VOLUMETRIC BEHAVIOR OF BENZENE, PROPANE AND FOUR MIXTURES OF THESE SUBSTANCES

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ABSTRACT

The volumetric behavior of benzene and of propane was investigated over a pressure range from vapor pressure to 10,000 pounds per square inch absolute and a temperature range from 100 to 460° F. The results of these studies are presented in tabular form.

The volumetric behavior of four mixtures of benzene and propane was investigated at temperatures from 100 to 460° F. in the pressure range from substantially below bubble point to 10,000 pounds per square inch absolute. The single phase and two-phase data are presented in separate tabulations for each mixture. Deviations of the mixtures from the behavior of ideal solutions are shown graphically.

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A. THE VOLUMETRIC BEHAVIOR OF PROPANE

I. INTRODUCTION

Propane is one of the important components of natural gas and is useful as the starting material for the preparation of a number of organic compounds of industrial interest. For this reason it is desirable to know accurately the influence of pressure and temperature upon the specific volume of this hydrocarbon. The volumetric behavior of propane has been studied by a number of investigators. Dana et al. (4) measured the vapor pressure and the volume of bubble point liquid and dew point gas of propane from approximately -50° to 130° F. Later studies by Sage, Lacey and Schaafsma (6) gave values of the vapor pressure up to the critical temperature and the volume of liquid and gas from approximately 50 to 3000 pounds per square inch absolute. Beattie and co-workers studied the influence of pressure and temperature upon the volume of propane at lower pressures and at temperatures up to 525° F. (1) and also made extensive measurements in the critical region (2).

The present work was undertaken in order to obtain more accurate vapor pressure data and to extend the upper limit of the pressure range.

II. APPARATUS AND METHOD

The equipment used in this study has been described in detail (5). In principle it consisted of a stainless steel chamber within which a known quantity of the material under investigation was confined. The volume occupied by the sample was varied by the introduction or withdrawal of mercury and the resulting equilibrium pressure measured. The quantity of mercury added to the equilibrium chamber was established from the change in elevation of a mercury-air interface within an interconnected vessel. The weight of sample introduced was determined by weighing bomb techniques (5). After completing a set of isotherms, the propane was withdrawn. A comparison of the weight of material added and later withdrawn showed agreement within 0.03 percent in all cases. The weight of sample and the accuracy of the volumetric measurements were such that the measured specific volume at a given state did not involve uncertainties greater than 0.2 per cent.

The pressure was measured by a balance based upon a piston-cylinder combination (5). This equipment was calibrated against the vapor pressure of carbon dioxide at the ice point (3). The weights used in the balance were consistent with one another within 0.002 per cent. It is believed that the pressure at equilibrium was measured within 0.1 pound per square inch or 0.05 per cent, with the

larger uncertainty being significant.

The temperature of the equilibrium vessel was controlled by immersion in an agitated oil bath. Provision was made to minimize the effect of thermal gradients in the tubing which connected this vessel with equipment outside the bath. The temperature of the oil bath was measured with a strain-free platinum resistance thermometer which was compared at periodic intervals with a standardized instrument. In addition, the resistance of the service thermometer at the ice point was checked at frequent intervals.

Attainment of thermal and phase equilibrium was accomplished rapidly by mechanical agitation within the working vessel. This agitation was provided by means of a spiral agitator (5) rotated around the major axis of the vessel by a set of externally mounted electromagnets.

After introducing a measured quantity of propane, the pressure within the apparatus was raised to approximately 10,000 pounds per square inch absolute and the system brought to equilibrium at a constant temperature. The total volume occupied by the sample, the pressure, and the temperature were then measured. The total volume was then increased, equilibrium re-established, and the measurements repeated. This procedure was continued throughout the single-phase region. The vapor pressure was measured at several total volumes of the system. A slightly longer time was allowed for the attainment of equilibrium in the

two-phase region. After the measurements were completed, the temperature was raised to the next higher predetermined value and the sequence repeated. Upon completion of the determinations at the maximum temperature (460° F.), a set of check measurements was made at the initial temperature studied. The maximum deviation between the initial and final measurements was 0.1 per cent.

III. MATERIAL

The propane used in these investigations was obtained from the Phillips Petroleum Company. The material as supplied contained less than 0.1 per cent of impurities. It was subjected to a fractionation at a reflux ratio of approximately 40 to 1 in a column packed with glass rings. The initial and final tenths of the overhead were discarded in the course of the fractionation. The purified material showed less than 0.2 pound per square inch variation in vapor pressure at 100° F. when expanded from bubble point to a state in which more than one half of the propane was in the gas phase. The purified hydrocarbon was stored in a stainless steel container from which it was transferred into a weighing bomb before addition to the equilibrium cell.

IV. EXPERIMENTAL RESULTS

The experimental results were interpolated to even values of pressure and are recorded in Table I for each of the experimentally studied temperatures.

A detailed comparison of the present measurements with the data of Beattie (1) at pressures and temperatures removed from the critical state shows unusually good agreement. The average deviation of the two sets of data for approximately 50 states is 0.22 per cent. The maximum deviation encountered was less than 0.4 per cent. The values of the vapor pressure of propane recorded in Table I are based on present measurements and agree well with the work of Beattie (1).

B. VOLUMETRIC BEHAVIOR OF BENZENE

I. INTRODUCTION

Benzene is an aromatic compound which is widely employed as a solvent and as the starting material for the preparation of many organic compounds. The vapor pressure, critical constants, and volume of benzene as saturated liquid and saturated gas were determined by Young (13). This work was supplemented by later investigations of the vapor pressure at relatively low temperatures (11, 12). The influence of pressure and temperature upon the volume and refractive index of this compound was studied by Gibson and Kincaid (8). Limited information concerning the heat capacity was obtained by Burlew (7). Gilliland and Lukes (9) measured directly the effect of pressure upon the enthalpy of benzene. These investigations serve to establish the volumetric behavior at low pressures. It would be possible to calculate the specific volume at higher pressures from the enthalpy-pressure measurements of Gilliland and Lukes if volumetric data were available for one temperature throughout the range of pressures. However, at the lower reduced temperatures and higher pressures there does not appear to be adequate volumetric information. For this reason a study was made of the influence of pressure and temperature upon the volume of benzene at seven temperatures between 100° and 460° F. and for pressures between vapor

pressure and 10,000 pounds per square inch absolute.

II. METHOD AND APPARATUS

The method and equipment employed in this investigation were described in Part A.

III. MATERIAL

The benzene used in this investigation was obtained commercially as the chemically pure grade and was subjected to the following purification procedure. The sample was first distilled from a glass fractionating column containing thirty plates at a reflux ratio of approximately 40 to 1. The initial and final quarters of the sample were discarded. The benzene was solidified, allowed to melt partially, and the material first melted was discarded. The remaining solid material was then distilled under high vacuum and condensed as a solid. It was then transferred by distillation into a steel weighing bomb. The index of refraction for the D line of sodium at 77° F. was 1.5013. The specific volume at 100° F. and atmospheric pressure as measured in a glass pycnometer was 0.01861 cubic foot per pound.

