8.1 Introduction

Studies of the excess properties of liquid mixtures are of incredible potential for many applications and for theoretical aspect of the nature of molecular interactions. In this respect, great efforts have been devoted to the experimental studies of excess properties of mixtures. Volumetric properties of binary mixtures are complex because they not only depend on solute–solute, solvent–solvent and solute–solvent interactions, but also on the result of the structural effects arising from interstitial accommodation due to the difference in molar volume and free volume between components present in the solution. Liquids are said to have a short-range order and long-range disorder. A certain range of order in liquids gives the characteristic property of fluidity. Thermodynamic properties of liquids and liquid mixtures can be interpreted successfully by treating the molecules as consisting of various groups or segments and to determine the single set of parameters, which characterize the molecular structure and group interactions. In binary liquid mixtures excess molar volume of mixing has been used as a qualitative guide to study the intermolecular interaction and complex formation between the component molecules. The molecular interactions in these systems are complex, and mixing volume data certainly provide valuable information for understanding their molecular packing. Partial molar properties can often be determined because chemical mixtures are often maintained at constant temperature and pressure and under these conditions, the value of any extensive property can be obtained from its partial molar property. They are especially useful when considering specific properties of pure substances and properties of mixing [1-7].

Partial molar volume, excess partial molar volume and partial molar volume at infinite dilution are interesting from a theoretical point of view since, at infinite dilution the only interactions present are solute – solvent interactions.

H. Iloukhani and M. Jafarnejad [8] measured excess molar volumes, partial molar volumes, apparent molar volumes and refractive index deviations of binary systems (1,2-dichloroethane+ benzene, +bromobenzene, +chlorobenzene, and +nitrobenzene at T = 10 K intervals and ambient pressure 81.5 kPa, using Anton Paar DMA 4500 oscillating densimeter and Anton Paar Abbemat 500 automatic refractometer. Apparent molar volume, partial molar volume, excess partial molar volume and their limiting values at infinite dilution, respectively have been calculated

from the experimental density measurements of binary mixtures of ionic liquid (1-butyl-3-methylimidazolium hexafluorophosphate) with alkoxyethanols at several temperatures by Amalendu Pal [9].

The apparent partial molar properties and their deviations at infinite dilution were calculated by Gyan Prakash Dubey [10] in the binary mixtures of 1-tert-butoxy-2-propanol with four structurally different alcohols, viz., 1-propanol, 2-propanol 1-butanol and 2-butanol. The excess molar volume, partial molar volumes, and at infinite dilution, and excess partial molar volumes, and at infinite dilution were calculated by Anil Kumar Nain[11] for the binary mixtures of methyl acrylate + benzene, toluene, o- xylene, p- xylene or mesitylene.

Akl M. Awwada *et al*. [12] measured the experimental densities of binary mixtures of 2- methyl pyrrolidone with aromatic hydrocarbons (benzene, toluene, o-xylene, m-xylene). Apparent molar volumes and partial molar volumes at infinite dilution have been calculated. The variation of these properties with composition and temperature of the binary mixtures are discussed in terms of molecular interactions. Razieh Sadat Neyband [13] calculated partial molar volumes, excess partial molar volumes, excess partial molar volumes at infinite dilution, {(benzyl alcohol + methanol, ethanol, 1-propanol, 2-propanol, 1-butanol, and 2-butanol)} binary mixtures at T = 298.15 K and ambient pressure (81 500 Pa). M. Kondaiah *et al.* [14] measured the partial molar volumes, excess partial molar volumes and excess partial molar volumes at infinite dilution for binary mixtures of ethylene glycol with amides at 308.15 K.

Li Xu *et al.* [15] computed the partial molar volumes and excess partial molar volumes from the measured density data for the systems glycerol + DMF and glycerol + H_2O at 25^0C and 35^0C. Partial molar volumes and excess partial molar volumes are calculated by A.K. Nain [16] for acetonitrile and amide systems at different temperatures. R.B Torres *et al.* [17] calculated partial molar volumes, apparent molar volumes and PMV at infinite dilution for the binary mixtures of acetonitrile and alcohols at various temperatures. Roghayeh Majdan-Cegincara [18] measured partial molar volumes, apparent molar volumes and PMV at infinite dilution for the binary mixtures of 1-butyl-1-methylpyrrolidinium trifluoromethanesulfonate + acetonitrile.

8.2 Theory

Intermolecular interactions are the most fundamental forces, which strongly influence the physic chemical properties of matter. Partial molar properties of dilute solutions provide information about the molecular interactions between solute – solute and solute – solvent interaction. Infinite values have been evaluated to understand interaction even at dilute conditions. The partial molar volumes of the components of a mixture vary with the composition of the mixture, since, the environment of the molecules in the mixture changes with the composition. The changing molecular environment results in the thermodynamic properties of a mixture as its composition is altered.

The results of excess molar volume can be substantiated by studying partial molar volumes. The partial molar volumes of components diethyl malonate (DEM) and sub compound 1- alkanols, 2- alkoxyethanols, amides and substituted benzenes respectively, in the binary liquid mixtures from their molar volumes are calculated using the following relations [19].

$$\tilde{V}_{m,1} = V^{E}_{m} + V^{0}_{1} + (1-X_1)(\partial V^{E}_{m} / \partial X_1)_{T,P} \quad (1)$$

$$\tilde{V}_{m,2} = V^{E}_{m} + V^{0}_{2} - x_1(\delta V^{E}_{m} / \delta x_1)_{T,P} \quad (2)$$

where $V_1{}^{o}$ and $V_2{}^{o}$ are the molar volumes of the pure DEM and sub compounds respectively. The derivatives are the molar volumes of the pure DEM and sub compounds respectively.

The derivatives $(\partial V^{E}_{m} / \partial X_1)_{T,P}$ of Eq. (3) and Eq. (4) are obtained by differentiating Eq. (2) with respect to X_1. This leads to the partial molar volumes as expressed by the following relationships**:**

$$\tilde{V}_{m,1} = V^{0}_{1} + x^{2}_{2} \sum_{i=0}^{n} A_i (1-2x_2)^i - 2x^{2}_{2} (1-x_2) \sum_{i=1}^{n} iA_i(1-2x_2)^{i-1} \quad (3)$$

$$\tilde{V}_{m,2} = V^{0}_{2} + (1-x_2)^2 \sum_{i=0}^{n} A_i (1-2x_2)^i + 2x_2 (1-x_2)^2 \sum_{i=1}^{n} iA_i(1-2x_2)^{i-1} \quad (4)$$

The values of partial molar volumes are used to calculate the excess partial molar volumes using the equations

$$\tilde{V}^{E}_{m,1} = \tilde{V}_{m,1} - \tilde{V}^{*}_{1} \quad (5)$$

$$\tilde{V}^{E}_{m,2} = \tilde{V}_{m,2} - \tilde{V}^{*}_{2} \quad (6)$$

The apparent molar volume of DEM in alkanols, alkoxyethanols, amides and in benzenes and substituted benzenes. $V_\phi 1$, and the apparent molar volume of 1-alkanols 2-alkoxyethanols amides and substituted benzenes in DEM, $V_\phi 2$, can be expressed [20] as:

$$V_{\phi 1} = V^0_1 + (V^E_m/x_1) \quad (7)$$

$$V_{\phi 2} = V^0_2 + (V^E_m/x_2) \quad (8)$$

Graphical extrapolation of $V_{\phi 1}$ to $X_1 = 0$ leads to the desired value of V_1^∞ and extrapolation of $V_{\phi 2}$ to $X_2 = 0$ gives V_2^∞

Partial molar volumes at infinite dilution can also be calculated from the excess molar volumes using a method based on extrapolation of the "reduced volume" [21]. Linear extrapolation of the reduced volume represented by V^E_m / X_1X_2 to $X_2 = 0$ leads to V_2^∞.

