Densities of *m*-Cresol + *m*-Xylene and *m*-Cresol + Tetralin Mixtures at 298–348 K and up to 30 MPa

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Densities were measured for mixtures of *m*-cresol + *m*-xylene and *m*-cresol + tetralin (1,2,3,4-tetrahydronaphthalene) at temperatures of 298.15, 323.15, and 348.15 K and pressures up to 30 MPa over the entire composition range. The Tait model was capable of correlating the density data accurately. Isothermal compressibilities of the fluids and their mixtures were calculated. It was also found that the excess volumes of *m*-cresol + *m*-xylene are negative and those of *m*-cresol + tetralin are positive over the investigated conditions.

Introduction

Densities of fluids and fluid mixtures are needed for engineering applications. A series of density measurements are being conducted in our laboratory for the mixtures containing *m*-cresol, *m*-xylene, tetralin, 1-methylnaphthalene, and quinoline from 298 to 348 K and at pressures up to 30 MPa. This paper reports the results of *m*-cresol + *m*-xylene and *m*-cresol + tetralin. While some density data are available in the literature for pure *m*-cresol, *m*-xylene, and tetralin (Oshmyansky et al., 1986; Goncalves et al., 1989; Serrano et al., 1990; Yu and Tsai, 1994; TRC Data Bases, 1994), no density data are found under conditions similar to those of this work for these two binary mixtures.

Experimental Section

m-Cresol (99 mass %), *m*-xylene (99+ mass %), and tetralin (99 mass %) were purchased from Aldrich. All the substances were used without further purification. Mixture samples (about 30 g) were prepared metrically with an accuracy of better than ±0.5 mg. The sample was introduced into a high-pressure densimeter (DMA-512, Anton Paar) via a hand pump (model 2426-801, Ruska). High pressure was generated by this hand pump, and pressure in the sample tube was monitored by a pressure transducer (model PDCR 330, 0–40 MPa, Druck) connected to a digital indicator (model DPI 261, Druck). The accuracy of pressure measurements was better than ±0.75 %. A circulating thermostated water bath was employed to control the temperature of the measuring cell within ±0.03 K. A precision digital thermometer (model 1506, Hart Scientific) incorporated with a thermister probe measured the temperature to an accuracy of ±0.015 K. The oscillation period of sample i in the vibrating U tube (t_i) was displayed by a DMA-60 processing unit (Anton Paar) which can be converted into density (ϱ_i) via

$$\varrho_i = A(t_i^2 - B) \quad (1)$$

where A and B are apparatus constants determined by using pure water (Haar et al., 1984) and dry nitrogen (Vargaftik, 1975) as calibrated fluids. The calibration was made at each temperature of interest over 0.1–30 MPa. It was found that the parameter A in eq 1 decreases with pressure and temperature. The parameter was then correlated with a linear function of pressure at a given temperature. Equation 1 reproduced water densities with a standard deviation of 5×10^{-5} g·cm^{-3} and an average absolute percent deviation of 0.004% over the entire range of the investigated conditions. The uncertainty of the density measurements was estimated to be less than ±0.1%.

Table 1. Densities of Pure Liquids at 0.1 MPa

		ϱ /(g·cm^{-3})		
substance	T/ K	this work	literature	reference
m-cresol	298.15	1.0297	1.0275	Oshmyansky et al. (1986)
			1.0300	TRC Data Bases (1994)
	323.15	1.0098	1.0100	TRC Data Bases (1994)
m-xylene	298.15	0.8596	0.8592	Oshmyansky et al. (1986)
			0.8600	TRC Data Bases (1994)
			0.86006	Serrano et al. (1990)
	323.15	0.8378	0.8384	TRC Data Bases (1994)
tetralin	298.15	0.9645	0.9641	Oshmyansky et al. (1986)
			0.9649	Yu and Tsai (1994)
			0.96538	Goncalves et al. (1989)
			0.9660	TRC Data Bases (1994)
	323.15	0.9447	0.94571	Goncalves et al. (1989)