IV. EXPERIMENTAL RESULTS

The specific volume of benzene was determined at seven temperatures between 100° and 460° F. The values, which were obtained at irregular pressures, were smoothed graphically to even pressures. The results are recorded in Table II. The values of the two-phase pressure given in this table are critically chosen ones based upon the recent measurements of Hixson et al. (10) and the earlier data of Young (13). The agreement between the two experimenters was satisfactory and no effort was made in the present investigation to determine the vapor pressure.

Table III presents a comparison of the specific volumes at bubble point as measured by Young (13) with those obtained in this study. The data of Young were interpolated in order to obtain values of the specific volume at states corresponding to those reported in Table I. The average deviation of the present results from these of Young was 0.3 per cent. Similar deviations were also found with more recent data (8). The present measurements, which were carried out in stainless steel apparatus over mercury agree within 0.05% with the independently determined values of the specific volume of the liquid obtained with a glass pycnometer at 100° F. and atmospheric pressure.

C. VOLUMETRIC BEHAVIOR OF FOUR MIXTURES OF BENZENE AND PROPANE

I. INTRODUCTION

While a certain, albeit limited, amount of experimental information is available for mixtures of aliphatic hydrocarbons, the amount of experimental information available on the properties of mixtures of aromatic and aliphatic compounds is limited. In order to determine the effect of temperature, pressure, and composition on the properties of a mixture of an aliphatic and aromatic compound, an investigation was made on the volumetric behavior of four mixtures of benzene and propane. No information is reported in the literature on mixtures of these substances.

II. METHODS AND APPARATUS

The method and apparatus used in this investigation were the same as those described in Part A. The samples of benzene and propane were added to the equilibrium cell using weighing bomb techniques. After the completion of a series of isotherms on a sample of given composition in the high pressure region, the sample was reduced in size by displacing a portion of it at a temperature and pressure which insured homogeneity of phase. The amount of material remaining was accurately determined by condensing it into

an evacuated weighing bomb with liquid air after the completion of volumetric measurements in the low pressure region.

In the neighborhood of bubble point and dew point, numerous experimental measurements were made so that the pressure and volume corresponding to these points could be determined accurately.

III. MATERIALS

The propane and benzene used in this investigation were part of the large supply prepared for the investigation of the properties of the pure substances. Their purification and checks upon purity are described in Parts A and B.

IV. EXPERIMENTAL RESULTS

The volumetric properties of the propane-benzene system in the single-phase region are presented in Tables IV - VII, whereas data in the two-phase region are presented in Tables VIII - XI. The experimental data, obtained at irregular pressures at seven temperatures between 100° and 460° F., were interpolated to even values of pressure. The specific volume and the compressibility factor were used in this work, depending upon which variable lent itself to most accurate interpolation in the region under consideration. In general, the specific volume was employed in the liquid region while the compressibility factor was used in the two-phase region.

Because of the limited amount of data in certain portions of the two-phase region, it was not possible to accurately smooth all of these data as a function of temperature. It is believed that the maximum uncertainty in the two-phase region is approximately 0.5 per cent, while in the liquid region, where sufficient data are available to make accurate smoothing possible, the maximum uncertainty is not greater than 0.2 per cent. The uncertainties introduced in the measurement of pressure, temperature, volume, and composition are all less than the above mentioned deviations.

The values of bubble-point and dew-point pressure and volume were determined by the method described by Sage, Backus, and Lacey (14). In certain cases use was made of the compressibility factor-pressure plot instead of the specific volume-pressure plot.

The effect of pressure upon the compressibility factor at 460° F. for benzene, propane, and three mixtures of these substances is shown in Figure I. In Figure III the percentage deviation of the bubble-point pressure at 100° and 160° F. from that predicted on the basis of the assumption of ideal solution behavior is shown. The "ideal pressure" is determined from the following relationship:

$$P_I = X_3 P_3'' + X_6 P_6''$$

The wide deviations from ideal solution behavior in mixtures

high in propane is clearly shown in this Figure. In Figure II percentage deviations from the specific volume predicted from a relationship analagous to that above are shown at 160°F. for pressures of 1000 and 5000 pounds per square inch absolute.

NOMENCLATURE

P = pressure, pounds per square inch, absolute

V = specific volume, cubic foot per pound

T = absolute temperature ^{o}R, = 459.69 + ^{o}F

b = specific gas constant = $\frac{R}{M}$, $\frac{(lbs./in.^2)(ft.^3/lb.)}{^{o}R}$

for propane	= 0.24338
for propane-benzene, 88.27 mole % propane	= 0.22318
for propane-benzene, 59.83 mole % propane	= 0.18580
for propane-benzene, 39.48 mole % propane	= 0.16592
for propane-benzene, 19.36 mole % propane	= 0.15019
for benzene	= 0.13740

M = molecular weight

P_3^n = vapor pressure of pure component

X_6 = mole % of component in mixture

Z = compressibility factor = $\frac{PV}{bT}$

SUBSCRIPTS

3 refers to propane

6 refers to benzene

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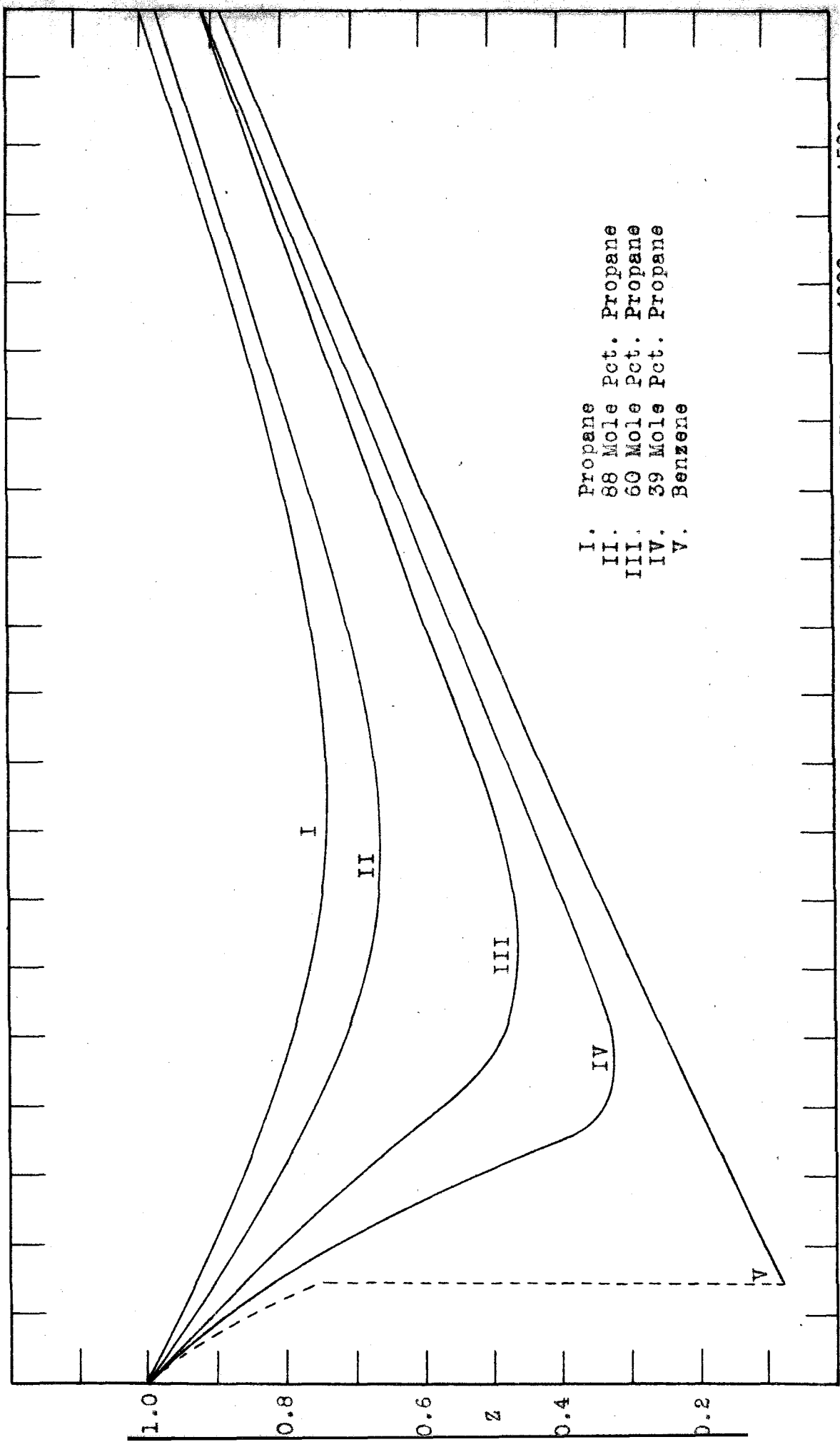

