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# Excess molar volumes, deviations in viscosity and refractive index of the binary mixtures of mesitylene with ethanol, propan-1-ol, propan-2-ol, butan-1-ol, pentan-1-ol, and 3-methylbutan-1-ol at 298.15, 303.15, and 308.15 K ☆

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**Abstract**

Experimental values of density, viscosity, and refractive index at 298.15, 303.15, and 308.15 K have been measured over the whole range of composition for the binary liquid mixtures of mesitylene with ethanol, propan-1-ol, propan-2-ol, butan-1-ol, pentan-1-ol, and 3-methylbutan-1-ol. Using these data, excess molar volumes, deviations in viscosity, and Lorenz–Lorentz molar refractivity have been calculated. These results have been fitted to Redlich and Kister polynomial equation to derive the coefficients and standard errors. These quantities have been discussed in terms of the intermolecular interactions between the components of the mixtures.


*Keywords:* Excess molar volume; Mesitylene; Viscosity; Binary mixture

## 1. Introduction

In recent years, several studies have been made on thermodynamic and transport properties of binary liquid mixtures containing protic, aprotic, and associated liquids in addition to volumetric properties of alkanols + aromatic hydrocarbons [1–8]. The calculated excess quantities from such data have been interpreted in terms of the differences in the size of the molecules as well as the strength of specific and nonspecific interactions between components of the mixtures. In this study, interactions of six alkanols with mesitylene have been investigated. Alkanols exist in their associated forms, whereas mesitylene has a non-associated structure in the liquid state. When alkanols are mixed with mesitylene, their mixing properties vary depending upon their intermolecular interactions. In the present investigation, density ($\rho$), viscosity ($\eta$), and refractive index ($n_D$) of the binary mixtures of ethanol, propan-1-ol, propan-2-ol, butan-1-ol, pentan-1-ol, or 3-methylbutan-1-

Table 1
Comparison of experimental densities ($\rho$) and refractive indices ($n_D$) of pure liquids with literature values at 298.15 K

| Liquid | Purity (mol%) | $\rho$ (kg m$^{-3}$) | | $n_D$ | |
|---|---|---|---|---|---|
| | | Experimental | Literature | Experimental | Literature |
| Ethanol | 99.9 | 785.91 | 785.46 [12] | 1.3591 | 1.3593 [13] |
| Propan-1-ol | 99.5 | 799.96 | 799.62 [13] | 1.3826 | 1.3830 [13] |
| Propan-2-ol | 99.5 | 781.36 | 781.40 [15] | 1.3745 | 1.3752 [14] |
| Butan-1-ol | 99.0 | 806.12 | 806.00 [14] | 1.3968 | 1.3973 [14] |
| Pentan-1-ol | 99.0 | 810.92 | 810.83 [13] | 1.4073 | 1.4080 [13] |
| 3-Methylbutan-1-ol | 99.0 | 807.20 | 807.10 [16] | 1.4050 | 1.4052 [16] |
| Mesitylene | 99.0 | 860.50 | 860.60 [17] | 1.4958 | 1.4978 [17] |

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Table 2
Experimental density ($\rho$), viscosity ($\eta$), and refractive index ($n_D$) of the binary mixtures at different temperatures

Mesitylene (1)+Ethanol (2)

| $x_1$ | $\rho$ (kg m$^{-3}$) | $\eta$ (mPa s) | $n_D$ |
|---|---|---|---|
| *298.15 K* | | | |
| 0.0000 | 785.91 | 1.073 | 1.3591 |
| 0.0997 | 801.27 | 0.969 | 1.3873 |
| 0.2017 | 813.24 | 0.923 | 1.4108 |
| 0.3005 | 822.70 | 0.883 | 1.4282 |
| 0.3970 | 830.47 | 0.816 | 1.4454 |
| 0.4955 | 837.17 | 0.763 | 1.4550 |
| 0.5978 | 842.97 | 0.721 | 1.4656 |
| 0.6988 | 848.01 | 0.684 | 1.4752 |
| 0.7964 | 852.32 | 0.649 | 1.4836 |
| 0.8542 | 854.82 | 0.645 | 1.4866 |
| 1.0000 | 860.50 | 0.641 | 1.4958 |
| *303.15 K* | | | |
| 0.0000 | 781.60 | 0.971 | 1.3572 |
| 0.0997 | 796.93 | 0.882 | 1.3848 |
| 0.2017 | 808.87 | 0.807 | 1.4079 |
| 0.3005 | 818.32 | 0.752 | 1.4255 |
| 0.3970 | 826.10 | 0.704 | 1.4419 |
| 0.4955 | 832.82 | 0.665 | 1.4525 |
| 0.5978 | 838.63 | 0.643 | 1.4624 |
| 0.6988 | 843.71 | 0.633 | 1.4728 |
| 0.7964 | 847.85 | 0.628 | 1.4806 |
| 0.8542 | 850.61 | 0.613 | 1.4848 |
| 1.0000 | 856.40 | 0.601 | 1.4928 |
| *308.15 K* | | | |
| 0.0000 | 777.26 | 0.889 | 1.3550 |
| 0.0997 | 792.53 | 0.809 | 1.3822 |
| 0.2017 | 804.47 | 0.746 | 1.4057 |
| 0.3005 | 813.92 | 0.691 | 1.4228 |
| 0.3970 | 821.69 | 0.656 | 1.4386 |
| 0.4955 | 828.44 | 0.639 | 1.4498 |
| 0.5978 | 834.29 | 0.619 | 1.4599 |
| 0.6988 | 839.41 | 0.594 | 1.4709 |
| 0.7964 | 843.78 | 0.579 | 1.4796 |
| 0.8542 | 846.40 | 0.568 | 1.4821 |
| 1.0000 | 852.29 | 0.566 | 1.4898 |