The expression for reduced volume can be obtained by rearranging Eq. (7) and division by X_2

$$V^E_m / x_1x_2 = (V_{\phi 1}-V^0_1)/x_2 \quad (9)$$

The above three methods will provide much insight into partial molar volumes at infinite dilution where, the condition of vanishing solute- solute interaction prevail and provide much information on solute – solvent interactions independent of composition effect [22]. Values of the limiting properties at infinite dilution are particularly significant so as to know the volume change of each participating component with varying concentration of other component, by a keen observance of magnitudes and their variations. Hence an attempt has been made to study partial molar volume, apparent molar volumes and reduced molar volumes for the systems.

8.3 Results and Discussion

Partial molar volumes, excess partial molar volumes, apparent molar volumes are calculated for DEM + 1- alkanols DEM + 2- alkoxyethanols, DEM+ amides and DEM + benzene and benzene and monosubstituted benzenes. Excess molar volumes at infinite dilutions are also calculated for the binary mixtures using PMV, AMV and reduced volumes.

The molar volumes, partial molar volumes excess partial molar volumes, apparent molar volumes reduced molar volumes and excess partial molar volumes at

infinite dilutions for DEM + alkanols are presented in Tables 8.1.1, 8.1.2, 8.1.3 and 8.1.4. The excess partial molar volumes are negative for all the three alkanols systems due to hydrogen bonding and dipole – dipole interactions. The negative value decreases with increase of chain length. The negative excess partial molar volume decreases from 1-butanol to 1- hexanol due to steric effects. Similar results were derived by Gyan prakash Dubey [23] in case of 1- hexanol, 1-octanol and 1- decanol ($C_6H_{14}O>C_8H_{18}O>C_{10}H_{22}O$). This shows that as we increase the number of carbon atoms in the alcohol molecule the intermolecular interaction becomes weaker.

The molar volumes, partial molar volumes, excess partial molar volumes, apparent molar volume, reduced molar volumes and excess partial molar volumes at infinite dilutions are presented in tables 8.2.1 to 8.2.4 for the mixtures DEM + alkoxyethanols. The excess partial molar volumes are negative for the three studied alkoxyethanols systems and the negative values decreased with the increase in chain length of alkoxyethanols. Negative values of excess partial molar volume decreased from MOE to BOE. Similar trends were observed by A. Hossen Zaire [24] in the case of acetic acid + alkanols system.

The addition of DEM into the alkoxyethanols due to formation of hydrogen bonding and dipole-dipole interactions between the component molecules leads to the negative values of excess partial molar volumes. The excess partial molar volumes at infinite dilution are negative for alkoxyethanol systems which again supports the existence of hydrogen bond between the consecutive molecules. Negative excess partial molar volumes indicate that interaction is stronger between unlike molecules than like molecules. Negative value of excess partial molar volume decreases with increase in chain length. Hence we can say that strength of interaction decreases with increase in chain length. The values are negative for three studied systems which support the existence of strong interactions between the studied three binaries of DEM and alkoxyethanols.

Tables 8.3.1, 8.3.2 represent the partial molar volumes and excess partial molar volumes respectively, for the binary systems DEM + foramide, DEM + dimethylforamide and DEM + dimethylacetamide. The computed values of apparent molar volumes of DEM + amides systems are presented in Table 8.3.3. Excess partial molar volumes at infinite dilutions (Table 8.3.4) are also calculated and the values are negative for three amide systems. From the tables it can be observed that the excess

partial molar volumes are negative and the negative values decreases from formamide (FA) to DMA, which indicates presence of strong interactions through hydrogen bonding dipole- dipole interactions, between the component molecules.

The partial molar volumes and excess partial molar volume values of DEM + benzene and mono substituted benzenes are presented in Tables 8.4.1 and 8.4.2 which indicate the variations of excess partial molar volumes of DEM in BEN and BEN in DEM respectively. Tables 8.4.3 represent the apparent molar volumes and Table 8.4.4 presents excess partial molar volumes at infinite dilutions. The excess partial molar volumes are negative in the case of nitrobenzene but in toluene and benzene the values are positive. The NO_2 group is electron with drawing inductive effect, which tend to intensify the positive charge of the nearest C atom of the benzene ring. It accepts the electron pair easily and shows strong interactions. The observed V^E are positive for DEM + toluene because the CH_3 methyl group being an electron releasing group would enhance the electron density of the benzene ring of the aromatic molecules. The electron accepting tendency of the aromatic ring decreases as we move from toluene to benzene resulting in the decrease of donor acceptor interaction between the unlike molecules resulting in the volume expansion shows positive excess molar volumes.

From the results it can be observed that excess partial molar volume is negative and negative value increased with increase of temperature in case of DEM + NB. Its value is positive for DEM + TOL and DEM + BEN. The magnitude of this value decreases with increase of temperature, inferring that the interaction decreases with rise of temperature. Partial molar volumes at infinite dilutions are considered of particular interest, because of their usefulness in examining solute- solvent interactions, as solute - solvent interactions can be assumed to be eliminated at infinite dilution. At infinite dilution the partial molar volume and apparent molar volume are almost equal. The limiting partial molar volumes were estimated by extrapolating the apparent molar volumes to infinite dilution.

8.4 Conclusion

- Excess partial molar volumes and excess partial molar volumes at infinite dilutions are negative in DEM + alkanols systems which confirms the strong

interactions through hydrogen bonding and dipole-dipole interactions and strength of molecular interactions varies in the order:

DEM + 1-butanol > DEM + 1-pentanol > DEM + 1-hexanol

- Negative values for excess partial molar volumes and excess partial molar volumes at infinite dilutions are observed for alkoxyethanols system which indicates the presence of strong interaction through hydrogen bonding, dipole – dipole interactions, and charge transfer complex formation between unlike molecules under study. Thus, the strength of interaction is in the order:

DEM + 2-ethoxyethanol > DEM + 2-ethoxyethanol > DEM + 2-butoxyethanol.

- Excess partial molar volumes and excess partial molar volumes at infinite dilutions are negative in DEM + amides systems which confirms the strong interactions between DEM and amides molecules and strength of interaction follows the order :

DEM + formamide > DEM + N,N-dimethylformamide > DEM + N,N-dimethylacetamide

- Negative excess molar volumes and excess partial molar volumes at infinite dilutions are observed for DEM+ NB. Positive values for excess molar volumes and excess partial molar volumes at infinite dilutions were observed in the case of DEM+ TOL and DEM+ BEN system. Even though the excess molar volume values are positive, by considering the all other factors like excess viscosity and velocity and Gibb's free energy change, which show positive deviations, which indicates the strong interactions, we can confirm the existence of strong interactions between the DEM + substituted benzenes. Hence, the strength of molecular interactions between the investigated binary liquid mixtures are follows the order:

DEM +Nitrobenzene > DEM + Toluene > DEM + Benzene

- The observed negative excess partial molar volumes in mixture of DEM + alkanols/alkoxyethanols/amides and positive values in DEM + toluene/ benzene substantiate the conclusions drawn from V^E in the binary liquid mixtures.

Table 8.1.1
PMV of each component $\tilde{V}_{m1}$, $\tilde{V}_{m2}$ calculated through PMV equations for (DEM in butanol) and (butanol in DEM), (DEM in pentanol) and (pentanol in DEM) and (DEM in hexanol) and (hexanol in DEM)