Figure 1. Compressibility Factor for Propane-Benzene System at 460° F.

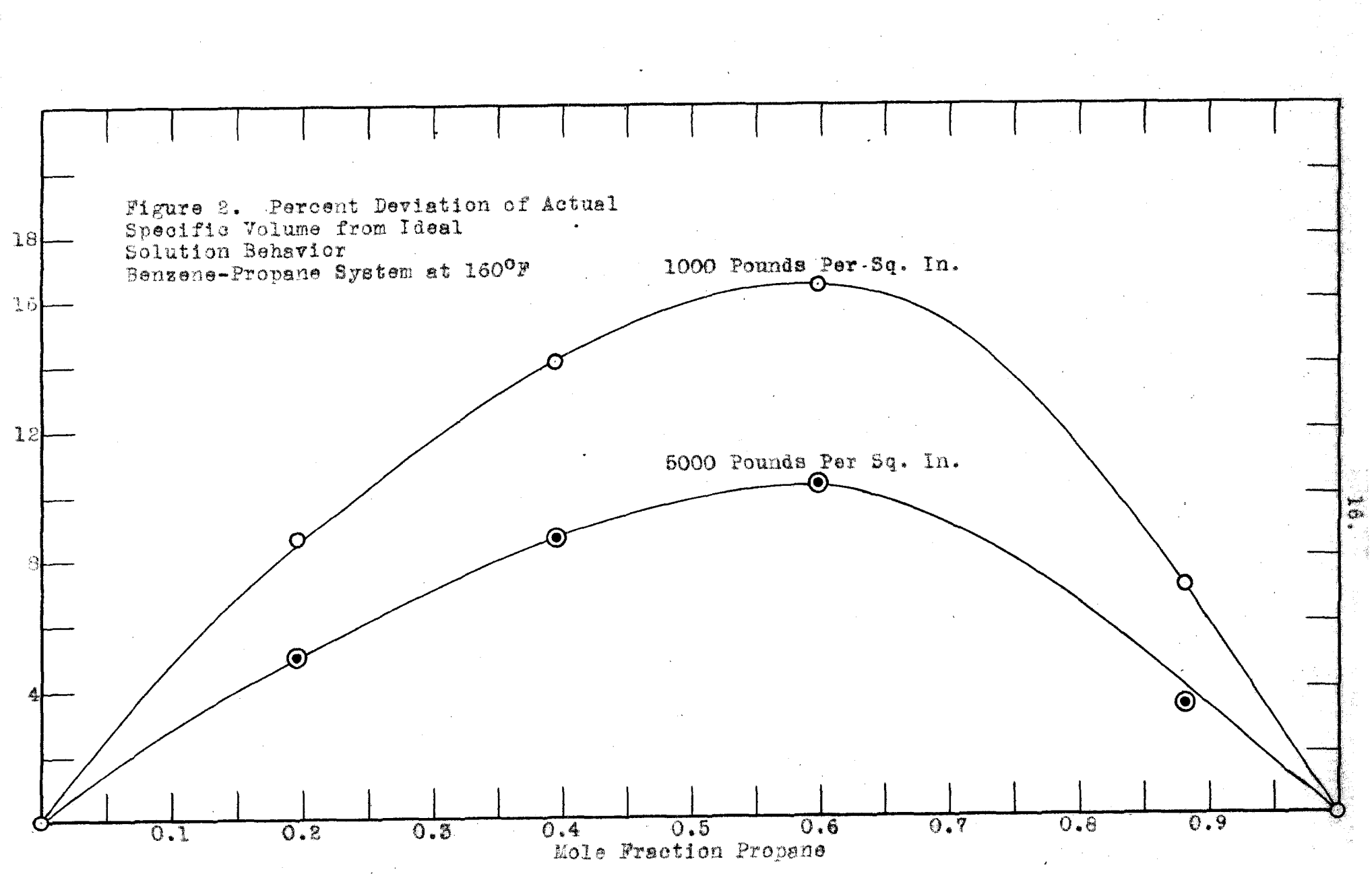
Figure 2. Percent Deviation of Actual Specific Volume from Ideal Solution Behavior Benzene-Propane System at 160°F
1000 Pounds Per-Sq. In.
5000 Pounds Per Sq. In.
18
16
12
8
4
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Mole Fraction Propane