Results and Discussion

Table 1 compares our measurements with the literature values for the pure fluid densities at 0.1 MPa. The agreement is generally within ±0.1%. As indicated in the table, the density of *m*-cresol at 298.15 K reported by Oshmyansky et al. (1986) is obviously inconsistent with others. Also, the densities of tetralin from the present work, Oshmyansky et al. (1986), and Yu and Tsai (1994) are lower than those from Goncalves et al. (1989), who claimed that their measurements were accurate to within ±0.015%. Trace impurities may lead to the inconsistency. Table 2 compiles the experimental densities and the calculated isothermal compressibilities (κ_T) of pure *m*-cresol, *m*-xylene, and tetralin from 298.15 to 348.15 K and at pressures up to 30 MPa. The results of *m*-cresol + *m*-xylene and *m*-cresol + tetralin mixtures are reported in Tables 3 and 4, respectively. The isothermal compressibilities as tabulated in Tables 2–4 were calculated from the following definition with the aid of the Tait equation:

$$\kappa_T = \frac{-1}{V}\left(\frac{\partial V}{\partial P}\right)_{T,x} = \frac{V_o}{V}\left(\frac{C}{D+P}\right) \quad (2)$$

where V is the molar volume, V_o is the molar volume at

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Table 2. Experimental Density and Calculated Isothermal Compressibility for Pure *m*-Cresol, *m*-Xylene, and Tetralin

	298.15 K		323.15 K		348.15 K			298.15 K		323.15 K		348.15 K	
P/MPa	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	P/MPa	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}
						m-Cresol							
0.1	1.0296	5.468	1.0098	6.060	0.9893	7.854	10.0	1.0349	4.891	1.0157	5.599	0.9958	6.127
1.0	1.0301	5.410	1.0103	6.014	0.9899	7.656	12.0	1.0359	4.789	1.0168	5.514	0.9971	5.868
2.0	1.0306	5.346	1.0109	5.964	0.9905	7.448	14.0	1.0368	4.692	1.0179	5.432	0.9983	5.630
3.0	1.0311	5.285	1.0115	5.916	0.9912	7.252	16.0	1.0379	4.599	1.0190	5.353	0.9995	5.411
4.0	1.0316	5.224	1.0121	5.868	0.9919	7.066	18.0	1.0388	4.509	1.0201	5.276	1.0006	5.209
5.0	1.0321	5.165	1.0127	5.821	0.9925	6.889	20.0	1.0398	4.423	1.0212	5.201	1.0018	5.022
6.0	1.0328	5.108	1.0133	5.776	0.9932	6.722	25.0	1.0421	4.221	1.0239	5.024	1.0046	4.609
8.0	1.0338	4.997	1.0145	5.686	0.9945	6.410	30.0	1.0445	4.038	1.0264	4.859	1.0075	4.261
						m-Xylene							
0.1	0.8596	9.119	0.8378	10.824	0.8157	12.778	8.0	0.8654	8.217	0.8447	9.679	0.8233	11.299
1.0	0.8602	9.005	0.8385	10.677	0.8165	12.587	10.0	0.8668	8.018	0.8462	9.427	0.8251	10.979
2.0	0.8609	8.882	0.8394	10.521	0.8176	12.387	12.0	0.8681	7.827	0.8477	9.188	0.8272	10.681
3.0	0.8618	8.765	0.8403	10.371	0.8186	12.191	14.0	0.8696	7.647	0.8493	8.962	0.8288	10.395
4.0	0.8625	8.649	0.8411	10.223	0.8195	11.999	16.0	0.8710	7.476	0.8510	8.750	0.8305	10.126
5.0	0.8631	8.536	0.8419	10.079	0.8206	11.817	18.0	0.8722	7.311	0.8524	8.545	0.8323	9.872
6.0	0.8638	8.426	0.8429	9.943	0.8215	11.638	20.0	0.8735	7.154	0.8538	8.350	0.8339	9.630
						Tetralin							
0.1	0.9645	6.481	0.9447	8.114	0.9246	8.908	10.0	0.9703	5.667	0.9511	6.439	0.9318	7.410
1.0	0.9651	6.397	0.9453	7.925	0.9252	8.747	12.0	0.9714	5.527	0.9524	6.182	0.9332	7.168
2.0	0.9656	6.307	0.9459	7.726	0.9260	8.574	14.0	0.9724	5.394	0.9536	5.946	0.9346	6.942
3.0	0.9662	6.219	0.9466	7.537	0.9267	8.408	16.0	0.9734	5.267	0.9548	5.728	0.9359	6.730
4.0	0.9668	6.133	0.9473	7.357	0.9275	8.249	18.0	0.9745	5.147	0.9560	5.526	0.9372	6.531
5.0	0.9674	6.050	0.9479	7.186	0.9282	8.096	20.0	0.9756	5.033	0.9572	5.337	0.9385	6.344
6.0	0.9679	5.969	0.9486	7.022	0.9289	7.948	25.0	0.9782	4.768	0.9601	4.920	0.9417	5.921
8.0	0.9691	5.814	0.9499	6.718	0.9304	7.670	30.0	0.9807	4.530	0.9629	4.565	0.9447	5.553