	$10^6\tilde{V}m$, 1 m^3mol^{-1}				$10^6\tilde{V}m$, 2 m^3mol^{-1}			
DEM + 1-BUTANOL								
X_1	**303.15K**	**308.15K**	**313.15K**	**318.15K**	**303.15K**	**308.15K**	**313.15K**	**318.15K**
0.0000	137.1361	134.4717	129.9406	126.8433	92.532	92.720	93.139	93.669
0.0627	143.8974	143.5794	143.0951	135.0537	92.439	92.462	92.769	93.239
0.1309	147.0051	147.5444	148.3581	140.0008	92.179	92.064	92.247	92.628
0.2052	148.2713	148.8324	149.4782	142.8828	91.763	91.818	92.042	92.394
0.2865	149.0575	149.3696	149.4541	144.7890	91.175	91.643	92.050	92.447
0.3759	150.0507	150.2346	150.0571	146.5469	90.405	91.205	91.734	92.198
0.4747	151.1776	151.4981	151.5442	148.5736	89.471	90.264	90.617	91.086
0.5843	151.8597	152.4663	152.9238	150.8065	88.374	89.200	89.090	89.473
0.7067	151.8076	152.6028	153.2018	152.8297	86.719	89.007	88.671	88.987
0.8443	152.0580	152.8641	153.3613	154.2682	82.150	87.778	87.788	88.075
1.0000	153.4200	154.2770	154.9630	154.9630	65.017	63.195	59.032	57.510
DEM + 1-PENTANOL								
0.000	148.680	147.098	147.689	146.972	109.110	109.981	110.174	110.672
0.073	153.417	154.045	154.596	148.444	109.059	109.764	109.957	110.400
0.151	154.552	155.681	156.367	147.886	108.945	109.586	109.760	110.249
0.234	154.285	155.220	156.069	146.814	108.795	109.705	109.841	110.522
0.322	153.904	154.584	155.526	146.256	108.620	109.944	110.047	110.873
0.416	153.815	154.435	155.357	146.696	108.450	110.023	110.139	110.864
0.516	153.784	154.479	155.291	148.111	108.353	109.988	110.202	110.666
0.624	153.410	154.131	154.809	150.112	108.366	110.481	110.872	111.478
0.740	152.760	153.391	153.996	152.204	108.171	112.091	112.631	114.390
0.865	152.681	153.333	153.966	154.006	106.148	111.932	112.331	114.668
1.000	153.390	154.277	154.963	154.963	97.017	93.242	92.767	84.503
DEM + 1-HEXANOL								
0.000	144.852	142.660	140.436	140.996	125.639	126.495	126.951	127.617
0.083	152.832	152.895	153.016	148.569	125.566	126.124	126.494	127.184
0.170	154.628	155.733	156.595	151.942	125.430	125.755	126.027	126.686
0.260	154.222	155.641	156.552	152.953	125.279	125.798	126.061	126.611
0.353	153.641	154.990	155.763	152.894	125.115	126.085	126.410	126.874
0.450	153.451	154.568	155.214	152.580	124.954	126.363	126.773	127.313
0.551	153.396	154.261	154.806	152.456	124.840	126.676	127.186	128.037
0.656	153.112	153.797	154.245	152.714	124.753	127.400	128.060	129.356
0.766	152.709	153.352	153.750	153.391	124.303	128.477	129.250	130.760
0.881	152.819	153.576	154.084	154.342	122.041	127.074	127.250	128.092
1.000	153.390	154.277	154.963	154.963	114.114	112.396	108.990	107.497

Table 8.1.2
Excess partial molar volumes for the binary systems
DEM + Alkanols

	$10^6V^{\infty}_{m,1}$/ $m^3.mol^{-1}$				$10^6V^{\infty}_{m,2}$/ $m^3.mol^{-1}$			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
DEM + 1-BUTANOL								
0.0000	-16.284	-19.805	-25.022	-28.120	0.000	0.000	0.000	0.000
0.0627	-9.523	-10.698	-11.868	-19.909	-0.093	-0.258	-0.370	-0.430
0.1309	-6.415	-6.733	-6.605	-14.962	-0.353	-0.656	-0.892	-1.041
0.2052	-5.149	-5.445	-5.485	-12.080	-0.769	-0.902	-1.097	-1.275
0.2865	-4.362	-4.907	-5.509	-10.174	-1.357	-1.077	-1.089	-1.222
0.3759	-3.369	-4.042	-4.906	-8.416	-2.127	-1.515	-1.405	-1.471
0.4747	-2.242	-2.779	-3.419	-6.389	-3.061	-2.456	-2.522	-2.583
0.5843	-1.560	-1.811	-2.039	-4.157	-4.158	-3.520	-4.049	-4.196
0.7067	-1.612	-1.674	-1.761	-2.133	-5.813	-3.713	-4.468	-4.682
0.8443	-1.362	-1.413	-1.602	-0.695	-10.382	-4.942	-5.351	-5.594
1.0000	0.000	0.000	0.000	0.000	-27.515	-29.525	-34.107	-36.159
DEM + 1-PENTANOL								
0.000	-4.711	-7.179	-7.274	-7.991	0.000	0.000	0.000	0.000
0.073	0.027	-0.232	-0.367	-6.519	-0.051	-0.217	-0.217	-0.272
0.151	1.162	1.404	1.404	-7.077	-0.165	-0.395	-0.414	-0.423
0.234	0.895	0.943	1.106	-8.149	-0.315	-0.276	-0.333	-0.150
0.322	0.514	0.307	0.563	-8.707	-0.490	-0.037	-0.127	0.201
0.416	0.425	0.158	0.394	-8.267	-0.660	0.042	-0.035	0.192
0.516	0.394	0.202	0.328	-6.852	-0.757	0.007	0.028	-0.006
0.624	0.020	-0.146	-0.154	-4.851	-0.744	0.500	0.698	0.806
0.740	-0.630	-0.886	-0.967	-2.759	-0.939	2.110	2.457	3.718
0.865	-0.709	-0.944	-0.997	-0.957	-2.962	1.951	2.157	3.996
1.000	0.000	0.000	0.000	0.000	-12.094	-16.739	-17.407	-26.169
DEM + 1-HEXNOL								
0.000	-8.538	-11.617	-14.527	-13.967	0.000	0.000	0.000	0.000
0.083	-0.558	-1.382	-1.947	-6.394	-0.073	-0.371	-0.457	-0.433
0.170	1.238	1.456	1.632	-3.021	-0.209	-0.740	-0.924	-0.931
0.260	0.832	1.364	1.589	-2.010	-0.360	-0.697	-0.890	-1.006
0.353	0.251	0.713	0.800	-2.069	-0.524	-0.410	-0.541	-0.743
0.450	0.061	0.291	0.251	-2.383	-0.685	-0.132	-0.178	-0.304
0.551	0.006	-0.016	-0.157	-2.507	-0.799	0.181	0.235	0.420
0.656	-0.278	-0.480	-0.718	-2.249	-0.886	0.905	1.109	1.739
0.766	-0.681	-0.925	-1.213	-1.572	-1.336	1.982	2.299	3.143
0.881	-0.571	-0.701	-0.879	-0.621	-3.598	0.579	0.299	0.475
1.000	0.000	0.000	0.000	0.000	-11.525	-14.099	-17.961	-20.121

Table 8.1.3

AMV of each component $V_{\phi,1}$, $V_{\phi,2}$ calculated through AMV equations for (DEM in Alkanols) and (Alkanols in DEM)

X_1	303.15K	308.15K	313.15K	318.15K	X_2	303.15K	308.15K	313.15K	318.15K
DEM in BUT						**BUT in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	92.532	92.532	93.139	93.669
0.0627	134.371	133.821	131.777	130.809	0.9373	91.259	91.259	91.587	92.028
0.1309	140.385	139.627	138.790	138.392	0.8691	90.574	90.514	90.704	91.119
0.2052	144.160	144.057	143.592	143.349	0.7948	90.149	90.081	90.203	90.577
0.2865	146.299	146.309	145.985	145.866	0.7135	89.685	89.520	89.534	89.871
0.3759	147.728	147.770	147.562	147.548	0.6241	89.121	88.800	88.681	88.984
0.4747	148.691	148.897	148.888	148.946	0.5253	88.286	87.859	87.650	87.906
0.5843	149.513	149.913	150.097	150.245	0.4157	87.082	86.587	86.299	86.531
0.7067	150.598	151.148	151.409	151.589	0.2933	85.805	85.181	84.576	84.669
0.8443	151.710	152.390	152.865	153.061	0.1557	83.425	82.493	81.766	81.403
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000
DEM in PEN						**PEN in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	92.532	92.532	93.139	93.669
0.0627	134.371	133.821	131.777	130.809	0.9373	91.259	91.259	91.587	92.028
0.1309	140.385	139.627	138.790	138.392	0.8691	90.574	90.514	90.704	91.119
0.2052	144.160	144.057	143.592	143.349	0.7948	90.149	90.081	90.203	90.577
0.2865	146.299	146.309	145.985	145.866	0.7135	89.685	89.520	89.534	89.871
0.3759	147.728	147.770	147.562	147.548	0.6241	89.121	88.800	88.681	88.984
0.4747	148.691	148.897	148.888	148.946	0.5253	88.286	87.859	87.650	87.906
0.5843	149.513	149.913	150.097	150.245	0.4157	87.082	86.587	86.299	86.531
0.7067	150.598	151.148	151.409	151.589	0.2933	85.805	85.181	84.576	84.669
0.8443	151.710	152.390	152.865	153.061	0.1557	83.425	82.493	81.766	81.403
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000
DEM in HEX						**HEX in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	92.532	92.532	93.139	93.669
0.0627	134.371	133.821	131.777	130.809	0.9373	91.259	91.259	91.587	92.028
0.1309	140.385	139.627	138.790	138.392	0.8691	90.574	90.514	90.704	91.119
0.2052	144.160	144.057	143.592	143.349	0.7948	90.149	90.081	90.203	90.577
0.2865	146.299	146.309	145.985	145.866	0.7135	89.685	89.520	89.534	89.871
0.3759	147.728	147.770	147.562	147.548	0.6241	89.121	88.800	88.681	88.984
0.4747	148.691	148.897	148.888	148.946	0.5253	88.286	87.859	87.650	87.906
0.5843	149.513	149.913	150.097	150.245	0.4157	87.082	86.587	86.299	86.531
0.7067	150.598	151.148	151.409	151.589	0.2933	85.805	85.181	84.576	84.669
0.8443	151.710	152.390	152.865	153.061	0.1557	83.425	82.493	81.766	81.403
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000

