**Table VII. Calculated Average Deviations $(\Delta n)_{av}$ for Different Mixing Rules at Various Temperatures**

| | $(\Delta n)_{av} \times 10^3$ | | | | |
|---|---|---|---|---|---|
| $t$/°C | AB[a] | GD[b] | LL[c] | W[d] | H[e] |
| 5 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| 10 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| 15 | 1.03 | 1.03 | 1.03 | 1.03 | 1.03 |
| 20 | 0.84 | 0.84 | 0.84 | 0.84 | 0.84 |
| 25 | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 |
| 30 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |
| 35 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| 40 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| 45 | 0.95 | 0.95 | 0.95 | 0.95 | 0.96 |
| 50 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| 55 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 |
| 60 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| 65 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 |
| 70 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 |
| 75 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| 80 | 0.66 | 0.66 | 0.66 | 0.66 | 0.66 |
| av | 0.89 | 0.89 | 0.89 | 0.89 | 0.89 |

[a] Arago–Biot equation (7). [b] Gladstone–Dale equation (8). [c] Lorentz–Lorenz equation (9). [d] Wiener equation (10). [e] Heller equation (11).

The results of this analysis are summarized in Table VII, where we have reported the average deviations of the refractive index differences, $(\Delta n)$, expressed as

$$\Delta n = n_{\text{exptl}} - n_{\text{calcd}} \tag{12}$$

with $n_{\text{calcd}}$ evaluated by means of different mixing rules. The five mixing rules tested are equivalent to each other, all reproducing the experimental data within the limits of experimental uncertainty over the range of temperature and composition studied.

### Acknowledgment

We thank Dr. Luca Rovatti for his experimental work and the "Centro Interdipartimentale di Calcolo Automatico ed Informatica Applicata" (CICAIA) of Modena University for the computing facilities.

### Glossary

| | |
|---|---|
| $A'$,$B'$ | coefficients in eq 3 |
| $a_i'$ | coefficients in eq 4 |
| $b_i'$ | coefficients in eq 5 |
| $n$ | refractive index |
| $t$ | Celsius temperature |
| $T$ | absolute temperature, K |

*Greek Letters*

| | |
|---|---|
| $\alpha_i$ | coefficients in eq 1 |
| $\beta_i$ | coefficients in eq 2 |
| $\epsilon$ | dielectric constant |
| $\phi_i$ | volume fraction of the $i$th component |
| $\sigma$ | standard deviation |

**Registry No.** DMF, 68-12-2; DHE, 107-21-1.

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Received for review August 27, 1990. Accepted April 10, 1991. We thank the Consiglio Nazionale delle Ricerche (CNR) of Italy for the financial support.

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# Densities and Excess Molar Volumes of the 1,2-Ethanediol + 2-Methoxyethanol Solvent System at Various Temperatures

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**Densities are reported for the binary mixture 1,2-ethanediol + 2-methoxyethanol in the whole composition range at 19 temperatures between −10 and +80 °C. The excess molar volumes, $V^E$, calculated from the density values, are negative at all concentrations and become more negative with increasing temperature.**

### Introduction

In recent papers we have reported some electroanalytical studies about acid–base equilibria which take place in solutions of 1,2-ethanediol and 2-methoxyethanol and in their binary mixtures operating at different temperatures in the range −10 to +80 °C (*1–4*). These alcohols appear very interesting from the point of view of practical and theoretical applications, being protic, protophilic, and dipolar, as well as potentially acidic, nonaqueous solvents. 1,2-Ethanediol is the simplest homologue of the diol series, largely utilized as thermoregulator fluid, as a controlling agent of density/viscosity reaction baths, and as emulsion coating owing to its unusual physicochemical properties (*5*).