Table 3. Experimental Density and Calculated Isothermal Compressibility for *m*-Cresol (1) + *m*-Xylene (2)

	298.15 K		323.15 K		348.15 K			298.15 K		323.15 K		348.15 K	
P/MPa	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	P/MPa	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}
						$x_1 = 0.2$							
0.1	0.8899	8.470	0.8686	9.983	0.8460	12.129	8.0	0.8954	7.572	0.8748	8.847	0.8535	10.381
1.0	0.8905	8.356	0.8695	9.840	0.8470	11.901	10.0	0.8969	7.376	0.8766	8.604	0.8552	10.017
2.0	0.8912	8.234	0.8703	9.684	0.8479	11.655	12.0	0.8982	7.190	0.8782	8.372	0.8569	9.679
3.0	0.8921	8.116	0.8709	9.532	0.8489	11.421	14.0	0.8994	7.012	0.8794	8.151	0.8586	9.364
4.0	0.8927	8.001	0.8717	9.386	0.8497	11.195	16.0	0.9008	6.844	0.8809	7.943	0.8602	9.070
5.0	0.8933	7.888	0.8728	9.248	0.8507	10.980	18.0	0.9021	6.685	0.8825	7.748	0.8618	8.794
6.0	0.8942	7.781	0.8734	9.110	0.8516	10.771	20.0	0.9032	6.532	0.8837	7.559	0.8633	8.534
						$x_1 = 0.4$							
0.1	0.9225	7.807	0.9014	9.032	0.8795	10.662	8.0	0.9279	6.981	0.9075	8.032	0.8862	9.231
1.0	0.9232	7.704	0.9021	8.905	0.8803	10.476	10.0	0.9291	6.800	0.9089	7.815	0.8879	8.931
2.0	0.9241	7.592	0.9029	8.768	0.8813	10.279	12.0	0.9305	6.628	0.9103	7.608	0.8895	8.650
3.0	0.9245	7.481	0.9037	8.636	0.8822	10.088	14.0	0.9317	6.465	0.9117	7.413	0.8911	8.386
4.0	0.9252	7.375	0.9044	8.507	0.8830	9.903	16.0	0.9328	6.309	0.9131	7.228	0.8926	8.138
5.0	0.9259	7.273	0.9052	8.383	0.8838	9.726	18.0	0.9341	6.162	0.9145	7.053	0.8941	7.905
6.0	0.9268	7.174	0.9059	8.262	0.8846	9.555	20.0	0.9354	6.022	0.9158	6.886	0.8956	7.686
						$x_1 = 0.6$							
0.1	0.9564	7.281	0.9357	8.014	0.9137	9.552	8.0	0.9613	6.199	0.9412	7.166	0.9201	8.338
1.0	0.9570	7.139	0.9363	7.907	0.9144	9.395	10.0	0.9623	5.975	0.9427	6.982	0.9216	8.080
2.0	0.9576	6.987	0.9369	7.791	0.9152	9.228	12.0	0.9637	5.768	0.9439	6.805	0.9230	7.836
3.0	0.9583	6.842	0.9377	7.680	0.9162	9.067	14.0	0.9648	5.575	0.9452	6.637	0.9245	7.608
4.0	0.9589	6.703	0.9385	7.572	0.9168	8.909	16.0	0.9661	5.395	0.9465	6.478	0.9259	7.394
5.0	0.9594	6.569	0.9392	7.466	0.9177	8.759	18.0	0.9670	5.225	0.9478	6.327	0.9273	7.191
6.0	0.9600	6.441	0.9398	7.362	0.9186	8.615	20.0	0.9681	5.067	0.9492	6.184	0.9288	7.000
						$x_1 = 0.8$							
0.1	0.9913	6.283	0.9711	6.927	0.9502	8.246	8.0	0.9958	5.572	0.9762	6.383	0.9560	7.240
1.0	0.9917	6.192	0.9716	6.860	0.9508	8.117	10.0	0.9970	5.418	0.9775	6.259	0.9573	7.023
2.0	0.9924	6.095	0.9722	6.787	0.9515	7.978	12.0	0.9981	5.272	0.9786	6.140	0.9587	6.820
3.0	0.9930	6.001	0.9729	6.716	0.9523	7.844	14.0	0.9992	5.134	0.9799	6.025	0.9600	6.629
4.0	0.9935	5.910	0.9736	6.646	0.9530	7.715	16.0	1.0002	5.003	0.9810	5.915	0.9612	6.448
5.0	0.9941	5.821	0.9743	6.579	0.9537	7.590	18.0	1.0013	4.879	0.9823	5.810	0.9625	6.277
6.0	0.9946	5.735	0.9749	6.512	0.9545	7.469	20.0	1.0022	4.761	0.9834	5.708	0.9638	6.115