Table 8.1.4
Partial molar volumes at infinite dilutions through PMV, AMV and RV graphs

T/K	$(V_{m1}^{)}$	(V_{m1}) PMV	(V_{m1}) AMV	(V_{m1}) RV	(V_{m2})	(V_{m2}) PMV	(V_{m2}) AMV	(V_{m2}) RV
		DEM in BUT				BUT in DEM		
303.15K	153.39	154.08	138.39	138.00	92.53	125.64	92.19	86.30
308.15K	154.28	155.04	137.75	137.40	92.72	126.49	92.34	85.50
313.15K	154.96	155.70	136.42	136.00	93.14	126.95	92.71	85.00
318.15K	155.32	150.04	135.80	135.40	93.67	127.62	93.27	85.00
		DEM in PEN						
303.15K	153.39	154.41	142.78	142.69	109.11	109.11	109.02	103.20
308.15K	154.28	155.29	141.57	141.41	109.98	110.04	109.82	103.66
313.15K	154.96	147.69	140.26	140.08	110.17	110.46	110.00	102.42
318.15K	155.32	146.97	137.56	137.12	110.67	110.57	110.23	103.26
		DEM in HEX				HEX in DEM		
303.15K	153.39	154.08	144.95	145.15	125.64	125.64	125.84	120.17
308.15K	154.28	155.04	123.69	144.15	126.49	126.49	126.95	119.17
313.15K	154.96	155.70	142.46	143.03	126.95	126.95	127.52	118.52
318.15K	155.32	150.04	140.75	141.35	127.62	127.62	128.22	117.95

Table 8.2.1
PMV of each component $V^{\infty}_{m,1}$, $V^{\infty}_{m,2}$ calculated through PMV equations for (DEM in MOE) and (MOE in DEM), (DEM in EOE) and (EOE in DEM) and (DEM in BOE) and (BOE in DEM)

	$10^6 V_{m,1}$/ $m^3.mol^{-1}$				$10^6 V_{m,2}$/ $m^3.mol^{-1}$			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
DEM + MOE								
0.0000	147.0682	146.1668	145.4299	143.9702	79.926	80.044	80.467	80.715
0.0547	151.3805	151.7554	152.1542	148.5644	79.931	79.906	80.301	80.510
0.1153	153.0920	154.0433	154.9327	151.4231	79.954	79.711	80.064	80.222
0.1825	153.1228	154.1759	155.1406	152.9823	79.985	79.700	80.041	80.211
0.2578	152.4272	153.3471	154.2010	153.7331	79.979	79.938	80.311	80.560
0.3426	151.8280	152.5935	153.3361	154.1494	79.856	80.254	80.674	81.007
0.4387	151.7952	152.5192	153.2373	154.5756	79.511	80.285	80.719	81.036
0.5487	152.2610	153.0591	153.7952	155.0972	78.857	79.744	80.161	80.350
0.6758	152.7159	153.5833	154.2612	155.4919	77.854	78.936	79.454	79.672
0.8242	152.9254	153.7769	154.3563	155.4762	76.156	78.346	79.147	79.817
1.0000	153.3902	154.2766	154.9632	155.3239	70.618	69.798	68.457	66.190
DEM + EOE								
0.0000	152.662	152.608	151.369	150.869	97.999	98.256	98.837	99.229
0.0664	153.534	154.134	154.700	152.335	97.990	98.213	98.742	99.118
0.1379	153.578	154.460	155.486	152.873	97.958	98.182	98.666	99.027
0.2152	153.313	154.254	155.099	152.951	97.887	98.229	98.755	99.122
0.2990	153.094	153.997	154.553	152.948	97.756	98.316	98.941	99.325
0.3901	153.075	153.926	154.376	153.108	97.550	98.349	99.027	99.414
0.4897	153.200	154.026	154.574	153.500	97.278	98.268	98.864	99.254
0.5988	153.291	154.114	154.791	154.029	96.988	98.168	98.612	99.085
0.7190	153.235	154.061	154.720	154.511	96.727	98.281	98.777	99.523
0.8520	153.206	154.051	154.634	154.822	96.316	98.255	99.009	99.921
1.0000	153.390	154.277	154.963	154.963	94.553	93.999	92.468	91.068
DEM + BOE								
0.0000	152.857	153.875	154.226	153.129	132.474	133.176	133.870	134.433
0.0876	153.271	154.213	155.060	153.623	132.430	133.163	133.841	134.362
0.1776	153.353	154.313	155.155	153.570	132.316	133.149	133.830	134.327
0.2701	153.324	154.337	155.092	153.404	132.155	133.143	133.848	134.371
0.3654	153.290	154.338	155.072	153.347	131.970	133.143	133.856	134.411
0.4634	153.283	154.315	155.072	153.466	131.785	133.160	133.857	134.419
0.5644	153.294	154.256	155.003	153.734	131.631	133.224	133.934	134.517
0.6683	153.306	154.178	154.847	154.085	131.536	133.350	134.190	134.900
0.7755	153.321	154.138	154.718	154.456	131.513	133.447	134.515	135.454
0.8860	153.355	154.193	154.789	154.790	131.539	133.131	134.069	134.882
1.0000	153.390	154.277	154.963	154.963	131.504	131.385	130.333	129.057

Table 8.2.2
Excess partial molar volumes for the binary systems of DEM + 2-alkoxyethanols

