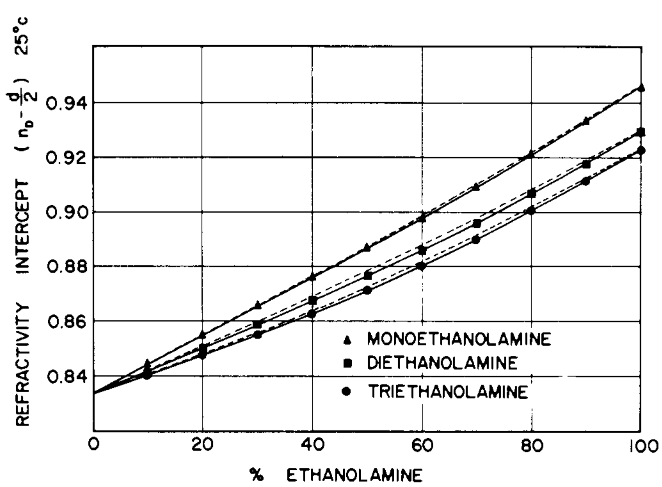

Figure 3. Refractivity intercepts for aqueous amine solutions at 25° C. Solid lines, weight %; dashed lines, volume %

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Density, Refractive Indices, Molar Refractions, and Viscosities of Diethylene Glycol Dimethyl Ether-Water Solutions at 25° C.

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Densities, refractive indices, and viscosities of mixtures of water and diethylene glycol dimethyl ether have been determined at 25°. Molar refractions are also presented. The refractive index values of the solutions increase sharply from pure water to 0.2 mole fraction ether and then slowly increase to the value for the pure ether. The partial molal volume of the ether passes through a minimum which is about 10 per cent less than the ideal molal volume at 0.03 mole fraction ether. The viscosity exhibits a pronounced maximum at 0.15 mole fraction ether. The viscosity data indicate the interaction of this ether with water is greater than that of ethylene glycol dimethyl ether while density data indicate a smaller interaction than that of the monomethyl ethers of both ethylene glycol and diethylene glycol.

DENSITIES, refractive indices, and viscosities of mixtures of diethylene glycol dimethyl ether and water have been determined at 25° as part of a study of polyether and polyether-water solvent systems. These data as well as the molar refractions of these solutions are presented.

EXPERIMENTAL

Technical diethylene glycol dimethyl ether (Ansul Chemical Company, Ansul E-141) was refluxed over metallic sodium and distilled from sodium immediately before use. The ether had a boiling point of 162° (uncorr.) and gave a negative peroxide test (*2*). Water used for the solutions was distilled from dilute potassium permanganate solution in a seasoned all Pyrex assembly. Methods of preparation of solutions and measurement of densities, refractive indices, and viscosities were the same as described earlier (*6*).

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All data are shown in Table I with solution composition being indicated as mole fraction of diethylene glycol dimethyl ether (X_2).

RESULTS AND DISCUSSION

Inspection of Table I shows that the refractive index values increase sharply to about 0.2 mole fraction ether and then increase slowly to the value of the pure ether. The molar refraction of the solutions is nearly linear with composition, with the variation being almost identical with that observed in the ethylene glycol dimethyl ether-water system, although the maximum in the refractive index of the latter is missing in the present system (*6*).

The density data were used to calculate the partial molal volumes by the graphical method of intercepts (*3*). The results of this calculation are shown in Figure 1 as the differences between the calculated partial molal volume and the ideal molal volume. These results are similar to those reported for ethylene glycol dimethyl ether-water (*6*)

Table I. Densities, Refractive Indices, Molar Refractions, and Viscosities of Water-Diethylene Glycol Dimethyl Ether

X_2	d_4^{25} obsd.	N_D^{25} obsd.	$[R]_{1,2}$ exptl.[a]	Viscosity, cp.
0.0000	0.99707	1.33251	3.712	0.894
0.0104	0.9986	1.33990	4.034	1.160
0.0199	1.0002	1.34589	4.327	1.362
0.0398	1.0036	1.35692	4.940	1.877
0.0677	1.0064	1.36917	5.805	2.567
0.1000	1.0060	1.37914	6.809	2.959[b]
0.1492	1.0011	1.38796	8.331	3.175[c]
0.1978	0.9938	1.39318	9.848	2.936
0.2959	0.9801	1.39883	12.924	2.342
0.4011	0.9690	1.40177	16.226	1.881
0.4988	0.9610	1.40322	19.297	1.552
0.5770	0.9557	1.40396	21.759	1.398
0.8569	0.9425	1.40532	30.590	1.084
1.0000	0.9384	1.40576	35.102	0.989

[a] $[R]_{1,2}\text{ exptl.} = \frac{N_{1,2}^2 - 1}{N_{1,2}^2 + 2} \times \frac{x_1M_1 + x_2M_2}{d_{1,2}}$

[b] ± 0.007.

