Dew-Point Loci for the Methane–Toluene System

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The elution technique has been used to study the vapor-phase composition for the methane–toluene system at three temperatures, 40, 20, and 0 °F, from 50 up to 2500 psia. No lower temperatures could be examined due to experimental limitations.

The vapor–liquid equilibria of the methane–toluene system have been studied by several investigators. Elbishlawi and Spencer (*3*) studied the equilibrium relations at 150 °F, from 100 psia up to the critical pressure of the mixture. Savvina and Velikovski (*6*) measured vapor–liquid equilibria from 40 to 150 °C. Chang and Kobayashi (*1*) reported measurements from 0 down to −100 °F. No experimental data for the methane–toluene system exist for temperatures between 0 and 100 °F.

Experimental Method

The experimental equipment and procedure are essentially the same as discussed in previous papers (*2*, *5*). However, in order to ensure good mixing of toluene with methane during calibration of thermal conductivity detector, the mixing valve, the sampling lines, and the detector cell were kept at a temperature (270 °F) above the normal boiling point of toluene (231.1 °F).

Materials

Ultrahigh purity methane (99.97 mol % minimum) was purchased from Matheson Gas Products. The research grade (99.94 mol %) toluene used in this investigation was donated by the Phillips Petroleum Co. All materials were used as received without further purification.

Accuracy

Four Heise gauges with ranges of 0–200, 0–500, 0–2000, and 0–4000 psia were used to measure the pressure in the equilibrium cell. The gauges were calibrated by the manufacturer with an accuracy of 0.1% of full scale. The temperature in the equilibrium cell could be controlled to ±0.02 °F. It was measured with a Leeds and Northrup Model 8163-B platinum resistance thermometer which is accurate to at least ±0.01 °C with respect to the IPTS (1968). The overall error in the dew-point data is either less than 2% or 0.000 05 in mole fraction of toluene, depending on which is larger.

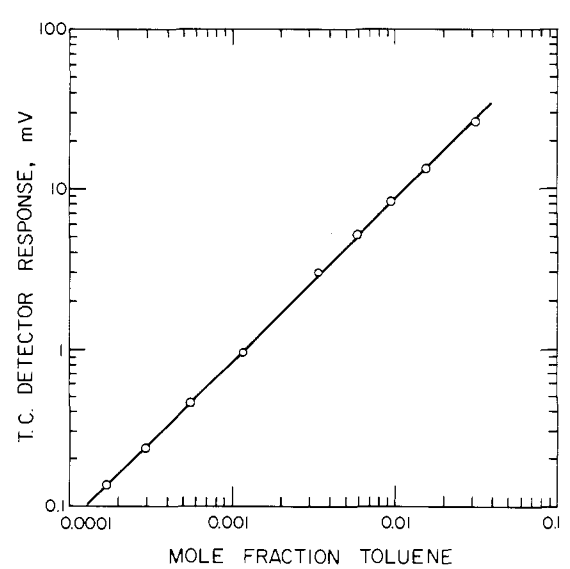

Figure 1. Calibration curve for the methane–toluene system.

Experimental Results

Figure 1 shows the calibration curve of the thermal conductivity detector for the methane–toluene system. The response curve was linear in the concentration ranges covered by this calibration.

The experimental dew-point data for the methane–toluene

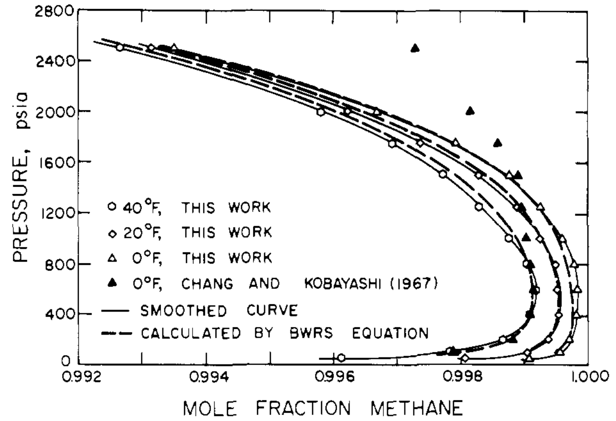

Figure 2. Isothermal dew-point data for the methane–toluene system.