	$10^6V^{\infty}_{m,1}$ /$m^3.mol^{-1}$				$10^6V^{\infty}_{m,2}$ /$m^3.mol^{-1}$			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
				DEM + MOE				
0.0000	-6.322	-8.110	-9.533	-11.354	0.000	0.000	0.000	0.000
0.0547	-2.010	-2.521	-2.809	-6.760	0.005	-0.138	-0.166	-0.205
0.1153	-0.298	-0.233	-0.030	-3.901	0.028	-0.333	-0.403	-0.493
0.1825	-0.267	-0.101	0.177	-2.342	0.059	-0.344	-0.426	-0.504
0.2578	-0.963	-0.930	-0.762	-1.591	0.053	-0.106	-0.156	-0.155
0.3426	-1.562	-1.683	-1.627	-1.175	-0.070	0.210	0.207	0.292
0.4387	-1.595	-1.757	-1.726	-0.748	-0.415	0.241	0.252	0.321
0.5487	-1.129	-1.218	-1.168	-0.227	-1.069	-0.300	-0.306	-0.365
0.6758	-0.674	-0.693	-0.702	0.168	-2.072	-1.108	-1.013	-1.043
0.8242	-0.465	-0.500	-0.607	0.152	-3.770	-1.698	-1.320	-0.898
1.0000	0.000	0.000	0.000	0.000	-9.308	-10.246	-12.010	-14.525
				DEM + EOE				
0.0000	-0.728	-1.669	-3.594	-4.094	0.000	0.000	0.000	0.000
0.0664	0.144	-0.143	-0.263	-2.628	-0.009	-0.043	-0.095	-0.111
0.1379	0.188	0.183	0.523	-2.090	-0.041	-0.074	-0.171	-0.202
0.2152	-0.077	-0.023	0.136	-2.012	-0.112	-0.027	-0.082	-0.107
0.2990	-0.296	-0.280	-0.410	-2.015	-0.243	0.060	0.104	0.096
0.3901	-0.315	-0.351	-0.587	-1.855	-0.449	0.093	0.190	0.185
0.4897	-0.190	-0.251	-0.389	-1.463	-0.721	0.012	0.027	0.025
0.5988	-0.099	-0.163	-0.172	-0.934	-1.011	-0.088	-0.225	-0.144
0.7190	-0.155	-0.216	-0.243	-0.452	-1.272	0.025	-0.060	0.294
0.8520	-0.184	-0.226	-0.329	-0.141	-1.683	-0.001	0.172	0.692
1.0000	0.000	0.000	0.000	0.000	-3.446	-4.257	-6.369	-8.161
				DEM + BOE				
0.0000	-0.533	-0.402	-0.737	-1.834	0.000	0.000	0.000	0.000
0.0876	-0.119	-0.064	0.097	-1.340	-0.044	-0.013	-0.029	-0.071
0.1776	-0.037	0.036	0.192	-1.393	-0.158	-0.027	-0.040	-0.106
0.2701	-0.066	0.060	0.129	-1.559	-0.319	-0.033	-0.022	-0.062
0.3654	-0.100	0.061	0.109	-1.616	-0.504	-0.033	-0.014	-0.022
0.4634	-0.107	0.038	0.109	-1.497	-0.689	-0.016	-0.013	-0.014
0.5644	-0.096	-0.021	0.040	-1.229	-0.843	0.048	0.064	0.084
0.6683	-0.084	-0.099	-0.116	-0.878	-0.938	0.174	0.320	0.467
0.7755	-0.069	-0.139	-0.245	-0.507	-0.961	0.271	0.645	1.021
0.8860	-0.035	-0.084	-0.174	-0.173	-0.935	-0.045	0.199	0.449
1.0000	0.000	0.000	0.000	0.000	-0.970	-1.791	-3.537	-5.376

Table 8.2.3

AMV of each component $V_{\phi,1}$, $V_{\phi,2}$ calculated through AMV equations for (DEM in AOE) and (AOE in DEM)

	$(V_{\Phi,1})$ / $m^3.mol^{-1}$					$(V_{\Phi,2})$ / $m^3.mol^{-1}$			
X_1	303.15K	308.15K	313.15K	318.15K	X_2	303.15K	308.15K	313.15K	318.15K
	DEM in MOE					**MOE in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	79.9265	80.044	80.467	80.715
0.0547	144.928	144.980	144.261	142.802	0.9453	79.4366	79.506	79.848	79.990
0.1153	146.987	147.208	147.335	146.954	0.8847	79.0923	79.123	79.474	79.625
0.1825	148.249	148.669	148.877	148.664	0.8175	78.7783	78.792	79.108	79.228
0.2578	149.132	149.643	149.990	149.955	0.7422	78.4472	78.435	78.740	78.850
0.3426	149.970	150.496	150.957	151.001	0.6574	78.1445	78.074	78.380	78.462
0.4387	150.772	151.392	151.817	151.956	0.5613	77.8798	77.790	78.009	78.083
0.5487	151.486	152.149	152.665	152.788	0.4513	77.6112	77.458	77.673	77.632
0.6758	152.134	152.824	153.399	153.619	0.3242	77.3089	77.016	77.208	77.162
0.8242	152.773	153.551	154.135	154.407	0.1758	77.0305	76.641	76.581	76.416
1.0000	153.390	154.277	154.963	155.324	0.0000	0.0000	0.0000	0.0000	0.0000
	DEM in EOE					**EOE in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	97.999	97.999	98.837	99.229
0.0664	150.488	150.465	149.978	148.878	0.9336	97.793	97.793	98.483	98.771
0.1379	151.466	151.771	151.848	151.758	0.8621	97.691	97.855	98.339	98.659
0.2152	152.053	152.401	152.775	152.697	0.7848	97.633	97.741	98.237	98.509
0.2990	152.311	152.798	153.219	153.314	0.7010	97.539	97.625	98.094	98.372
0.3901	152.543	153.087	153.549	153.697	0.6099	97.457	97.495	97.933	98.189
0.4897	152.749	153.343	153.870	154.060	0.5103	97.384	97.359	97.788	98.017
0.5988	152.897	153.579	154.153	154.335	0.4012	97.263	97.214	97.629	97.753
0.7190	153.091	153.790	154.398	154.627	0.2810	97.234	97.009	97.390	97.445
0.8520	153.252	154.029	154.660	154.928	0.1480	97.205	96.831	97.090	96.953
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000
	DEM in EOE					**EOE in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	132.474	132.474	133.870	134.433
0.0876	152.467	151.679	151.281	150.516	0.9124	132.385	132.385	133.516	133.972
0.1776	152.696	152.248	152.601	152.582	0.8224	132.324	132.738	133.360	133.841
0.2701	152.881	152.803	153.229	153.317	0.7299	132.285	132.630	133.228	133.690
0.3654	153.018	153.035	153.556	153.729	0.6346	132.260	132.461	133.059	133.515
0.4634	153.082	153.294	153.817	154.008	0.5366	132.207	132.327	132.880	133.297
0.5644	153.137	153.463	154.016	154.248	0.4356	132.145	132.121	132.643	133.040
0.6683	153.222	153.652	154.229	154.466	0.3317	132.135	131.918	132.389	132.703
0.7755	153.281	153.838	154.445	154.680	0.2245	132.098	131.659	132.080	132.210
0.8860	153.320	154.043	154.681	154.955	0.1140	131.931	131.360	131.679	131.565
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000

Table 8.2.4

Partial molar volumes at infinite dilutions through PMV, AMV and RV graphs

T/K	(V_{m1})	(V_{m1}) **PMV**	(V_{m1}) **AMV**	(V_{m1}) **RV**	(V_{m2})	(V_{m2}) **PMV**	(V_{m2}) **AMV**	(V_{m2}) **RV**
			DEM in MOE				MOE in DEM	
303.15K	153.39	152.22	146.07	145.51	79.93	80.87	79.80	78.22
308.15K	154.28	152.95	146.25	145.70	80.04	80.28	79.97	77.88
313.15K	154.96	153.74	146.09	145.52	80.47	80.56	80.30	78.16
318.15K	155.32	150.34	145.36	144.75	80.71	80.68	80.25	78.41
			DEM in EOE				EOE in DEM	
303.15K	153.39	153.43	151.1	150.87	98	98.11	97.79	97.67
308.15K	154.28	154.23	151.2	151.02	98.3	98.23	98.06	97.36
313.15K	154.96	154.98	151.1	150.89	98.8	98.75	98.60	97.92
318.15K	155.32	152.18	150.6	150.41	99.2	98.97	99.00	98.09
			DEM in BOE				BOE in DEM	
303.15K	153.39	153.3	152.39	152.15	132	132.5	132.57	132.10
308.15K	154.28	153.9	151.48	151.80	133	133.2	133.13	131.50
313.15K	154.96	154.2	151.85	151.80	134	133.9	133.81	132.00
318.15K	155.32	153.1	151.52	151.50	134	134.4	134.44	132.20

Table 8.3.1
PMV of each component $V^{\infty}_{m,1}$, $V^{\infty}_{m,2}$ calculated through PMV equations for (DEM in FA) and (FA in DEM), (DEM in DMF) and (DMF in DEM) and (DEM in DMA) and (DMA in DEM)