On the other hand, 2-methoxyethanol is widely used for various industrial processes (*6*) and has unique solvating properties associated with its quasi-aprotic character (*5*). 2-Methoxyethanol, an ether alcohol, shows physicochemical characteristics midway between protic and dipolar aprotic solvents. It is a quite-toxic solvent, a weak narcotic, and a

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**Table I. Experimental Densities $\rho$ for 1,2-Ethanediol (1) + 2-Methoxyethanol (2) Mixtures at Temperature $t$ and 1,2-Ethanediol Mole Fraction $X_1$**

| | $\rho(t)/(\mathrm{g\ cm^{-3}})$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $t$/°C | $X_1$ = 1.0000 | $X_1$ = 0.9272 | $X_1$ = 0.8499 | $X_1$ = 0.7676 | $X_1$ = 0.6799 | $X_1$ = 0.5861 | $X_1$ = 0.4856 | $X_1$ = 0.3776 | $X_1$ = 0.2614 | $X_1$ = 0.1359 | $X_1$ = 0.0000 |
| −10 | 1.133 634 | 1.122 202 | 1.110 813 | 1.098 209 | 1.085 729 | 1.070 110 | 1.054 848 | 1.038 826 | 1.026 487 | 1.010 245 | 0.993 991 |
| −5 | 1.130 452 | 1.118 673 | 1.107 184 | 1.094 298 | 1.081 503 | 1.065 827 | 1.050 744 | 1.034 589 | 1.022 101 | 1.005 586 | 0.989 269 |
| 0 | 1.127 069 | 1.115 021 | 1.103 481 | 1.090 306 | 1.077 314 | 1.061 729 | 1.046 656 | 1.030 608 | 1.017 692 | 1.000 959 | 0.984 554 |
| 5 | 1.123 664 | 1.111 518 | 1.099 695 | 1.086 543 | 1.073 294 | 1.057 585 | 1.042 436 | 1.026 387 | 1.013 150 | 0.996 487 | 0.979 847 |
| 10 | 1.120 296 | 1.107 882 | 1.095 817 | 1.082 441 | 1.069 197 | 1.053 481 | 1.038 353 | 1.022 291 | 1.008 704 | 0.991 703 | 0.975 032 |
| 15 | 1.116 906 | 1.104 475 | 1.091 976 | 1.078 597 | 1.065 028 | 1.049 326 | 1.034 117 | 1.018 069 | 1.004 203 | 0.987 067 | 0.970 166 |
| 20 | 1.113 440 | 1.100 808 | 1.088 293 | 1.074 614 | 1.060 991 | 1.045 274 | 1.030 032 | 1.014 071 | 0.999 655 | 0.982 510 | 0.965 443 |
| 25 | 1.109 913 | 1.097 382 | 1.084 387 | 1.070 649 | 1.056 987 | 1.041 097 | 1.025 949 | 1.009 983 | 0.995 099 | 0.977 821 | 0.960 490 |
| 30 | 1.106 512 | 1.093 799 | 1.080 547 | 1.066 795 | 1.052 926 | 1.037 069 | 1.021 698 | 1.005 723 | 0.990 612 | 0.973 268 | 0.955 845 |
| 35 | 1.103 089 | 1.090 167 | 1.076 791 | 1.062 799 | 1.048 845 | 1.033 050 | 1.017 505 | 1.001 639 | 0.986 106 | 0.968 765 | 0.951 088 |
| 40 | 1.099 747 | 1.086 603 | 1.072 955 | 1.058 792 | 1.044 743 | 1.029 002 | 1.013 318 | 0.997 490 | 0.981 608 | 0.964 084 | 0.946 292 |
| 45 | 1.096 312 | 1.082 933 | 1.069 052 | 1.054 882 | 1.040 518 | 1.024 798 | 1.009 150 | 0.993 172 | 0.977 233 | 0.959 648 | 0.941 621 |
| 50 | 1.092 946 | 1.079 448 | 1.065 369 | 1.050 990 | 1.036 511 | 1.020 629 | 1.005 091 | 0.989 004 | 0.972 696 | 0.955 005 | 0.936 878 |
| 55 | 1.089 471 | 1.075 813 | 1.061 563 | 1.046 907 | 1.032 404 | 1.016 613 | 1.000 986 | 0.984 748 | 0.968 288 | 0.950 522 | 0.932 133 |
| 60 | 1.086 011 | 1.072 201 | 1.057 814 | 1.043 059 | 1.028 162 | 1.012 369 | 0.996 739 | 0.980 629 | 0.963 869 | 0.945 932 | 0.927 387 |
| 65 | 1.082 634 | 1.068 671 | 1.053 993 | 1.039 208 | 1.024 105 | 1.008 397 | 0.992 615 | 0.976 407 | 0.959 506 | 0.941 276 | 0.922 714 |
| 70 | 1.079 003 | 1.065 177 | 1.050 218 | 1.035 293 | 1.019 847 | 1.004 246 | 0.988 319 | 0.972 290 | 0.955 077 | 0.936 777 | 0.917 811 |
| 75 | 1.075 369 | 1.061 687 | 1.046 572 | 1.031 403 | 1.015 848 | 1.000 332 | 0.984 214 | 0.968 195 | 0.950 632 | 0.932 055 | 0.913 087 |
| 80 | 1.071 699 | 1.058 169 | 1.042 838 | 1.027 627 | 1.011 990 | 0.996 274 | 0.980 113 | 0.964 025 | 0.946 094 | 0.927 455 | 0.908 144 |