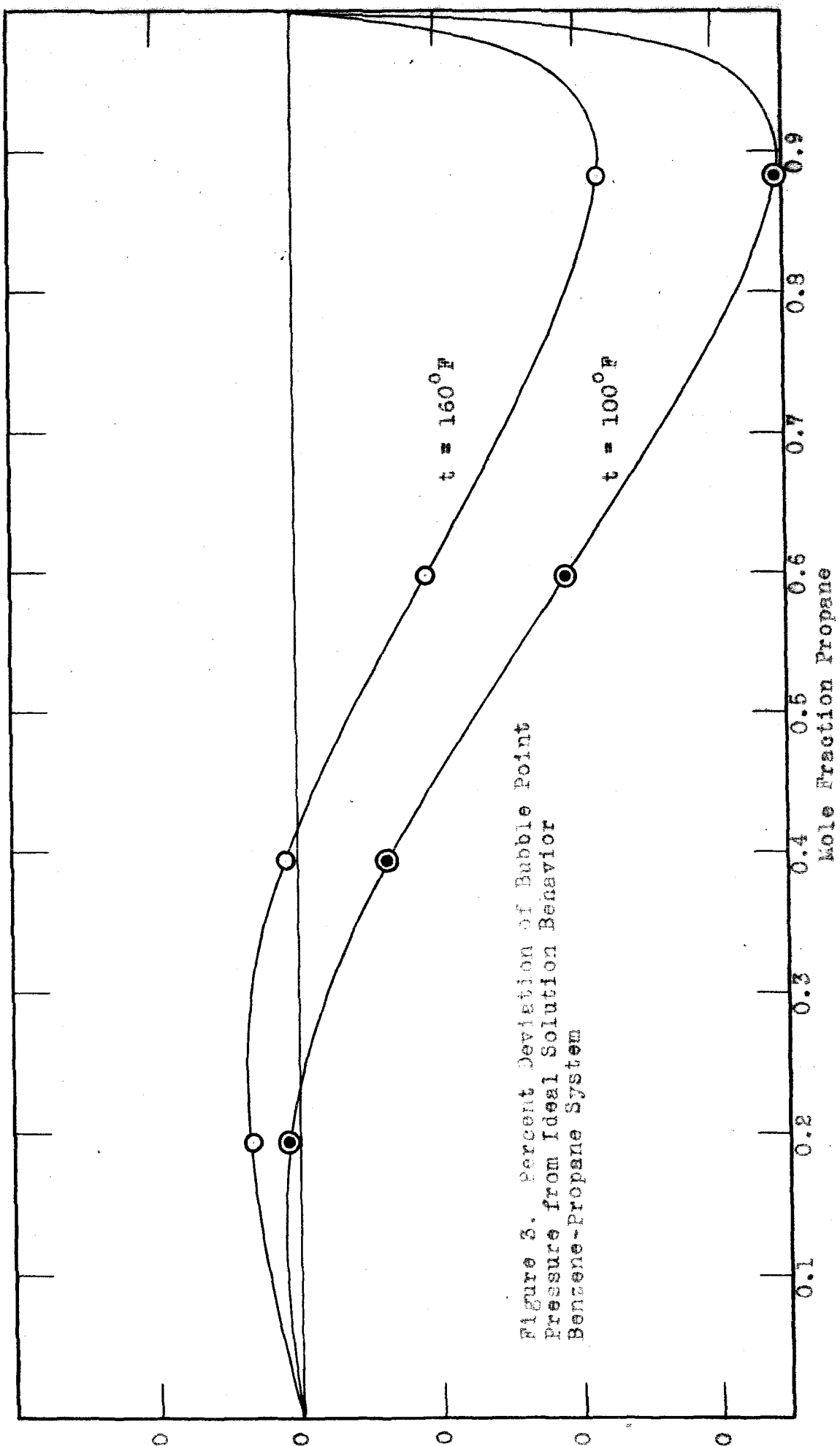

Figure 3. Percent Deviation of Bubble Point Pressure from Ideal Solution Behavior Benzene-Propane System

TABLE I

VOLUMETRIC BEHAVIOR OF PROPANE

IN THE CONDENSED-LIQUID REGION

Pressure lb/sq.in.abs.	100° F. V (188.2)[a]	100° F. Z	130° F. V (271.6)	130° F. Z
Bubble Point	.03391[b]	.04685	.03636	.06881
200	.03389	.04976	--	--
300	.03371	.07425	.03626	.07580
400	.03354	.09849	.03592	.1001
500	.03338	.1225	.03563	.1241
600	.03322	.1462	.03535	.1477
800	.03293	.1933	.03488	.1944
1000	.03267	.2398	.03447	.2401
1250	.03237	.2970	.03403	.2963
1500	.03209	.3531	.03364	.3514
1750	.03184	.4093	.03329	.4062
2000	.03161	.4641	.03297	.4595
2250	.03140	.5191	.03268	.5128
2500	.03119	.5724	.03240	.5644
2750	.03099	.6250	.03215	.6160
3000	.03080	.6790	.03190	.6668
3500	.03045	.7815	.03150	.7681
4000	.03015	.8853	.03116	.8681
4500	.02988	.9880	.03087	.967
5000	.02964	1.0879	.03051	1.0630
6000	.02918	1.2826	.02996	1.2500
7000	.02878	1.4774	.02952	1.4388
8000	.02843	1.6696	.02912	1.6232
9000	.02812	1.8597	.02875	1.8047
10000	.02782	2.0422	.02837	1.9767

a Figures in parentheses are vapor pressures in pounds per square inch absolute.

b Volumes in cubic feet per pound.

TABLE I. (Cont'd.)

Pressure lb/sq.in.abs.	160° F. V (383.9)	160° F. Z	190° F. V (526.9)	190° F. Z
Bubble Point	.03986	.10146	.04874	.1624
400	.03974	.1054	--	--
500	.03908	.1295	--	--
600	.03852	.1532	.04446	.1686
800	.03761	.1995	.04160	.2104
1000	.03689	.2446	.04008	.2534
1250	.03615	.2996	.03880	.3067
1500	.03553	.3531	.03785	.3588
1750	.03499	.4063	.03707	.4105
2000	.03453	.4579	.03643	.4607
2250	.03413	.5092	.03588	.5110
2500	.03377	.5597	.03540	.5597
2750	.03345	.6093	.03497	.6075
3000	.03316	.6602	.03459	.6569
3500	.03264	.7566	.03393	.7503
4000	.03220	.8540	.03337	.8441
4500	.03180	.9502	.03289	.9345
5000	.03145	1.0426	.03246	1.0265
6000	.03080	1.2229	.03165	1.1986
7000	.03028	1.4040	.03109	1.3750
8000	.02982	1.5818	.03057	1.5467
9000	.02940	1.7562	.03010	1.7150
10000	.02902	1.9242	.02966	1.8758

TABLE I. (Cont'd.)

Pressure lb/sq.in.abs.	220° F. V	220° F. Z	280° F. V	280° F. Z
200	.7339	.8873	.8249	.9164
300	.4533	.8221	.5233	.8720
400	.3096	.7487	.3714	.8253
500	.2190	.6620	.2793	.7757
600	.1515	.5495	.2167	.7227
800	.05152	.2491	.1355	.6023
1000	.04569	.2762	.08593	.4773
1250	.04269	.3225	.05991	.4159
1500	.04090	.3706	.05148	.4287
1750	.03966	.4198	.04761	.4631
2000	.03871	.4680	.04501	.5000
2250	.03793	.5164	.04330	.5417
2500	.03727	.5632	.04196	.5826
2750	.03670	.6095	.04091	.6242
3000	.03621	.6573	.04004	.6678
3500	.03537	.7476	.03866	.7516
4000	.03468	.8385	.03761	.8342
4500	.03408	.9280	.03669	.9180
5000	.03355	1.0141	.03592	.9976
6000	.03266	1.1823	.03470	1.1544
7000	.03194	1.3502	.03374	1.3106
8000	.03133	1.5151	.03293	1.4633
9000	.03081	1.6779	.03226	1.6144
10000	.03035	1.8347	.03167	1.7592

TABLE I. (Cont'd.)