	$10^6V^{\infty}_{m,1}$ /$m^3.mol^{-1}$				$10^6V^{\infty}_{m,2}$ /$m^3.mol^{-1}$			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
DEM + FA								
0.0000	146.548	129.921	127.009	118.290	40.057	40.218	40.377	40.544
0.0282	148.931	139.906	138.478	129.475	40.052	40.082	40.221	40.338
0.0613	150.841	147.933	147.692	139.967	40.036	39.716	39.801	39.781
0.1007	152.178	153.586	154.176	149.402	40.010	39.231	39.245	39.044
0.1483	152.873	156.560	157.589	157.348	39.976	38.825	38.778	38.427
0.2071	152.935	156.863	157.951	163.328	39.928	38.778	38.721	38.351
0.2815	152.533	155.129	156.003	166.892	39.847	39.351	39.365	39.199
0.3786	152.077	152.934	153.546	167.734	39.669	40.415	40.555	40.766
0.5109	152.144	152.428	152.987	165.735	39.225	40.729	40.902	41.243
0.7015	152.841	153.696	154.307	160.657	38.149	38.755	38.863	38.846
1.0000	153.420	154.277	154.963	154.963	34.132	31.195	29.310	27.090
DEM + DMF								
0.0000	154.420	149.111	148.827	141.375	77.813	78.246	78.575	78.948
0.0534	148.500	148.136	148.359	144.310	77.751	78.269	78.585	78.816
0.1125	146.199	147.945	148.467	146.370	77.538	78.282	78.572	78.585
0.1786	146.451	148.414	149.064	147.804	77.157	78.197	78.467	78.432
0.2527	148.059	149.354	150.011	148.895	76.630	77.936	78.204	78.378
0.3366	149.883	150.518	151.127	149.919	76.019	77.449	77.738	78.244
0.4321	151.127	151.634	152.202	151.072	75.407	76.755	77.069	77.712
0.5421	151.662	152.489	153.071	152.383	74.797	75.952	76.250	76.606
0.6699	152.091	153.071	153.720	153.655	73.913	75.062	75.254	75.363
0.8203	152.973	153.667	154.369	154.574	72.057	73.226	73.273	74.206
1.0000	153.390	154.277	154.963	154.963	69.524	65.496	65.874	61.445
DEM + DMA								
0.0000	149.303	149.025	146.671	149.328	93.496	93.920	94.367	94.840
0.0634	150.149	150.165	150.355	150.034	93.507	93.886	94.263	94.823
0.1322	150.442	150.776	151.703	150.769	93.513	93.823	94.129	94.764
0.2071	150.478	151.087	151.836	151.517	93.456	93.761	94.109	94.648
0.2889	150.542	151.332	151.703	152.258	93.255	93.680	94.151	94.450
0.3787	150.853	151.709	151.942	152.971	92.813	93.487	94.022	94.126
0.4776	151.504	152.334	152.743	153.631	92.045	93.011	93.408	93.591
0.5872	152.395	153.166	153.828	154.206	90.949	92.054	92.165	92.718
0.7091	153.209	153.965	154.652	154.648	89.773	90.586	90.675	91.379
0.8458	153.531	154.353	154.914	154.904	89.373	89.322	89.845	89.715
1.0000	153.390	154.277	154.963	154.963	91.985	91.211	88.803	89.064

Table 8.3.2
Excess partial molar volumes for the binary systems of DEM + amides

	$10^6V^{\infty}_{m,1}$ /m^3.mol^{-1}				$10^6V^{\infty}_{m,2}$ /m^3.mol^{-1}			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
DEM + FA								
0.0000	-6.872	-24.356	-27.954	-36.673	0.000	0.000	0.000	0.000
0.0282	-4.489	-14.371	-16.485	-25.488	-0.005	-0.136	-0.156	-0.206
0.0613	-2.579	-6.344	-7.271	-14.996	-0.021	-0.502	-0.576	-0.763
0.1007	-1.242	-0.691	-0.787	-5.561	-0.047	-0.987	-1.132	-1.500
0.1483	-0.547	2.283	2.626	2.385	-0.081	-1.393	-1.599	-2.117
0.2071	-0.485	2.586	2.988	8.365	-0.129	-1.440	-1.656	-2.193
0.2815	-0.887	0.852	1.040	11.929	-0.210	-0.867	-1.012	-1.345
0.3786	-1.343	-1.343	-1.417	12.771	-0.388	0.197	0.178	0.222
0.5109	-1.276	-1.849	-1.976	10.772	-0.832	0.511	0.525	0.699
0.7015	-0.579	-0.581	-0.656	5.694	-1.908	-1.463	-1.514	-1.698
1.0000	0.000	0.000	0.000	0.000	-5.925	-9.023	-11.067	-13.454
DEM + DMF								
0.0000	1.030	-5.166	-6.136	-13.588	0.000	0.000	0.000	0.000
0.0534	-4.890	-6.141	-6.604	-10.653	-0.062	0.023	0.010	-0.132
0.1125	-7.191	-6.332	-6.496	-8.593	-0.275	0.036	-0.003	-0.363
0.1786	-6.939	-5.863	-5.899	-7.159	-0.656	-0.049	-0.108	-0.516
0.2527	-5.331	-4.923	-4.952	-6.068	-1.183	-0.310	-0.371	-0.570
0.3366	-3.507	-3.759	-3.836	-5.044	-1.794	-0.797	-0.837	-0.704
0.4321	-2.263	-2.643	-2.761	-3.891	-2.406	-1.491	-1.506	-1.236
0.5421	-1.728	-1.788	-1.892	-2.580	-3.016	-2.294	-2.325	-2.342
0.6699	-1.299	-1.206	-1.243	-1.308	-3.900	-3.184	-3.321	-3.585
0.8203	-0.417	-0.610	-0.594	-0.389	-5.756	-5.020	-5.302	-4.742
1.0000	0.000	0.000	0.000	0.000	-8.289	-12.750	-12.701	-17.503
DEM + DMA								
0.0000	-4.087	-5.252	-8.292	-5.635	0.000	0.000	0.000	0.000
0.0634	-3.241	-4.112	-4.608	-4.929	0.011	-0.034	-0.104	-0.017
0.1322	-2.948	-3.501	-3.260	-4.194	0.017	-0.097	-0.238	-0.076
0.2071	-2.912	-3.190	-3.127	-3.446	-0.040	-0.159	-0.258	-0.192
0.2889	-2.848	-2.945	-3.260	-2.705	-0.241	-0.240	-0.216	-0.390
0.3787	-2.537	-2.568	-3.021	-1.992	-0.683	-0.433	-0.345	-0.714
0.4776	-1.886	-1.943	-2.220	-1.332	-1.451	-0.909	-0.959	-1.249
0.5872	-0.995	-1.111	-1.135	-0.757	-2.547	-1.866	-2.202	-2.122
0.7091	-0.181	-0.312	-0.311	-0.315	-3.723	-3.334	-3.692	-3.461
0.8458	0.141	0.076	-0.049	-0.059	-4.123	-4.598	-4.522	-5.125
1.0000	0.000	0.000	0.000	0.000	-1.511	-2.709	-5.564	-5.776

Table 8.3.3

AMV of each component $V^{\infty}_{m,1}$, $V^{\infty}_{m,2}$ calculated through AMV equations for (DEM in Amides) and (Amides in DEM)