Mesitylene (1)+Propan-1-ol (2)

| $x_1$ | $\rho$ (kg m$^{-3}$) | $\eta$ (mPa s) | $n_D$ |
|---|---|---|---|
| *298.15 K* | | | |
| 0.0000 | 799.96 | 1.792 | 1.3826 |
| 0.1037 | 806.01 | 1.522 | 1.4019 |
| 0.2027 | 812.06 | 1.303 | 1.4180 |
| 0.3015 | 818.12 | 1.079 | 1.4323 |
| 0.4040 | 824.17 | 0.949 | 1.4419 |
| 0.5037 | 830.23 | 0.832 | 1.4557 |
| 0.5984 | 836.28 | 0.774 | 1.4643 |
| 0.7014 | 842.34 | 0.716 | 1.4735 |
| 0.7976 | 848.39 | 0.658 | 1.4815 |
| 0.9065 | 854.45 | 0.646 | 1.4893 |
| 1.0000 | 860.50 | 0.641 | 1.4958 |
| *303.15 K* | | | |
| 0.0000 | 795.93 | 1.706 | 1.3808 |
| 0.1037 | 801.98 | 1.382 | 1.3996 |
| 0.2027 | 808.02 | 1.167 | 1.4157 |
| 0.3015 | 814.07 | 0.971 | 1.4296 |

Table 2 (*continued*)

Mesitylene (1)+Propan-1-ol (2)

| $x_1$ | $\rho$ (kg m$^{-3}$) | $\eta$(mPa s) | $n_D$ |
|---|---|---|---|
| *303.15 K* | | | |
| 0.4040 | 820.12 | 0.867 | 1.4414 |
| 0.5037 | 826.16 | 0.762 | 1.4535 |
| 0.5984 | 832.22 | 0.716 | 1.4628 |
| 0.7014 | 838.26 | 0.671 | 1.4707 |
| 0.7976 | 844.31 | 0.634 | 1.4783 |
| 0.9065 | 850.35 | 0.625 | 1.4863 |
| 1.0000 | 856.40 | 0.601 | 1.4928 |
| *308.15 K* | | | |
| 0.0000 | 791.86 | 1.518 | 1.3782 |
| 0.1037 | 797.90 | 1.241 | 1.3976 |
| 0.2027 | 803.95 | 1.056 | 1.4139 |
| 0.3015 | 809.98 | 0.883 | 1.4282 |
| 0.4040 | 816.03 | 0.791 | 1.4386 |
| 0.5037 | 822.07 | 0.709 | 1.4508 |
| 0.5984 | 828.12 | 0.662 | 1.4587 |
| 0.7014 | 834.16 | 0.635 | 1.4680 |
| 0.7976 | 840.20 | 0.615 | 1.4771 |
| 0.9065 | 846.25 | 0.569 | 1.4843 |
| 1.0000 | 852.29 | 0.566 | 1.4898 |

Mesitylene (1)+Propan-2-ol (2)

| $x_1$ | $\rho$ (kg m$^{-3}$) | $\eta$ (mPa s) | $n_D$ |
|---|---|---|---|
| *298.15 K* | | | |
| 0.0000 | 781.36 | 2.042 | 1.3745 |
| 0.1011 | 793.81 | 1.489 | 1.3940 |
| 0.2005 | 804.44 | 1.183 | 1.4115 |
| 0.3055 | 814.27 | 1.000 | 1.4272 |
| 0.4001 | 822.26 | 0.882 | 1.4393 |
| 0.5008 | 829.63 | 0.800 | 1.4483 |
| 0.6035 | 836.85 | 0.734 | 1.4634 |
| 0.6979 | 842.79 | 0.689 | 1.4711 |
| 0.8014 | 848.84 | 0.668 | 1.4813 |
| 0.8940 | 854.10 | 0.647 | 1.4879 |
| 1.0000 | 860.50 | 0.641 | 1.4958 |
| *303.15 K* | | | |
| 0.0000 | 777.09 | 1.755 | 1.3721 |
| 0.1011 | 789.43 | 1.293 | 1.3919 |
| 0.2005 | 800.01 | 1.042 | 1.4092 |
| 0.3055 | 809.81 | 0.894 | 1.4248 |
| 0.4001 | 817.79 | 0.806 | 1.4370 |
| 0.5008 | 825.18 | 0.728 | 1.4465 |
| 0.6035 | 832.45 | 0.674 | 1.4607 |
| 0.6979 | 838.43 | 0.641 | 1.4688 |
| 0.8014 | 844.55 | 0.623 | 1.4779 |
| 0.8940 | 849.87 | 0.605 | 1.4850 |
| 1.0000 | 856.40 | 0.601 | 1.4928 |
| *308.15 K* | | | |
| 0.0000 | 772.75 | 1.521 | 1.3702 |
| 0.1011 | 784.98 | 1.138 | 1.3894 |
| 0.2005 | 795.51 | 0.933 | 1.4064 |
| 0.3055 | 805.51 | 0.806 | 1.4219 |
| 0.4001 | 813.28 | 0.735 | 1.4347 |
| 0.5008 | 820.69 | 0.681 | 1.4458 |
| 0.6035 | 828.01 | 0.622 | 1.4576 |
| 0.6979 | 834.04 | 0.596 | 1.4656 |
| 0.8014 | 840.22 | 0.587 | 1.4756 |
| 0.8940 | 845.62 | 0.577 | 1.4824 |
| 1.0000 | 852.29 | 0.566 | 1.4898 |