Pressure lb/sq.in.abs.	340° F.		400° F.		460° F.	
	V	Z	V	Z	V	Z
200	.9110	.9362	.9947	.9508	1.0767	.9620
300	.5862	.9036	.6459	.9261	.7039	.9434
400	.4236	.8707	.4716	.9017	.5176	.9250
500	.3258	.8371	.3670	.8772	.4059	.9068
600	.2604	.8029	.2975	.8533	.3317	.8891
800	.1780	.7320	.2107	.8057	.2391	.8548
1000	.1289	.6627	.1590	.7599	.1841	.8226
1250	.09183	.5898	.1188	.7098	.1409	.7870
1500	.07170	.5523	.09406	.6740	.1114	.7471
1750	.06136	.5521	.07830	.6554	.09430	.7373
2000	.05501	.5652	.06832	.6530	.08231	.7354
2250	.05112	.5910	.06171	.6642	.07330	.7375
2500	.04863	.6246	.05693	.6802	.06689	.7471
2750	.04660	.6577	.05368	.7048	.06200	.7609
3000	.04502	.6946	.05118	.7345	.05832	.7824
3500	.04271	.7672	.04752	.7941	.05312	.8298
4000	.04102	.8430	.04498	.8599	.04955	.8854
4500	.03970	.9188	.04312	.9283	.04696	.9450
5000	.03862	.9921	.04162	.9946	.04498	1.0047
6000	.03694	1.1365	.03936	1.1265	.04208	1.1257
7000	.03567	1.2816	.03774	1.2614	.03998	1.2490
8000	.03466	1.4246	.03647	1.3944	.03839	1.3721
9000	.03384	1.5664	.03546	1.5268	.03714	1.4949
10000	.03310	1.7007	.03458	1.6527	.03613	1.6141

TABLE II

SPECIFIC VOLUME OF BENZENE

Pressure Lbl/Sq. In.Abs.	100°F.	160°F.	220°F.	280°F.
	(3.21)[a]	(11.08)	(29.15)	(64.68)
Bubble Point	0.01862[b]	0.01943	0.02028	0.02133
100	0.01859	0.01941	0.02026	0.02131
200	0.01858	0.01940	0.02024	0.02127
300	0.01857	0.01938	0.02021	0.02123
400	0.01856	0.01936	0.02018	0.02118
500	0.01855	0.01935	0.02015	0.02114
600	0.01854	0.01932	0.02013	0.02110
800	0.01851	0.01928	0.02008	0.02102
1000	0.01849	0.01924	0.02003	0.02095
1250	0.01845	0.01920	0.01997	0.02087
1500	0.01842	0.01915	0.01992	0.02080
1750	0.01839	0.01910	0.01987	0.02073
2000	0.01836	0.01906	0.01981	0.02065
2250	0.01832	0.01902	0.01976	0.02058
2500	0.01829	0.01897	0.01970	0.02052
2750	0.01826	0.01893	0.01965	0.02045
3000	0.01823	0.01889	0.01961	0.02039
3500	0.01816	0.01881	0.01952	0.02027
4000	0.01810	0.01874	0.01942	0.02015
4500	0.01804	0.01867	0.01932	0.02003
5000	0.01799	0.01860	0.01923	0.01922
6000	0.01790	0.01848	0.01907	0.01974
7000	0.01783	0.01837	0.01895	0.01957
8000	0.01776	0.01826	0.01882	0.01940
9000	0.01767	0.01814	0.01869	0.01925
10000	0.01758	0.01804	0.01856	0.01911

[a] Figures in parentheses are vapor pressures in pounds per square inch absolute

[b] Specific volumes in cubic feet per pound

TABLE II. (Cont'd.)

Pressure Lb./Sq. In.Abs.	340°F.	400°F.	460°F.
	(126.0)	(222.06)	(363.46)
Bubble Point	0.02262	0.02441	0.02704
100	--	--	--
200	0.02258	--	--
300	0.02252	0.02432	--
400	0.02246	0.02422	0.02693
500	0.02241	0.02412	0.02665
600	0.02235	0.02402	0.02640
800	0.02224	0.02382	0.02598
1000	0.02214	0.02365	0.02562
1250	0.02200	0.02343	0.02526
1500	0.02188	0.02325	0.02494
1750	0.02176	0.02307	0.02466
2000	0.02165	0.02290	0.02442
2250	0.02155	0.02275	0.02420
2500	0.02145	0.02260	0.02400
2750	0.02136	0.02247	0.02381
3000	0.02128	0.02234	0.02362
3500	0.02113	0.02211	0.02330
4000	0.02099	0.02191	0.02300
4500	0.02085	0.02172	0.02274
5000	0.02071	0.02155	0.02250
6000	0.02048	0.02125	0.02210
7000	0.02025	0.02098	0.02177
8000	0.02005	0.02076	0.02147
9000	0.01988	0.02055	0.02121
10000	0.01973	0.02035	0.02098

TABLE III.

SPECIFIC VOLUME OF BENZENE AT BUBBLE POINT

Temperature °F.	Pressure Lb./Sq. In.Abs.	Authors	Young	% Deviation
100	3.2	0.01862	0.01862	0.0
160	11.1	0.01943	0.01943	0.0
220	29.2	0.02028	0.02028	0.0
280	64.7	0.02133	0.02144	0.5
340	126.0	0.02262	0.02278	0.7
400	222.1	0.02441	0.02953	0.5
460	363.5	0.02704	0.02716	0.4

TABLE IV

SINGLE-PHASE VOLUMETRIC BEHAVIOR OF A MIXTURE OF PROPANE AND BENZENE WITH 88.27 MOLE PER CENT PROPANE

Pressure Lb/Sq.In.Abs.	100°F. V	100°F. Z	160°F. V	160°F. Z
200	0.03032[a]	0.04855	--	--
300	0.03022	0.07258	--	--
400	0.03012	0.09645	0.03385	0.09790
500	0.03002	0.12017	0.03360	0.12148
600	0.02992	0.14372	0.03336	0.14473
800	0.02973	0.19041	0.03292	0.19043
1000	0.12955	0.2366	0.03252	0.2351
1250	0.12935	0.2937	0.03208	0.2899
1500	0.02916	0.3502	0.03171	0.3439
1750	0.02898	0.4060	0.03139	0.3972
2000	0.02882	0.4615	0.03111	0.4499
2250	0.02866	0.5163	0.03086	0.5021
2500	0.02851	0.5706	0.03063	0.5537
2750	0.02837	0.6246	0.03042	0.6049
3000	0.02823		0.03022	0.6555
3500	0.02798	0.7840	0.02985	0.7554
4000	0.02777	0.8893	0.02950	0.8532
4500	0.02757	0.9932	0.02918	0.9495
5000	0.02741	1.0972	0.02892	1.0456
6000	0.02709	1.3013	0.02846	1.2347
7000	0.02677	1.5002	0.02807	1.4208
8000	0.02646	1.6947	0.02770	1.6023
9000	0.02618	1.8863	0.02735	1.7798
10000	0.02590	2.0735	0.02701	1.9530

a Specific volumes in cubic feet per pound.

TABLE IV. (Cont'd.)

Pressure Lb/Sq.In.Abs.	220°F. V	220°F. Z	280°F. V	280°F. Z
200	---	---	0.7377	0.8937
300	---	---	0.4605	0.8368
400	---	---	0.3195	0.7742
500	---	---	0.2330	0.7058
600	0.04103	0.1623	0.1719	0.6248
800	0.03876	0.2044	0.08387	0.4064
1000	0.03734	0.2462	0.05151	0.3120
1250	0.03623	0.2986	0.04369	0.3308
1500	0.03540	0.3502	0.04180	0.3798
1750	0.03475	0.4009	0.03982	0.4221
2000	0.03419	0.4508	0.03857	0.4673
2250	0.03372	0.5002	0.03760	0.5124
2500	0.03331	0.5490	0.03681	0.5574
2750	0.03293	0.5970	0.03613	0.6018
3000	0.03260	0.6447	0.03555	0.6460
3500	0.03199	0.7381	0.03460	0.7335
4000	0.03147	0.8299	0.03378	0.8185
4500	0.03102	0.9202	0.03316	0.9039
5000	0.03063	1.0096	0.03257	0.9864
6000	0.02997	1.1854	0.03160	1.1485
7000	0.02942	1.3576	0.03088	1.3093
8000	0.02897	1.5279	0.03032	1.4693
9000	0.02857	1.6951	0.02983	1.6262
10000	0.02816	1.8564	0.02936	1.7784

TABLE IV. (Cont'd.)