X_1	303.15K	308.15K	313.15K	318.15K	X_2	303.15K	308.15K	313.15K	318.15K
DEM in FA						**FA in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	40.057	40.057	40.377	40.544
0.0282	116.224	115.752	115.141	115.111	0.9718	38.978	38.978	39.221	39.377
0.0613	126.485	126.478	126.347	126.316	0.9387	38.300	38.403	38.508	38.650
0.1007	129.378	129.341	129.484	129.429	0.8993	37.369	37.427	37.525	37.645
0.1483	131.123	131.228	131.378	131.393	0.8517	36.180	36.205	36.270	36.377
0.2071	132.305	132.297	132.479	132.607	0.7929	34.550	34.477	34.504	34.611
0.2815	134.346	134.613	134.887	135.103	0.7185	32.596	32.515	32.512	32.622
0.3786	137.064	137.509	137.723	137.951	0.6214	30.108	30.000	29.870	29.957
0.5109	140.760	141.263	141.590	142.006	0.4891	26.863	26.623	26.406	26.631
0.7015	145.639	146.296	146.710	146.925	0.2985	21.839	21.460	20.977	20.803
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000
DEM in DMF						**DMF in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	77.813	77.813	78.575	78.948
0.0534	144.842	143.373	143.990	141.772	0.9466	77.331	77.331	77.956	78.184
0.1125	144.484	144.758	144.963	144.961	0.8875	76.684	77.039	77.306	77.634
0.1786	145.883	146.451	146.928	146.877	0.8214	76.181	76.545	76.828	77.111
0.2527	147.165	147.833	148.347	148.437	0.7473	75.708	76.067	76.337	76.619
0.3366	147.957	148.717	149.194	149.400	0.6634	75.057	75.426	75.648	75.943
0.4321	148.876	149.638	150.138	150.379	0.5679	74.378	74.717	74.903	75.185
0.5421	149.793	150.563	151.135	151.415	0.4579	73.555	73.851	74.043	74.321
0.6699	150.966	151.686	152.225	152.451	0.3301	72.893	72.990	73.018	73.117
0.8203	152.144	152.944	153.563	153.817	0.1797	72.123	72.162	72.184	72.067
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000
DEM in DMA						**DMA in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	93.496	93.496	94.367	94.840
0.0634	150.784	150.699	149.882	149.464	0.9366	93.320	93.320	94.023	94.443
0.1322	150.312	150.385	150.129	150.010	0.8678	93.027	93.327	93.631	94.030
0.2071	149.688	150.015	150.278	149.928	0.7929	92.529	92.807	93.143	93.430
0.2889	149.656	150.089	150.426	150.385	0.7111	91.979	92.218	92.524	92.833
0.3787	150.023	150.617	150.933	151.086	0.6213	91.444	91.689	91.911	92.257
0.4776	150.680	151.262	151.674	151.854	0.5224	91.018	91.164	91.360	91.668
0.5872	151.372	152.047	152.504	152.669	0.4128	90.626	90.749	90.869	91.064
0.7091	152.115	152.836	153.358	153.567	0.2909	90.386	90.407	90.455	90.556
0.8458	152.801	153.543	154.133	154.414	0.1542	90.262	89.897	89.815	89.850
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000

Table 8.3.4

Partial molar volumes at infinite dilutions through PMV, AMV and RV graphs

T/K	$(V_{m1}^{)}$	(V_{m1}) PMV	(V_{m1}) AMV	(V_{m1}) RV	(V_{m2})	(V_{m2}) PMV	(V_{m2}) AMV	(V_{m2}) RV
		DEM in FA				**FA in DEM**		
303.15K	153.39	151.13	123.27	123.07	40.06	39.98	39.86	18.83
308.15K	154.28	149.72	123.05	122.82	40.22	39.50	39.57	20.89
313.15K	154.96	149.74	122.89	122.69	40.38	39.28	39.66	20.30
318.15K	155.32	145.02	122.86	122.67	40.54	39.14	39.80	20.46
		DEM in DMF				**DMF in DEM**		
303.15K	153.39	151.48	148.30	143.80	77.81	77.72	77.44	71.61
308.15K	154.28	148.78	143.97	143.59	78.25	78.25	77.87	72.23
313.15K	154.96	148.60	144.39	144.03	78.57	78.58	78.22	72.13
318.15K	155.32	143.68	143.62	143.27	78.95	78.49	78.59	72.71
		DEM in DMA				**DMA in DEM**		
303.15K	153.39	149.40	149.47	149.30	93.50	92.94	93.34	88.55
308.15K	154.28	149.87	149.51	149.38	93.92	93.58	93.68	88.41
313.15K	154.96	150.35	149.15	148.99	94.37	93.61	93.25	88.62
318.15K	155.32	150.17	148.82	148.64	94.84	94.75	94.38	88.75

Table 8.4.1
PMV of each component $V^{\infty}_{m,1}$, $V^{\infty}_{m,2}$ calculated through PMV equations for (DEM in NB) and (NB in DEM), (DEM in TOL) and (TOL in DEM) and (DEM in BEN) and (BEN in DEM)

	$10^6V^{\infty}_{m,1}$ /m^3.mol^{-1}				$10^6V^{\infty}_{m,2}$ /m^3.mol^{-1}			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
DEM + NB								
0.0000	136.154	136.794	134.474	133.629	103.109	103.542	103.953	104.120
0.0695	140.706	141.090	141.260	139.369	103.010	103.398	103.733	103.888
0.1439	143.635	144.036	144.934	143.627	102.703	103.054	103.312	103.448
0.2237	145.655	146.202	146.972	146.827	102.156	102.571	102.863	102.988
0.3095	147.302	148.009	148.460	149.311	101.325	101.915	102.323	102.441
0.4020	148.875	149.688	149.997	151.306	100.167	100.988	101.469	101.574
0.5021	150.423	151.266	151.673	152.903	98.668	99.686	100.081	100.162
0.6107	151.788	152.613	153.194	154.077	96.880	98.001	98.179	98.237
0.7289	152.752	153.562	154.202	154.761	94.956	96.094	96.165	96.198
0.8582	153.248	154.080	154.694	154.976	93.122	94.130	94.293	94.108
1.0000	153.420	154.277	154.963	154.963	91.440	91.296	89.813	88.270
DEM + TOL								
0.0000	158.204	157.856	157.333	156.622	107.452	107.691	108.630	109.274
0.0722	158.494	158.959	159.459	158.509	107.444	107.658	108.565	109.193
0.1490	158.251	159.006	159.814	159.372	107.438	107.659	108.531	109.134
0.2309	157.663	158.469	159.257	159.506	107.466	107.789	108.668	109.260
0.3183	156.903	157.704	158.404	159.159	107.565	108.080	108.992	109.591
0.4119	156.112	156.931	157.597	158.522	107.790	108.525	109.455	110.074
0.5124	155.380	156.231	156.919	157.722	108.227	109.126	110.037	110.678
0.6204	154.738	155.592	156.292	156.846	109.020	109.965	110.862	111.525
0.7370	154.170	154.986	155.647	155.979	110.422	111.257	112.241	112.913
0.8631	153.666	154.481	155.117	155.268	112.888	113.302	114.370	114.942
1.0000	153.390	154.277	154.963	154.963	117.232	116.022	115.995	115.929
DEM + BEN								
0.0000	161.491	161.515	160.043	159.591	89.968	90.552	91.090	91.657
0.0612	160.973	161.396	161.685	160.742	89.978	90.558	91.048	91.610
0.1279	160.241	160.932	161.870	161.213	90.016	90.608	91.036	91.581
0.2009	159.355	160.201	161.156	161.125	90.100	90.754	91.182	91.700
0.2811	158.376	159.287	160.046	160.610	90.260	91.046	91.537	92.031
0.3697	157.369	158.276	158.910	159.789	90.546	91.535	92.084	92.576
0.4680	156.385	157.249	157.916	158.769	91.049	92.276	92.798	93.325
0.5778	155.451	156.267	157.022	157.630	91.941	93.355	93.781	94.373
0.7011	154.579	155.374	156.100	156.462	93.548	94.945	95.438	96.068
0.8407	153.805	154.637	155.253	155.440	96.522	97.458	98.314	98.854
1.0000	153.390	154.277	154.963	154.963	102.168	101.851	100.990	101.363

Table 8.4.2
Excess partial molar volumes for the binary systems of DEM +benzene and mono substituted benzenes