systemic poison (*7*) and must be handled with care.

Attention is here devoted to some correlation procedures available for the thermomechanical parameters, such as density and related mixing properties. The literature data collections on these properties of binary, or multicomponent, solvent systems are scarce, and the data are often reported incompletely or only graphically. The fact that the extrathermodynamic properties of binary mixtures depend on temperature and on composition makes possible the variation "in continuum" of these properties and can provide more and useful structural information for liquid mixtures not otherwise available.

## Experimental Section

***Materials.*** The solvents, 1,2-ethanediol and 2-methoxyethanol (containing <0.10% and <0.05% water, respectively, found by Karl-Fischer titration), were Carlo Erba (Milan) high-purity grade.

***Apparatus.*** The mixtures were prepared just before their use by weight through a Mettler PM 4800 Δ-range balance operating in a dry nitrogen atmosphere and then stored over molecular sieves. The estimated error in the 1,2-ethanediol mole fraction, $X_1$, is less than $1.5 \times 10^{-4}$. The densities were determined with a digital density meter (Anton Paar DMA 60) equipped with a density-measuring cell (DMA 602), with a sensitivity up to $10^{-6}$ g cm$^{-3}$. The temperature was maintained constant to ±0.02 °C by means of two Lauda K2R thermostatic baths in cascade. The thermal control was checked by a thermoresistance Pt100 (Tersid, Milan) inserted into the jacket of the measuring cell and near the sample capillary tube. Karl-Fisher titrations were performed with an automatic titration system (Crison Model KF431) equipped with a digital buret (Crison Model 738).

***Procedure.*** The density determination was performed by measuring the period of oscillation $\tau$ of a vibrating U-shaped sample tube, filled with the liquid sample. The following relationship exists between $\tau$ and the density $\rho$ at the temperature $t$:

$$\rho(t) = (\tau^2 - B)/A$$

where $A$ and $B$ are instrumental constants which are determined by calibration with fluids of known density (dried air and bidistilled water) at each investigated temperature.

For the measurements, we have selected the period of 2000 oscillation cycles at each temperature and collected the values at least 2 h after the sample injection. Temperature equilibration was conveniently followed over ca. 30 readout cycles until the $\tau$ value becomes constant within ±1 (*8*), and with a maximum variation between each series of $\tau$ of ±3.

**Table II. Reference Density Values $\rho$ of 1,2-Ethanediol and 2-Methoxyethanol at Temperature $t$**

| $\rho/(\mathrm{g\ cm^{-3}})$ | $t$/°C | measurement technique | ref |
|---|---|---|---|
| | 1,2-Ethanediol | | |
| 1.1099 | 25 | pycnometer | 17 |
| 1.10982 | 25 | pycnometer | 10 |
| 1.1098 | 25 | pycnometer | 18 |
| 1.1096 | 25 | oscillating tube | 19 |
| 1.10982 | 25 | oscillating tube | 20 |
| 1.1063 | 30 | oscillating tube | 21 |
| 1.109810 | 40 | oscillating tube | 9 |
| | 2-Methoxyethanol | | |
| 0.96002 | 25 | oscillating tube | 20 |
| 0.9605 | 25 | oscillating tube | 22 |
| 0.946169 | 40 | oscillating tube | 23 |

## Results and Discussion

The results of the experimental measurements of density for the two pure solvents and nine binary mixtures at 19 temperatures in the $-10 \leq t/°\mathrm{C} \leq +80$ range, with thermal scanning of 5 °C, are summarized in Table I.