0.1 MPa, T is temperature , and x is the mole fraction. The constants C and D are parameters of the Tait model:

$$\frac{\varrho - \varrho_o}{\varrho} = C \ln\left(\frac{D + P}{D + 0.1}\right) \tag{3}$$

where ϱ_o is the density at 0.1 MPa. The optimized C and D were obtained from fitting the above model to the isothermal density data at a given composition by minimization of the objective function π (i.e., average absolute percent deviations) with the modified Levenberg–Mar-

Table 4. Experimental Density and Calculated Isothermal Compressibility for *m*-Cresol (1) + tetralin (2)

	298.15 K		323.15 K		348.15 K			298.15 K		323.15 K		348.15 K	
P/MPa	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	P/MPa	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}	ϱ/(g·cm^{-3})	$10^4\kappa_T$/MPa^{-1}
							$x_1 = 0.2$						
0.1	0.9740	6.419	0.9538	7.510	0.9333	8.732	10.0	0.9796	5.602	0.9602	6.376	0.9405	7.276
1.0	0.9745	6.335	0.9544	7.390	0.9339	8.575	12.0	0.9807	5.463	0.9614	6.188	0.9419	7.040
2.0	0.9751	6.244	0.9551	7.261	0.9347	8.407	14.0	0.9818	5.330	0.9626	6.012	0.9432	6.819
3.0	0.9757	6.156	0.9557	7.137	0.9354	8.246	16.0	0.9829	5.204	0.9638	5.846	0.9446	6.613
4.0	0.9762	6.070	0.9564	7.017	0.9362	8.091	18.0	0.9840	5.084	0.9650	5.688	0.9458	6.418
5.0	0.9768	5.986	0.9570	6.901	0.9369	7.942	20.0	0.9850	4.969	0.9662	5.540	0.9471	6.236
6.0	0.9774	5.905	0.9577	6.789	0.9377	7.799	25.0	0.9875	4.705	0.9690	5.201	0.9503	5.823
8.0	0.9785	5.750	0.9589	6.576	0.9391	7.528	30.0	0.9899	4.468	0.9718	4.902	0.9533	5.463
							$x_1 = 0.4$						
0.1	0.9853	6.173	0.9650	6.977	0.9443	8.269	10.0	0.9909	5.434	0.9713	6.267	0.9515	7.194
1.0	0.9858	6.097	0.9656	6.905	0.9450	8.158	12.0	0.9919	5.307	0.9725	6.141	0.9528	7.010
2.0	0.9864	6.016	0.9663	6.828	0.9457	8.038	14.0	0.9930	5.185	0.9737	6.021	0.9541	6.837