[c] ± 0.024.

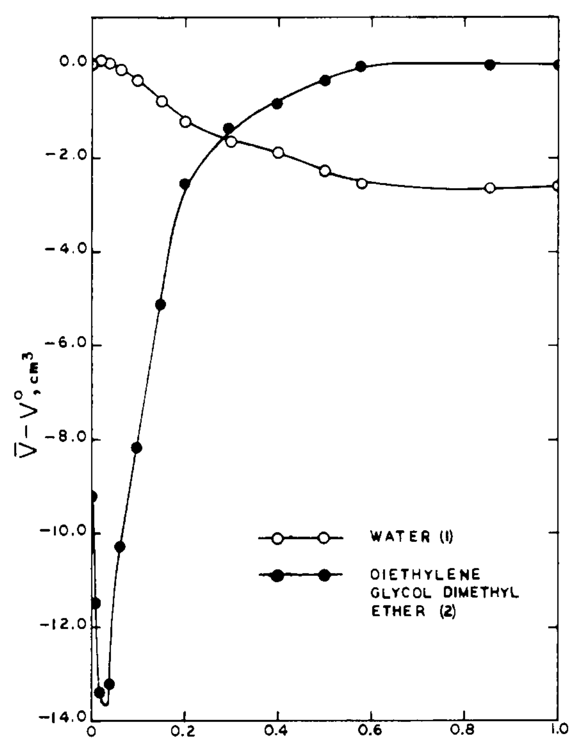

Figure 1. Partial molal volumes (molal volume of pure component subtracted from its partial molal volume) of water-diethylene glycol dimethyl ether as a function of mole fraction of ether

and for dioxane-water (*4*). The minimum partial molal volume of the diethylene glycol dimethyl ether occurs at a lower concentration (0.03 mole fraction ether) of ether than in either of the previous cases. Although the volume difference at the minimum is 13.5 cc. for the present case and 11.0 cc. for ethylene glycol dimethyl ether, the percentage decrease is about 10 per cent in both systems. In the case of both glycol dimethyl ethers, the partial molal volume of the water in ether rich solutions is significantly less than ideal. These interactions are not as great as are observed in systems where proton donor groups are present on both components. Calculation of density data for the monomethyl glycol ethers (*1*, *5*) show volume decreases of 12.3 cc. for ethylene glycol monomethyl ether and 48 cc. for diethylene glycol monomethyl ether, a 15 percent and 40 per cent decrease, respectively.

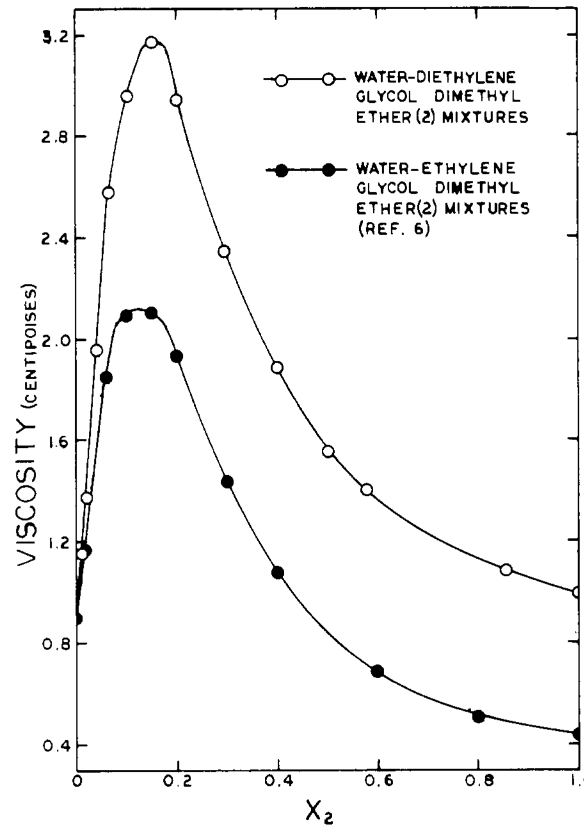

Figure 2. Viscosities of water-diethylene glycol dimethyl ether and water-ethylene glycol dimethyl ether as a function of mole fraction of ether

Figure 2 shows the viscosity of the diethylene glycol dimethyl ether-water system as well as the viscosity of the ethylene glycol dimethyl ether-water system (*6*). The greater viscosity observed in the case of the larger ether is consistent with the idea of strong hydrogen bonding between water and ether oxygens but could result from the difference in molecular weight of the two ethers.

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