For comparison purposes, the Table II shows some literature values relative to the two pure solvents and in particular to 1,2-ethanediol even if some authors reported many other data about the dependence of its density on the temperature (*9*). The discrepancies between these values are probably ascribable to the very different measurement methods and to the different procedures of samples purification adopted by the authors. These problems have been throughly discussed by Fogg et al. (*10*). Our density values were correlated as a function of temperature by the equation (*11*)

$$\rho(t)/(\mathrm{g\ cm^{-3}}) = \sum_{i=0}^{4} \rho_i (t/°\mathrm{C})^i \qquad (1)$$

through a multilinear regression package (*12*), and the $\rho_i$ coefficients are reported, together with the standard deviations $\sigma(\rho)$ for each solvent system, in Table 1 of supplementary material. The $\sigma(\rho)$ values were calculated with the equation

$$\sigma(\rho) = \left[\frac{\sum(\rho_{\mathrm{calcd}} - \rho_{\mathrm{exptl}})^2}{N - n}\right]^{1/2} \qquad (2)$$

**Table III. Coefficients $\rho_{ij}$ of Equation 5 for 1,2-Ethanediol (1) + 2-Methoxyethanol (2) and Standard Deviations $\sigma(\rho)$**

| $ij$ | variable quantity | $\rho_{ij}$ expanded eq | $\rho_{ij}$ simplified eq |
|---|---|---|---|
| 00 | | 0.969 361 | 0.969 169 |
| 01 | $X_1$ | 0.240 275 | 0.238 802 |
| 02 | $X_1^2$ | $-3.561\,28 \times 10^{-2}$ | $-2.424\,31 \times 10^{-2}$ |
| 03 | $X_1^3$ | 0.218 702 | 0.199 593 |
| 04 | $X_1^4$ | −0.123 268 | −0.113 657 |
| 10 | $t$ | $-1.881\,66 \times 10^{-3}$ | $-1.856\,22 \times 10^{-3}$ |
| 20 | $t^2$ | $-2.655\,17 \times 10^{-7}$ | |
| 30 | $t^3$ | $3.880\,03 \times 10^{-8}$ | $1.390\,47 \times 10^{-8}$ |
| 40 | $t^4$ | $-3.093\,06 \times 10^{-10}$ | $-8.432\,09 \times 10^{-11}$ |
| 11 | $tX_1$ | $2.015\,02 \times 10^{-4}$ | $2.080\,18 \times 10^{-4}$ |
| 21 | $t^2X_1$ | $-4.453\,78 \times 10^{-6}$ | |
| 31 | $t^3X_1$ | $4.682\,07 \times 10^{-8}$ | |
| 41 | $t^4X_1$ | $2.313\,53 \times 10^{-10}$ | |
| 12 | $tX_1^2$ | $1.387\,47 \times 10^{-3}$ | $9.817\,46 \times 10^{-4}$ |
| 22 | $t^2X_1^2$ | $3.056\,81 \times 10^{-5}$ | |
| 32 | $t^3X_1^2$ | $-6.647\,92 \times 10^{-7}$ | |
| 42 | $t^4X_1^2$ | $2.200\,58 \times 10^{-9}$ | |
| 13 | $tX_1^3$ | $-3.743\,38 \times 10^{-3}$ | $-2.774\,53 \times 10^{-3}$ |
| 23 | $t^2X_1^3$ | $-3.317\,73 \times 10^{-5}$ | |
| 33 | $t^3X_1^3$ | $7.158\,75 \times 10^{-7}$ | |
| 43 | $t^4X_1^3$ | $-8.405\,70 \times 10^{-10}$ | |
| 14 | $tX_1^4$ | $2.542\,65 \times 10^{-3}$ | $1.905\,07 \times 10^{-3}$ |
| 24 | $t^2X_1^4$ | $5.711\,84 \times 10^{-6}$ | |
| 34 | $t^3X_1^4$ | $-8.816\,39 \times 10^{-8}$ | |
| 44 | $t^4X_1^4$ | $-1.653\,21 \times 10^{-9}$ | |
| $\sigma(\rho)/(\mathrm{g\ cm^{-3}})$ | | 0.000 94 | 0.000 93 |