3.0	0.9870	5.936	0.9669	6.752	0.9464	7.921	16.0	0.9941	5.069	0.9749	5.905	0.9555	6.672
4.0	0.9876	5.859	0.9675	6.678	0.9472	7.808	18.0	0.9951	4.958	0.9760	5.794	0.9568	6.515
5.0	0.9882	5.783	0.9681	6.605	0.9479	7.698	20.0	0.9962	4.853	0.9772	5.688	0.9580	6.365
6.0	0.9887	5.710	0.9688	6.535	0.9486	7.591	25.0	0.9987	4.608	0.9801	5.438	0.9611	6.020
8.0	0.9898	5.569	0.9701	6.398	0.9501	7.387	30.0	1.0011	4.387	0.9828	5.210	0.9641	5.712
							$x_1 = 0.6$						
0.1	0.9982	6.204	0.9778	6.768	0.9571	7.994	10.0	1.0036	5.215	0.9839	6.073	0.9640	6.867
1.0	0.9987	6.098	0.9784	6.698	0.9578	7.876	12.0	1.0047	5.053	0.9851	5.951	0.9654	6.678
2.0	0.9993	5.985	0.9790	6.622	0.9585	7.749	14.0	1.0058	4.901	0.9863	5.833	0.9667	6.500
3.0	0.9998	5.876	0.9796	6.548	0.9592	7.626	16.0	1.0068	4.758	0.9875	5.720	0.9680	6.331
4.0	1.0004	5.772	0.9802	6.475	0.9599	7.507	18.0	1.0078	4.624	0.9886	5.612	0.9692	6.170
5.0	1.0010	5.670	0.9808	6.404	0.9606	7.392	20.0	1.0088	4.496	0.9897	5.507	0.9705	6.019
6.0	1.0015	5.573	0.9815	6.335	0.9613	7.280	25.0	1.0112	4.208	0.9925	5.264	0.9735	5.671
8.0	1.0025	5.387	0.9827	6.201	0.9627	7.068	30.0	1.0136	3.956	0.9952	5.041	0.9764	5.362
							$x_1 = 0.8$						
0.1	1.0129	5.693	0.9927	6.630	0.9718	7.670	10.0	1.0182	5.108	0.9987	5.833	0.9785	6.646
1.0	1.0134	5.634	0.9933	6.548	0.9723	7.563	12.0	1.0192	5.004	0.9999	5.696	0.9798	6.472
2.0	1.0140	5.570	0.9939	6.460	0.9731	7.449	14.0	1.0202	4.905	1.0010	5.565	0.9811	6.307
3.0	1.0145	5.508	0.9945	6.374	0.9738	7.337	16.0	1.0213	4.810	1.0022	5.440	0.9824	6.151
4.0	1.0151	5.447	0.9951	6.291	0.9745	7.229	18.0	1.0223	4.719	1.0033	5.321	0.9836	6.003
5.0	1.0155	5.387	0.9958	6.209	0.9752	7.125	20.0	1.0233	4.631	1.0044	5.207	0.9848	5.862
6.0	1.0161	5.328	0.9963	6.130	0.9758	7.023	25.0	1.0256	4.425	1.0072	4.943	0.9878	5.537
8.0	1.0172	5.216	0.9976	5.978	0.9772	6.829	30.0	1.0280	4.237	1.0098	4.705	0.9906	5.248