Pressure lb/sq.in. abs.	340°F.		400°F.		460°F.	
	V	Z	V	Z	V	Z
200	0.8020	0.8987	0.8962	0.9342	0.9747	0.9498
300	0.5225	0.8773	0.5787	0.9048	0.6332	0.9255
400	0.3732	0.8364	0.4192	0.8740	0.4629	0.9021
500	0.2821	0.7902	0.3232	0.8422	0.3604	0.8780
600	0.2217	0.7452	0.2594	0.8113	0.2921	0.8540
800	0.1440	0.6455	0.1791	0.7468	0.2068	0.8062
1000	0.09736	0.5455	0.1316	0.6860	0.1570	0.7651
1250	0.06687	0.4683	0.09560	0.6228	0.1186	0.7220
1500	0.05444	0.4575	0.07468	0.5838	0.09421	0.6885
1750	0.04853	0.4758	0.06274	0.5722	0.07858	0.6700
2000	0.04540	0.5087	0.05568	0.5804	0.06830	0.6655
2250	0.04331	0.5460	0.05126	0.6011	0.06128	0.6718
2500	0.04169	0.5839	0.04818	0.6278	0.05639	0.6868
2750	0.04045	0.6232	0.04594	0.6584	0.05285	0.7081
3000	0.03943	0.6628	0.04424	0.6917	0.05017	0.7333
3500	0.03782	0.7417	0.04144	0.7559	0.04636	0.7905
4000	0.03660	0.8203	0.03960	0.8256	0.04373	0.8522
4500	0.03560	0.8976	0.03827	0.8976	0.04175	0.9153
5000	0.03479	0.9746	0.03732	0.9725	0.04022	0.9798
6000	0.03349	1.1258	0.03562	1.1139	0.03794	1.1091
7000	0.03248	1.2739	0.03427	1.2503	0.03625	1.2363
8000	0.03171	1.4213	0.03329	1.3880	0.03500	1.3642
9000	0.03111	1.5687	0.03251	1.5249	0.03402	1.4917
10000	0.03060	1.7145	0.03188	1.6615	0.03320	1.6175

TABLE V.

SINGLE-PHASE VOLUMETRIC BEHAVIOR OF A MIXTURE OF PROPANE AND BENZENE WITH 59.83 Mole PER CENT PROPANE

Pressure Lb/Sq.In.Abs.	100°F. V	100°F. Z	160°F. V	160°F. Z
125	0.02430	0.02921	---	---
150	0.02428	0.03502	---	---
200	0.02426	0.04666	---	---
300	0.02422	0.06987	0.02605	0.06787
400	0.02417	0.09297	0.02598	0.09026
500	0.02412	0.1160	0.02591	0.1125
600	0.02407	0.1389	0.02585	0.1347
800	0.02398	0.1845	0.02572	0.1787
1000	0.02390	0.2298	0.02560	0.2223
1250	0.02380	0.2861	0.02545	0.2763
1500	0.02370	0.3418	0.02531	0.3297
1750	0.02361	0.3973	0.02517	0.3826
2000	0.02352	0.4523	0.02504	0.4349
2250	0.02344	0.5071	0.02491	0.4868
2500	0.02336	0.5615	0.02478	0.5380
2750	0.02329	0.6158	0.02467	0.5892
3000	0.02322	0.6698	0.02456	0.6399
3500	0.02309	0.7771	0.02435	0.7402
4000	0.02297	0.8835	0.02416	0.8393
4500	0.02285	0.9887	0.02398	0.9372
5000	0.02275	1.0938	0.02382	1.0344
6000	0.02256	1.3015	0.02355	1.2272
7000	0.02239	1.5070	0.02331	1.4171
8000	0.02222	1.7092	0.02308	1.6036
9000	0.02205	1.9082	0.02287	1.7876
10000	0.02189	2.1048	0.02268	1.9698

TABLE V. (Cont'd.)

Pressure lb./Sq.In.Abs.	220°F. V	220°F. Z	280°F. V	280°F. Z
125	---	---	0.9853	0.8961
150	---	---	0.7983	0.8712
400	0.02841	0.08998	---	---
500	0.02827	0.1119	---	---
600	0.02814	0.1337	0.03197	0.1396
800	0.02789	0.1767	0.03118	0.1815
1000	0.02766	0.2190	0.03059	0.2226
1250	0.02739	0.2711	0.03000	0.2728
1500	0.02714	0.3223	0.02954	0.3224
1750	0.02691	0.3729	0.02917	0.3714
2000	0.02670	0.4228	0.02885	0.4198
2250	0.02651	0.4723	0.02855	0.4674
2500	0.02633	0.5212	0.02827	0.5142
2750	0.02617	0.5699	0.02802	0.5606
3000	0.02601	0.6178	0.02776	0.6059
3500	0.02573	0.7130	0.02733	0.6960
4000	0.02548	0.8070	0.02695	0.7843
4500	0.02525	0.8997	0.02662	0.8716
5000	0.02505	0.9917	0.02633	0.9579
6000	0.02469	1.1729	0.02587	1.1294
7000	0.02435	1.3496	0.02545	1.2962
8000	0.02406	1.5240	0.02509	1.4604
9000	0.02380	1.6960	0.02477	1.6220
10000	0.02358	1.8670	0.02448	1.7811

TABLE V. (Cont'd.)

Pressure Lb./Sq. In.Abs.	340°F.		400°F.		460°F.	
	V	Z	V	Z	V	Z
150	0.8952	0.9038	---	---	---	---
200	0.6456	0.8690	0.7202	0.9018	0.7859	0.9198
250	0.4963	0.8350	---	---	---	---
300	0.3960	0.7995	0.4532	0.8512	0.5017	0.8808
400	---	---	0.3182	0.7968	0.3604	0.8437
500	---	---	0.2354	0.7370	0.2741	0.8020
600	---	---	0.1782	0.6692	0.2160	0.7584
800	---	---	0.09993	0.5005	0.1423	0.6660
1000	0.03650	0.2457	0.05995	0.3753	0.09803	0.5737
1250	0.03445	0.2898	0.04447	0.3480	0.06655	0.4868
1500	0.03325	0.3357	0.03975	0.3733	0.05267	0.4623
1750	0.03238	0.3814	0.03738	0.4095	0.04609	0.4720
2000	0.03168	0.4251	0.03587	0.4491	0.04228	0.4948
2250	0.03112	0.4713	0.03473	0.4892	0.03993	0.5257
2500	0.03062	0.5152	0.03382	0.5293	0.03836	0.5612
2750	0.03018	0.5586	0.03307	0.5694	0.02703	0.5955
3000	0.02980	0.6017	0.03244	0.6093	0.03590	0.6303
3500	0.02917	0.6871	0.03143	0.6887	0.03427	0.7019
4000	0.02865	0.7713	0.03065	0.7675	0.03312	0.7753
4500	0.02819	0.8538	0.03000	0.8452	0.03214	0.8464
5000	0.02780	0.9355	0.02945	0.9219	0.03135	0.9173
6000	0.02714	1.0960	0.02858	1.0736	0.03011	1.0572
7000	0.02658	1.2523	0.02790	1.2227	0.02922	1.1970
8000	0.02612	1.4064	0.02730	1.3673	0.02855	1.2366
9000	0.02573	1.5586	0.02680	1.5100	0.02800	1.4747
10000	0.02545	1.7129	0.02642	1.6540	0.02748	1.6081

TABLE VI.