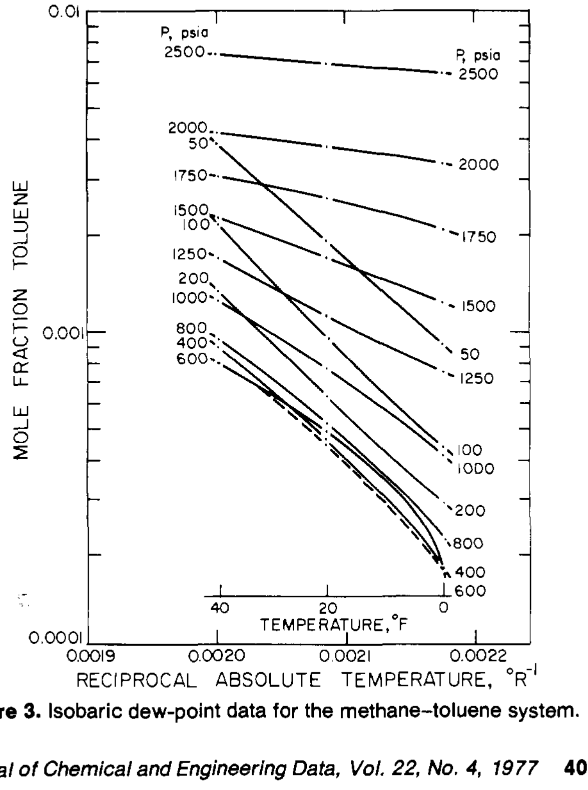

Figure 3. Isobaric dew-point data for the methane–toluene system.

Table I. Dew-Point Data for the Methane–Toluene System

Pressure, psia	Mole fraction of toluene	Pressure, psia	Mole fraction of toluene	Pressure, psia	Mole fraction of toluene
T = 40.00 °F = 4.44 °C		T = 20.00 °F = −6.67 °C		T = 0.00 °F = −17.78 °C	
50.0	0.003 87	50.0	0.001 93	50.0	0.000 914
100.0	0.002 15	100.0	0.000 949	100.0	0.000 435
200.0	0.001 33	200.0	0.000 625	200.0	0.000 290
400.0	0.000 895	400.0	0.000 460	400.0	0.000 181
600.0	0.000 801	600.0	0.000 489	600.0	0.000 177
800.0	0.000 955	800.0	0.000 520	800.0	0.000 233
1000	0.001 25	1000	0.000 770	1000	0.000 411
1250	0.001 70	1250	0.001 12	1250	0.000 750
1500	0.002 27	1500	0.001 71	1500	0.001 23
1750	0.003 08	1750	0.002 62	1750	0.002 08
2000	0.004 19	2000	0.003 78	2000	0.003 33
2500	0.007 34	2500	0.006 85	2500	0.006 49

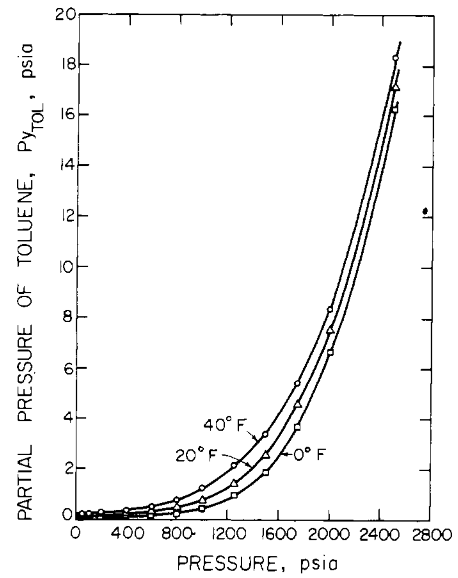

Figure 4. Partial pressure for toluene in the methane–toluene system.

system are shown in Table I at three temperatures, 40, 20, and 0 °F. Figure 2 is the isothermal pressure–composition plot. The vapor composition curves predicted by the BWRS equation of state (*4*) are also shown. The dew-point data are shown on an isobaric basis in Figure 3. The plot was made on a semilogarithmic scale of the mole fraction of toluene vs. the reciprocal of absolute temperature. The isobaric curves are almost linear except at 600 psia. This indicates that dew-point data at 20 °F and 600 psia might be in error. The dashed line shows the smoothed curve for this isobar. Figure 4 shows the partial pressure of toluene as a function of the system pressure.

The dew-point data for the methane–toluene system at 0 °F from a previous investigation by Chang and Kobayashi (*1*) are also shown in Figure 2 for comparison. It indicates that they qualitatively and quantitatively disagree with this investigation.

The comparisons with results predicted by the BWRS equation of state (*4*) are good in general (see Figure 2). The absolute average deviation between the predicted and experimental mole fractions of toluene is 0.000 094. The absolute average percent deviation is 8.90%.

Acknowledgment

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