this was ascribed by him to the formation of large clusters of molecules in the mixture. Although the opalescence is certainly produced by local fluctuations in density, the light-scattering data cannot furnish definite information regarding the actual composition of the particles producing the opalescence. It has, however, been shown recently by Sirkar and Sen<sup>2</sup> and also by Sen<sup>3</sup> that many ordinary organic liquids having polar molecules exhibit strong absorption in the ultra high-frequency region at suitable temperatures, and that the frequency in the region of absorption gives us an idea about the magnitude of viscous forces acting on the individual molecules, as pointed out by earlier workers. Since such viscous forces are produced by the surrounding molecules, any change in the intermolecular field produces a change in the frequency of the region of absorption of the ultra high-frequency radio waves, and this method is thus suitable for studying the nature of the intermolecular field acting on the individual polar molecule in opalescent binary liquid mixture. A programme for studying the absorption of ultra high-frequency radio waves in such opalescent mixtures has, therefore, been undertaken and the results obtained in the case of two such mixtures are discussed here.

A mixture of equal weights of nitrobenzene and hexane is opalescent at 14° C. The absorption of ultra high-frequency radio waves observed in the case of such a mixture, using the same technique as in previous investigations<sup>2</sup>, is shown in the accompanying graph along with that for the mixture at 30° C.



and the pure liquid at 14° C. The graph also includes similar data for an opalescent mixture containing 46 per cent by weight of aniline and 54 per cent of cyclohexane at 34° C. and for pure aniline at 34° C. (curves IV and V). It can be seen from curves I and II that in the case of the opalescent mixture of nitrobenzene there is a new absorption peak at about 427 Mc./sec., besides a peak in the original position at 496 Mc./sec. The height of the latter peak, however, is much less than that observed in the case of the pure liquid. In calculating the attenuation coefficient in the mixture, the equivalent thickness corresponding to the percentage of the liquid in the mixture has been taken, and therefore the height of this peak indicates the percentage of the molecules still existing in the same environment as in the pure liquid. The new peak disappears when the temperature of the mixture is raised to 30° C., at which the opalescence vanishes; but the peak at 496 Mc./sec., instead of disappearing completely, shifts towards higher frequencies. Even in the case of pure nitrobenzene, there is indication of a low broad peak at 427 Mc./sec., and its height increases in the opalescent mixture.

This new peak is not due to associated molecules, because the size of the associated molecule would be large enough to shift the peak to regions of much lower frequency. We believe the new peak is due to molecules subjected to viscous forces larger than those acting on the molecules in the pure liquid. Thus in the opalescent mixture, in addition to a small percentage of molecules in the same environment as in the pure liquid, there exists a small percentage of nitrobenzene molecules more closely packed than in the pure liquid; but in both these types of groupings the single molecule is free to oscillate with the impressed electromagnetic field. Since similar results are obtained in the case of the aniline - cyclohexane mixture, the phenomenon seems to be characteristic of all strongly anisotropic polar molecules.

The investigations are being continued. Details will be published elsewhere.

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<sup>1</sup> Krishnan, R. S., *Proc. Ind. Acad. Sci.*, **1**, 911 (1949).

<sup>2</sup> Sirkar, S. C., and Sen, S. N., *Nature*, **164**, 1048 (1949).

<sup>3</sup> Sen, S. N., *Ind. J. Phys.*, **23**, 495 (1949).