where $N$ is the number of data points for each system and $n$ is the number of parameters. Equation 1 reproduces the experimental values of Table I with a mean deviation $\Delta(\rho)$ equal to ±0.000 04 g cm$^{-3}$, calculated as follows:

$$\Delta(\rho) = \frac{\sum|\rho_{\mathrm{calcd}} - \rho_{\mathrm{exptl}}|}{N} \tag{3}$$

The dependence of the experimental densities on the composition of the binary mixture was represented by the polynomial equation (*13*)

$$\rho(X_1)/(\mathrm{g\ cm^{-3}}) = \sum_{j=0}^{4} \rho_j X_1^{\,j} \tag{4}$$

whose coefficients are listed in the Table 2 (supplementary material) at each investigated temperature. Equation 4 fits the experimental values (Table I) with a mean deviation $\Delta(\rho)$ = ±0.000 26 g cm$^{-3}$. This relatively large value does not significantly diminish when higher polynomials are used. Even for a polynomial of degree 9, that is the maximum degree compatible with the limited number of points available throughout the entire composition range, the above difference does not become comparable with the experimental uncertainty.

The two eqs 1 and 4 are now available for the dependence of $\rho$ on $t$ and $X_1$, respectively. They can be combined to give a single function $\rho = \rho(t,X_1)$ of the type

$$\rho(t,X_1)/(\mathrm{g\ cm^{-3}}) = [\rho(t)\ \rho(X_1)] = [\sum_{i,j=0}^{4} \rho_{i,j}(t/{}^\circ\mathrm{C})^i X_1^{\,j}]^{1/2} \tag{5}$$

Eq 5 in its complete form reproduces the experimental $\rho$ values with a mean deviation of ±0.000 30 g cm$^{-3}$.

In this way, eq 5 provides the lowest difference between calculated and experimental values. Now, another and perhaps more useful strategy is to reduce as much as possible the number of terms, having always acceptable mean relative deviation between calculated and observed values. This is obtained by omitting in successive steps all the terms having statistical weights less than unity, thus emphasizing the importance of the remaining ones (*12*). Table III contains the $\rho_{ij}$ coefficients of eq 5 in its complete form and in the simplified one, together with the corresponding variable quantities and the standard deviations $\sigma(\rho)$.

The simplified equation reproduces the experimental values within $\Delta(\rho)$ = ±0.00031 g cm$^{-3}$ (practically the same uncertainty found with the 25-terms complete form equation) and shows the advantage to contain only 12 terms, having eliminated all the $t^2$ terms and all the cross terms $t^iX_1^{\,j}$ with $i \geq 2$.

***Excess Volumes.*** The experimental $\rho$ values at each temperature were converted into excess molar volumes of mixing $V^{\mathrm{E}}$

$$V^{\mathrm{E}} = \frac{(X_1M_1 + X_2M_2)}{\rho} - (X_1V_1 + X_2V_2) \tag{6}$$

where $X_1$, $X_2$ are the mole fractions, $V_1$, $V_2$ the molar volumes of pure components, and $M_1$ and $M_2$ the molar masses of the solvents, respectively (Table IV). The system exhibits negative deviations from ideality at all the investigated temperatures. The experimental $V^{\mathrm{E}}$ data were fitted by least-squares to a smoothing equation of the Redlich–Kister (*14*) type, as employed by several authors (*15*, *16*),

$$V^{\mathrm{E}}/(\mathrm{cm^3\ mol^{-1}}) = X_1X_2\sum_{k=0}^{3} a_k(X_1 - X_2)^k \tag{7}$$