Table 5. Results of the Density Correlations with the Tait Equation

		m-cresol (1) + *m*-xylene (2)				*m*-cresol (1) + tetralin (2)			
T/K	x_1	C	D/MPa	π^a/%	$10^4\sigma^b$/(g·cm^{-3})	C	D/MPa	π^a/%	$10^4\sigma^b$/(g·cm^{-3})
298.15	0.0	0.061 44	67.28	0.010	1.02	0.042 61	65.65	0.011	1.75
298.15	0.2	0.053 31	62.84	0.009	1.00	0.041 69	64.85	0.010	1.34
298.15	0.4	0.049 42	63.20	0.010	1.14	0.042 94	69.45	0.012	1.61
298.15	0.6	0.031 87	43.67	0.013	1.55	0.031 31	50.36	0.018	2.49
298.15	0.8	0.037 40	59.42	0.012	1.21	0.046 81	82.12	0.006	0.85
298.15	1.0	0.043 77	79.94	0.010	1.38	0.043 77	79.94	0.010	1.38
323.15	0.0	0.067 11	61.90	0.013	1.21	0.029 89	36.73	0.031	4.21
323.15	0.2	0.057 82	57.82	0.012	1.34	0.040 04	53.22	0.018	2.55
323.15	0.4	0.054 06	59.76	0.006	0.80	0.057 34	82.09	0.008	1.19
323.15	0.6	0.050 69	63.15	0.012	1.44	0.055 23	81.50	0.008	1.04
323.15	0.8	0.060 19	86.79	0.006	0.80	0.045 75	68.90	0.011	1.57
323.15	1.0	0.067 71	111.65	0.005	0.68	0.067 71	111.65	0.005	0.68
348.15	0.0	0.071 32	55.72	0.009	0.95	0.041 67	46.68	0.020	2.64
348.15	0.2	0.053 60	44.09	0.008	0.89	0.041 27	47.16	0.019	2.70
348.15	0.4	0.051 43	48.14	0.009	1.06	0.051 73	62.46	0.008	1.12
348.15	0.6	0.049 11	51.31	0.007	0.94	0.045 88	57.30	0.013	1.91
348.15	0.8	0.044 62	54.01	0.007	0.87	0.046 81	60.92	0.011	1.46
348.15	1.0	0.026 78	34.00	0.032	4.46	0.026 78	34.00	0.032	4.46

[a] π as defined in eq 4. [b] σ(g·cm^{-3}) = $[[\sum_{k=1}^{n}(\Delta\varrho_k - \Delta\bar{\varrho})^2]/(n-2)]^{1/2}$ where $\Delta\varrho_k = \varrho_{k,\text{calc}} - \varrho_{k,\text{expt}}$ and $\Delta\bar{\varrho} = (\sum_{k=1}^{n}\Delta\varrho_k)/n$.

quardt algorithm:

$$\pi = [\sum_{k=1}^{n}|\varrho_{k,\text{calc}} - \varrho_{k,\text{expt}}|/\varrho_{k,\text{expt}})] \times 100/n \qquad (4)$$

where n is the number of data points and $\varrho_{k,\text{calc}}$ and $\varrho_{k,\text{expt}}$ represent the calculated and experimental densities for the kth point, respectively. Table 5 lists the calculated results including the optimized values of C and D, π, and the standard deviations of the fits (σ) which indicates that the Tait model is capable of correlating the densities over the entire pressure range accurately.

As an illustrative example, Figure 1 presents the variations of molar excess volumes (V^E) with the mole fraction of *m*-cresol at 323.15 K and 0.1 MPa. The excess volumes

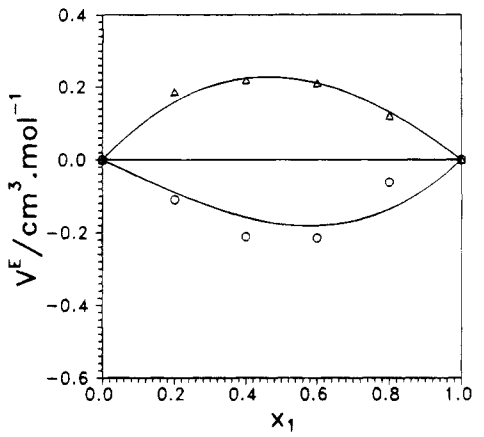

Figure 1. Molar excess volume at 323.15 K and 0.1 MPa: (o) *m*-cresol (1) + *m*-xylene (2); (Δ) *m*-cresol (1) + tetralin (2).

can be readily computed from the experimental density data via

$$V^E = V_m - x_1V_1^\circ - x_2V_2^\circ \quad (5)$$

with

$$V_m = \frac{x_1M_1 + x_2M_2}{\varrho} \quad (6)$$

where V_m is the molar volume of a mixture, V_i° denotes the molar volume of component i at the same temperature and pressure of the mixture, and M_i stands for the molecular weight of component i. The figure shows that the excess volumes of *m*-cresol + tetralin are positive, while those of *m*-cresol + *m*-xylene are negative. Over the entire investigated conditions, the absolute values of excess volumes generally increase with temperature and decrease with pressure.

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