	$10^6V^{\infty}_{m,1}$ /$m^3.mol^{-1}$				$10^6V^{\infty}_{m,2}$ /$m^3.mol^{-1}$			
X_1	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
				DEM + NB				
0.0000	-17.266	-17.484	-20.489	-21.334	0.000	0.000	0.000	0.000
0.0695	-12.714	-13.187	-13.703	-15.594	-0.099	-0.144	-0.220	-0.232
0.1439	-9.785	-10.241	-10.029	-11.336	-0.406	-0.488	-0.641	-0.672
0.2237	-7.765	-8.075	-7.991	-8.136	-0.953	-0.971	-1.090	-1.132
0.3095	-6.118	-6.268	-6.503	-5.652	-1.784	-1.627	-1.630	-1.679
0.4020	-4.545	-4.589	-4.966	-3.657	-2.942	-2.554	-2.484	-2.546
0.5021	-2.997	-3.011	-3.290	-2.060	-4.441	-3.856	-3.872	-3.958
0.6107	-1.632	-1.664	-1.769	-0.886	-6.229	-5.541	-5.774	-5.883
0.7289	-0.668	-0.715	-0.761	-0.202	-8.153	-7.448	-7.788	-7.922
0.8582	-0.172	-0.197	-0.269	0.013	-9.987	-9.412	-9.660	-10.012
1.0000	0.000	0.000	0.000	0.000	-11.669	-12.246	-14.140	-15.850
				DEM + TOL				
0.0000	4.814	3.579	2.370	1.659	0.000	0.000	0.000	0.000
0.0722	5.104	4.682	4.496	3.546	-0.008	-0.033	-0.065	-0.081
0.1490	4.861	4.729	4.851	4.409	-0.014	-0.032	-0.099	-0.140
0.2309	4.273	4.192	4.294	4.543	0.014	0.098	0.038	-0.014
0.3183	3.513	3.427	3.441	4.196	0.113	0.389	0.362	0.317
0.4119	2.722	2.654	2.634	3.559	0.338	0.834	0.825	0.800
0.5124	1.990	1.954	1.956	2.759	0.775	1.435	1.407	1.404
0.6204	1.348	1.315	1.329	1.883	1.568	2.274	2.232	2.251
0.7370	0.780	0.709	0.684	1.016	2.970	3.566	3.611	3.639
0.8631	0.276	0.204	0.154	0.305	5.436	5.611	5.740	5.668
1.0000	0.000	0.000	0.000	0.000	9.780	8.331	7.365	6.655
				DEM + BEN				
0.0000	8.101	7.238	5.080	4.628	0.000	0.000	0.000	0.000
0.0612	7.583	7.119	6.722	5.779	0.010	0.006	-0.042	-0.047
0.1279	6.851	6.655	6.907	6.250	0.048	0.056	-0.054	-0.076
0.2009	5.965	5.924	6.193	6.162	0.132	0.202	0.092	0.043
0.2811	4.986	5.010	5.083	5.647	0.292	0.494	0.447	0.374
0.3697	3.979	3.999	3.947	4.826	0.578	0.983	0.994	0.919
0.4680	2.995	2.972	2.953	3.806	1.081	1.724	1.708	1.668
0.5778	2.061	1.990	2.059	2.667	1.973	2.803	2.691	2.716
0.7011	1.189	1.097	1.137	1.499	3.580	4.393	4.348	4.411
0.8407	0.415	0.360	0.290	0.477	6.554	6.906	7.224	7.197
1.0000	0.000	0.000	0.000	0.000	12.200	11.299	9.900	9.706

Table 8.4.3

AMV of each component $V_{\phi,1}$, $V_{\phi,2}$ calculated through AMV equations for (DEM in sub.benzenes) and (sub.benzenes in DEM)

X_1	303.15K	308.15K	313.15K	318.15K	X_2	303.15K	308.15K	313.15K	318.15K
DEM in NB						**NB in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	103.109	103.109	103.953	104.1205
0.0695	142.496	142.918	142.513	141.683	0.9305	102.295	102.295	103.023	103.1017
0.1439	143.318	143.760	143.552	143.489	0.8561	101.416	101.775	102.036	102.132
0.2237	143.844	144.453	144.633	144.415	0.7763	100.358	100.712	100.978	100.978
0.3095	144.576	145.265	145.509	145.479	0.6905	99.159	99.504	99.717	99.708
0.4020	145.571	146.266	146.563	146.604	0.5980	97.853	98.158	98.307	98.259
0.5021	146.794	147.501	147.862	147.970	0.4979	96.458	96.710	96.794	96.706
0.6107	148.087	148.801	149.317	149.495	0.3893	94.791	94.953	95.097	94.978
0.7289	149.543	150.327	150.852	151.061	0.2711	92.764	92.923	92.898	92.658
0.8582	151.281	152.095	152.664	152.947	0.1418	90.348	90.347	90.046	89.743
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000
DEM in TOL						**TOL in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	107.452	107.452	108.630	109.2742
0.0722	161.815	161.876	162.123	162.030	0.9278	108.108	108.108	109.187	109.7962
0.1490	160.585	161.063	161.501	161.800	0.8510	108.712	108.712	109.775	110.408
0.2309	159.540	160.164	160.808	161.005	0.7691	109.298	109.298	110.385	110.980
0.3183	158.547	159.293	159.930	160.245	0.6817	109.860	109.860	110.950	111.572
0.4119	157.678	158.409	159.073	159.377	0.5881	110.456	110.456	111.509	112.114
0.5124	156.836	157.582	158.222	158.533	0.4876	111.073	111.073	112.055	112.646
0.6204	155.957	156.724	157.389	157.718	0.3796	111.648	111.648	112.595	113.187
0.7370	155.095	155.875	156.501	156.821	0.2630	112.229	112.229	112.938	113.469
0.8631	154.188	154.994	155.634	155.952	0.1369	112.480	112.480	112.856	113.234
1.0000	93.281	93.541	92.778	92.332	0.0000	0.000	0.000	0.000	0.000
DEM in BEN						**BEN in DEM**			
0.0000	0.000	0.000	0.000	0.000	1.0000	89.968	89.968	91.090	91.657
0.0612	164.341	164.559	164.636	164.818	0.9388	90.681	90.681	91.721	92.276
0.1279	162.969	163.540	163.976	164.371	0.8721	91.372	91.910	92.412	92.983
0.2009	161.938	162.506	163.223	163.493	0.7991	92.116	92.620	93.167	93.710
0.2811	160.695	161.486	162.144	162.561	0.7189	92.824	93.371	93.898	94.487
0.3697	159.638	160.399	161.095	161.447	0.6303	93.632	94.143	94.687	95.248
0.4680	158.542	159.309	159.980	160.338	0.5320	94.501	94.979	95.504	96.068
0.5778	157.325	158.139	158.798	159.148	0.4222	95.353	95.838	96.339	96.890
0.7011	156.088	156.888	157.539	157.858	0.2989	96.298	96.680	97.132	97.601
0.8407	154.775	155.587	156.214	156.528	0.1593	97.279	97.471	97.691	98.015
1.0000	153.390	154.277	154.963	155.324	0.0000	0.000	0.000	0.000	0.000

Table 8.4.4

Partial molar volumes at infinite dilutions through PMV, AMV and RV graphs

T/K	(V_{m1})	(V_{m1}) PMV Graph	(V_{m1}) AMV Graph	(V_{m1}) RV Graph	(V_{m2})	(V_{m2}) PMV Graph	(V_{m2}) AMV Graph	(V_{m2}) RV Graph
			DEM in NB				**NB in DEM**	
303.15K	153.39	141.67	141.44	142.01	103.11	103.71	102.91	87.05
308.15K	154.28	142.09	141.89	142.49	103.54	103.78	103.34	87.83
313.15K	154.96	142.59	141.64	142.23	103.95	103.95	104.23	87.77
318.15K	155.32	141.69	141.17	141.73	104.12	104.15	104.15	87.60
			DEM in TOL				**TOL in DEM**	
303.15K	153.39	159.01	161.88	163.18	107.45	107.45	107.95	110.67
308.15K	154.28	159.66	162.23	163.48	107.69	107.89	108.23	112.45
313.15K	154.96	160.36	162.66	163.54	108.63	108.81	109.21	112.71
318.15K	155.32	160.15	162.78	164.01	109.27	109.39	109.88	112.81
			DEM in BEN				**BEN in DEM**	
303.15K	153.39	161.2	164.43	164.83	89.96	88.516	89.90	97.87
308.15K	154.28	161.52	164.88	165.63	90.55	90.55	90.58	99.26
313.15K	154.96	162.59	165.29	165.77	91.09	91.09	90.98	99.78
318.15K	155.32	162.25	165.60	164.71	91.65	91.657	91.66	99.09

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