**Table IV. Excess Molar Volumes $V^{\mathrm{E}}$ of 1,2-Ethanediol (1) + 2-Methoxyethanol (2) at Temperature $t$ and 1,2-Ethanediol Mole Fraction $X_1$**

| | $V^{\mathrm{E}}/(\mathrm{cm^3\ mol^{-1}})$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $t$/°C | $X_1$ = 0.9272 | $X_1$ = 0.8499 | $X_1$ = 0.7676 | $X_1$ = 0.6799 | $X_1$ = 0.5861 | $X_1$ = 0.4856 | $X_1$ = 0.3776 | $X_1$ = 0.2614 | $X_1$ = 0.1359 |
| −10 | −0.1194 | −0.2537 | −0.3322 | −0.4285 | −0.3485 | −0.2867 | −0.1689 | −0.2957 | −0.1554 |
| −5 | −0.1110 | −0.2492 | −0.3238 | −0.4108 | −0.3385 | −0.2921 | −0.1795 | −0.3028 | −0.1526 |
| 0 | −0.1076 | −0.2463 | −0.3192 | −0.4013 | −0.3359 | −0.3009 | −0.1964 | −0.3098 | −0.1532 |
| 5 | −0.1078 | −0.2443 | −0.3174 | −0.3977 | −0.3387 | −0.3121 | −0.2175 | −0.3166 | −0.1563 |
| 10 | −0.1102 | −0.2427 | −0.3171 | −0.3980 | −0.3451 | −0.3249 | −0.2412 | −0.3232 | −0.1613 |
| 15 | −0.1137 | −0.2411 | −0.3175 | −0.4006 | −0.3537 | −0.3384 | −0.2662 | −0.3295 | −0.1677 |
| 20 | −0.1174 | −0.2393 | −0.3179 | −0.4037 | −0.3631 | −0.3522 | −0.2913 | −0.3359 | −0.1750 |
| 25 | −0.1206 | −0.2369 | −0.3180 | −0.4064 | −0.3726 | −0.3657 | −0.3155 | −0.3421 | −0.1828 |
| 30 | −0.1229 | −0.2340 | −0.3172 | −0.4078 | −0.3812 | −0.3785 | −0.3383 | −0.3484 | −0.1907 |
| 35 | −0.1241 | −0.2307 | −0.3155 | −0.4075 | −0.3888 | −0.3908 | −0.3593 | −0.3550 | −0.1986 |
| 40 | −0.1242 | −0.2271 | −0.3131 | −0.4052 | −0.3951 | −0.4023 | −0.3785 | −0.3620 | −0.2063 |
| 45 | −0.1236 | −0.2237 | −0.3104 | −0.4012 | −0.4005 | −0.4134 | −0.3964 | −0.3698 | −0.2138 |
| 50 | −0.1228 | −0.2207 | −0.3078 | −0.3960 | −0.4054 | −0.4244 | −0.4135 | −0.3786 | −0.2212 |
| 55 | −0.1226 | −0.2191 | −0.3061 | −0.3907 | −0.4106 | −0.4358 | −0.4309 | −0.3887 | −0.2285 |
| 60 | −0.1242 | −0.2194 | −0.3065 | −0.3867 | −0.4176 | −0.4485 | −0.4499 | −0.4005 | −0.2362 |
| 65 | −0.1291 | −0.2228 | −0.3102 | −0.3857 | −0.4278 | −0.4634 | −0.4724 | −0.4146 | −0.2446 |
| 70 | −0.1388 | −0.2303 | −0.3188 | −0.3900 | −0.4434 | −0.4818 | −0.5006 | −0.4313 | −0.2544 |
| 75 | −0.1556 | −0.2431 | −0.3341 | −0.4024 | −0.4666 | −0.5050 | −0.5368 | −0.4512 | −0.2663 |
| 80 | −0.1817 | −0.2627 | −0.3583 | −0.4259 | −0.5003 | −0.5347 | −0.5844 | −0.4751 | −0.2810 |