SINGLE-PHASE VOLUMETRIC BEHAVIOR OF A MIXTURE OF PROPANE AND BENZENE WITH 39.48 MOLE PER CENT PROPANE

Pressure Lb/Sq.In.Abs.	100°F. V	100°F. Z	160°F. V	160°F. Z
100	0.02195	0.02364	---	---
125	0.02194	0.02959	---	---
150	0.02193	0.03542	---	---
200	0.02192	0.04721	0.02327	0.04526
300	0.02189	0.07072	0.02324	0.06781
400	0.02187	0.09421	0.02320	0.09025
500	0.02184	0.1176	0.02316	0.1126
600	0.02182	0.1410	0.02312	0.1349
800	0.02177	0.1876	0.02304	0.1793
1000	0.02172	0.2339	0.02297	0.2234
1250	0.02165	0.2914	0.02287	0.2780
1500	0.02159	0.3488	0.02278	0.3323
1750	0.02153	0.4057	0.02270	0.3864
2000	0.02147	0.4624	0.02262	0.4400
2250	0.02141	0.5188	0.02253	0.4930
2500	0.02135	0.5748	0.02245	0.5459
2750	0.02129	0.6298	0.02237	0.5983
3000	0.02124	0.6862	0.02230	0.6507
3500	0.02115	0.7972	0.02216	0.7543
4000	0.02106	0.9072	0.02202	0.8566
4500	0.02097	1.0162	0.02191	0.9589
5000	0.02089	1.1248	0.02180	1.0601
6000	0.02074	1.3401	0.02158	1.2593
7000	0.02061	1.5526	0.02141	1.4576
8000	0.02050	1.7661	0.02125	1.6534
9000	0.02040	1.9772	0.02110	1.8469
10000	0.02031	2.1872	0.02096	2.0385

TABLE VI. (Cont'd.)

Pressure Lb/Sq.In.Abs.	220°F. V	220°F. Z	280°F. V	280°F. Z
100	---	---	1.0938	0.8912
300	0.02490	0.06624	---	---
400	0.02482	0.08803	---	---
500	0.02474	0.1097	0.02688	0.1095
600	0.02466	0.1312	0.02676	0.1308
800	0.02452	0.1739	0.02653	0.1729
1000	0.02439	0.2163	0.02632	0.2145
1250	0.02424	0.2687	0.02607	0.2655
1500	0.02410	0.3205	0.02583	0.3157
1750	0.02397	0.3719	0.02561	0.3652
2000	0.02385	0.4229	0.02539	0.4138
2250	0.02374	0.4736	0.02520	0.4620
2500	0.02363	0.5238	0.02502	0.5097
2750	0.02352	0.5735	0.02487	0.5573
3000	0.02342	0.6230	0.02472	0.6043
3500	0.02322	0.7206	0.02445	0.6973
4000	0.02305	0.8175	0.02422	0.7894
4500	0.02289	0.9133	0.02402	0.8807
5000	0.02274	1.0082	0.02383	0.9708
6000	0.02247	1.1954	0.02349	1.1484
7000	0.02225	1.3810	0.02317	1.3215
8000	0.02204	1.5634	0.02289	1.4921
9000	0.02185	1.7437	0.02264	1.6602
10000	0.02169	1.9232	0.02242	1.8268

TABLE VI. (Cont'd.)

Pressure Lb/Sq.In.Abs.	340°F.		400°F.		460°F.	
	V	Z	V	Z	V	Z
100	1.2221	0.9210	---	---	---	---
125	0.9554	0.9000	1.0564	0.9258	---	---
150	0.7758	0.8770	0.8653	0.9100	0.9438	0.9278
200	0.5507	0.8300	0.6249	0.8762	0.6896	0.9039
300	---	---	0.3826	0.8046	0.4338	0.8528
400	---	---	0.2572	0.7213	0.3037	0.7960
500	---	---	---	---	0.2237	0.7330
600	---	---	---	---	0.1688	0.6636
800	0.02953	0.1780	---	---	0.09194	0.4820
1000	0.02953	0.1780	0.03375	0.2366	0.05180	0.3395
1250	0.02848	0.2683	0.03226	0.2827	0.04028	0.3300
1500	0.02804	0.3170	0.03127	0.3288	0.03674	0.3612
1750	0.02766	0.3648	0.03050	0.3742	0.03479	0.3990
2000	0.02732	0.4118	0.02990	0.4192	0.03349	0.4390
2250	0.02702	0.4582	0.02939	0.4636	0.03247	0.4788
2500	0.02676	0.5042	0.02897	0.5077	0.03165	0.5185
2750	0.02652	0.5496	0.02858	0.5510	0.03105	0.5595
3000	0.02629	0.5944	0.02824	0.5939	0.03053	0.6002
3500	0.02589	0.6829	0.02765	0.6785	0.02963	0.6796
4000	0.02556	0.7705	0.02716	0.7616	0.02893	0.7584
4500	0.02527	0.8570	0.02676	0.8442	0.02835	0.8361
5000	0.02502	0.9428	0.02639	0.9251	0.02785	0.9126
6000	0.02456	1.1106	0.02577	1.0840	0.02704	1.0632
7000	0,02415	1.2740	0.02523	1.2382	0.02636	1.2093
8000	0.02381	1.4355	0.02479	1.3904	0.02577	1.3511
9000	0.02350	1.5939	0.02441	1.5402	0.02530	1.4922
10000	0.02319	1.7477	0.02406	1.6868	0.02490	1.6318

TABLE VII.