**Table V. Coefficients $a_k$ of Equation 7 for 1,2-Ethanediol (1) + 2-Methoxyethanol (2) at Temperature $t$**

| $t$/°C | $a_0$ | $a_1$ | $a_2$ | $a_3$ | $\sigma(V^E)$/ ($10^{-2}$ cm$^3$ mol$^{-1}$) |
|---|---|---|---|---|---|
| −10 | −1.2087 | −1.4023 | −1.2252 | 2.2868 | 4.8 |
| −5 | −1.2134 | −1.2110 | −1.1365 | 1.9737 | 4.7 |
| 0 | −1.2401 | −1.0456 | −1.0491 | 1.6945 | 4.5 |
| 5 | −1.2823 | −0.9024 | −0.9630 | 1.4467 | 4.2 |
| 10 | −1.3344 | −0.7743 | −0.8774 | 1.2269 | 3.9 |
| 15 | −1.3917 | −0.6583 | −0.7931 | 1.0345 | 3.5 |
| 20 | −1.4504 | −0.5466 | −0.7114 | 0.8592 | 3.1 |
| 25 | −1.5073 | −0.4404 | −0.6316 | 0.7063 | 2.8 |
| 30 | −1.5601 | −0.3333 | −0.5553 | 0.5635 | 2.4 |
| 35 | −1.6084 | −0.2243 | −0.4825 | 0.4295 | 2.1 |
| 40 | −1.6515 | −0.1115 | −0.4151 | 0.2980 | 1.8 |
| 45 | −1.6909 | 0.0073 | −0.3539 | 0.1598 | 1.6 |
| 50 | −1.7284 | 0.1323 | −0.2995 | 0.0109 | 1.3 |
| 55 | −1.7672 | 0.2636 | −0.2534 | −0.1604 | 1.1 |
| 60 | −1.8121 | 0.3988 | −0.2170 | −0.3562 | 0.9 |
| 65 | −1.8686 | 0.5394 | −0.1927 | −0.5937 | 0.7 |
| 70 | −1.9442 | 0.6808 | −0.1807 | −0.8753 | 0.6 |
| 75 | −2.0466 | 0.8196 | −0.1852 | −1.2106 | 0.8 |
| 80 | −2.1862 | 0.9544 | −0.2060 | −1.6158 | 1.3 |

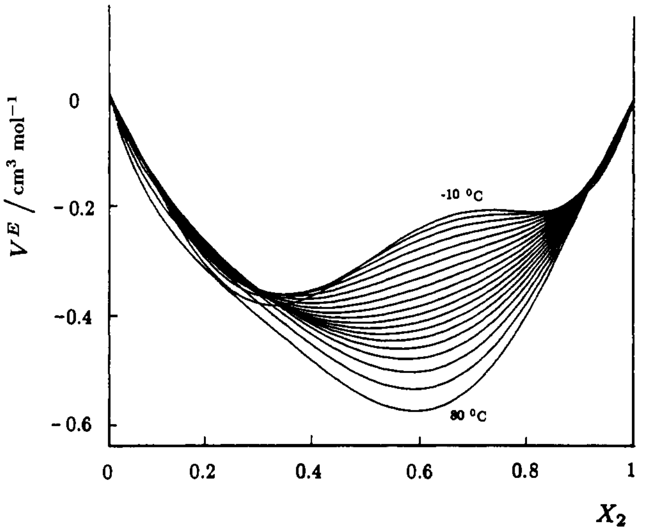

**Figure 1.** Excess molar volumes $V^E$ vs mole fraction $X_2$ of 2-methoxyethanol at various temperatures ranging from −10 to +80 °C.

whose coefficients $a_k$ are listed in Table V, along with the standard deviations $\sigma(V^E)$. This function reproduces the experimental $V^E$ with a mean deviation $\Delta(V^E)$ of ±0.051 cm$^3$ mol$^{-1}$.

The trend of eq 7 is shown in Figure 1, where, for the sake of clarity, the experimental points were not represented.

## Acknowledgment

We thank Prof. C. Preti for helpful discussions and Miss A. Riegler for her experimental work.

**Registry No.** 1,2-Ethanediol, 107-21-1; 2-methoxyethanol, 109-86-4.

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Received for review August 6, 1990. Accepted June 24, 1991. We thank the Ministero dell'Università e della Ricerca Scientifica e Tecnologica (MURST) of Italy for financial support.

**Supplementary Material Available:** Tables 1 and 2, listing the $\rho_i$ and $\rho_j$ coefficients of eqs 1 and 2, respectively (2 pages). Ordering information is given on any current masthead page.