SINGLE-PHASE VOLUMETRIC BEHAVIOR OF A MIXTURE OF PROPANE AND BENZENE WITH 19.56 MOLE PER CENT PROPANE

Pressure Lb/Sq.In.Abs.	100°F. V	100°F. Z	160°F. V	160°F. Z
80	0.02020	0.01922	---	---
100	0.02019	0.02402	---	---
125	0.02019	0.03002	0.02121	0.02849
150	0.02018	0.03601	0.02120	0.03417
200	0.02017	0.04799	0.02117	0.04549
300	0.02016	0.07195	0.02113	0.06811
400	0.02014	0.09584	0.02109	0.09064
500	0.02012	0.1197	0.02105	0.1131
600	0.02010	0.1435	0.02102	0.1355
800	0.02007	0.1910	0.02095	0.1801
1000	0.02004	0.2384	0.02088	0.2243
1250	0.01999	0.2973	0.02081	0.2795
1500	0.01994	0.3558	0.02074	0.3343
1750	0.01990	0.4143	0.02068	0.3888
2000	0.01986	0.4725	0.02063	0.4433
2250	0.01982	0.5305	0.02058	0.4975
2500	0.01977	0.5880	0.02053	0.5515
2750	0.01973	0.6455	0.02049	0.6054
3000	0.01969	0.7027	0.02045	0.6592
3500	0.01962	0.8169	0.02036	0.7657
4000	0.01954	0.9298	0.02027	0.8712
4500	0.01947	1.0423	0.02018	0.9757
5000	0.01940	1.1539	0.02009	1.0793
6000	0.01927	1.3754	0.01994	1.2855
7000	0.01913	1.5930	0.01979	1.4884
8000	0.01900	1.8082	0.01968	1.6916
9000	0.01889	2.0225	0.01957	1.8924
10000	0.01882	2.2389	0.01945	2.0898

TABLE VII. (Cont'd.)

Pressure Lb/Sq.In.Abs.	220°F. V	220°F. Z	280°F. V	280°F. Z
200	0.02230	0.04368	---	---
300	0.02226	0.06541	0.02377	0.06419
400	0.02222	0.08705	0.02371	0.08536
500	0.02218	0.1086	0.02365	0.1064
600	0.02214	0.1301	0.02359	0.1274
800	0.02206	0.1729	0.02348	0.1691
1000	0.02198	0.2153	0.02337	0.2104
1250	0.02189	0.2680	0.02323	0.2614
1500	0.02180	0.3203	0.02310	0.3119
1750	0.02172	0.3723	0.02298	0.3620
2000	0.02163	0.4237	0.02286	0.4115
2250	0.02155	0.4749	0.02275	0.4607
2500	0.02148	0.5260	0.02264	0.5095
2750	0.02141	0.5767	0.02253	0.5577
3000	0.02134	0.6270	0.02243	0.6057
3500	0.02122	0.7274	0.02225	0.7009
4000	0.02110	0.8266	0.02207	0.7946
4500	0.02100	0.9256	0.02192	0.8878
5000	0.02090	1.0235	0.02177	0.9797
6000	0.02072	1.2176	0.02150	1.1611
7000	0.02052	1.4069	0.02127	1.3401
8000	0.02037	1.5961	0.02107	1.5172
9000	0.02023	1.7833	0.02091	1.6939
10000	0.02009	1.9677	0.02075	1.8677

TABLE VII. (Cont'd.)

Pressure Lb/Sq.In.Abs.	340°F.		400°F.		460°F.	
	V	Z	V	Z	V	Z
400	0.02569	0.08555	---	---	---	---
500	0.02556	0.1064	---	---	---	---
600	0.02542	0.1270	0.02831	0.1316	---	---
800	0.02517	0.1676	0.02777	0.1721	0.03262	0.1889
1000	0.02495	0.2077	0.02730	0.2114	0.03108	0.2250
1250	0.02473	0.2574	0.02684	0.2598	0.03000	0.2715
1500	0.02453	0.3063	0.02645	0.3073	0.02921	0.3172
1750	0.02435	0.3548	0.02612	0.3540	0.02858	0.3621
2000	0.02420	0.4030	0.02582	0.3999	0.02806	0.4063
2250	0.02405	0.4505	0.02556	0.4454	0.02762	0.4499
2500	0.02390	0.4975	0.02533	0.4904	0.02723	0.4928
2750	0.02376	0.5440	0.02512	0.5350	0.02688	0.5351
3000	0.02362	0.5900	0.02492	0.5790	0.02657	0.5771
3500	0.02337	0.6810	0.02459	0.6666	0.02605	0.6601
4000	0.02313	0.7703	0.02430	0.7528	0.02562	0.7419
4500	0.02292	0.8587	0.02402	0.8371	0.02525	0.8226
5000	0.02272	0.9458	0.02375	0.9197	0.02492	0.9020
6000	0.02237	1.1175	0.02328	1.0818	0.02437	1.0506
7000	0.02207	1.2862	0.02290	1.2415	0.02390	1.2112
8000	0.02180	1.4520	0.02258	1.3990	0.02347	1.3593
9000	0.02160	1.6185	0.02232	1.5558	0.02311	1.5058
10000	0.02141	1.7825	0.02208	1.7100	0.02277	1.6484

TABLE VIII.

VOLUMETRIC DATA FOR A TWO-PHASE MIXTURE OF PROPANE AND BENZENE WITH 88.27 MOLE PER CENT PROPANE

100° F.			160° F.		
Pressure lb./sq.in. abs.	V	Z	Pressure lb./sq.in. abs.	V	Z
100	0.9243	0.7400	160	0.6787	0.7852
110	0.8006	0.7050	200	0.4923	0.7120
120	0.6893	0.6622	240	0.3573	0.6200
130	0.5804	0.6040	280	0.2343	0.4744
140	0.4638	0.5198	320	0.07909	0.1830
150	0.3368	0.4045	328.9[b]	0.03402	0.08091
160	0.1600	0.2050			
165.4[b]	0.03035	0.04019			

220°F.		
Pressure lb./sq.in. abs.	V	Z
150	0.9002	0.8902
200	0.6479	0.8542
250	0.4939	0.8140
300	0.3854	0.7623
350	0.0325	0.6980
400	0.2366	0.6240
450	0.1801	0.5343
500	0.1275	0.4202
550	0.06867	0.2490
571.8[b]	0.04152	0.1565

b Bubble-point pressure

TABLE IX.

VOLUMETRIC DATA FOR A TWO-PHASE MIXTURE OF PROPANE AND BENZENE WITH 59.83 MOLE PER CENT PROPANE

100°F.			160°F.		
Pressure lb./sq.in. abs.	V	Z	Pressure lb./sq.in. abs.	V	Z
60	0.8386	0.4838	80	0.8168	0.5675
70	0.6570	0.4422	100	0.6002	0.5213
80	0.5142	0.3955	120	0.4550	0.4742
90	0.3934	0.3404	140	0.3486	0.4239
100	0.2820	0.2712	160	0.2654	0.3688
110	0.1695	0.1793	180	0.1946	0.3042
120	0.04888	0.05640	200	0.1304	0.2265
122.1[b]	0.02431	0.02854	220	0.06600	0.1261
			232.4[b]	0.02608	0.05264

220°F.			280°F.		
Pressure lb./sq.in. abs.	V	Z	Pressure lb./sq.in. abs.	V	Z
120	0.7137	0.6782	168.5[d]	0.6949	0.8520
160	0.4578	0.5800	200	0.5137	0.7475
200	0.3189	0.5050	250	0.3509	0.6382
240	0.2302	0.4375	300	0.2562	0.5592
280	0.1629	0.3612	350	0.1925	0.4901
320	0.1083	0.2774	400	0.1453	0.4230
360	0.06241	0.1779	450	0.1084	0.3548
392.0[b]	0.02842	0.08821	500	0.07884	0.2868
			550	0.05343	0.2138
			595.4[b]	0.03200	0.1386

b Bubble-point pressure

d Dew-point pressure

TABLE IX. (Cont'd.)

340°F		
Pressure lb./sq.in. abs.	V	Z
345.8[d]	0.3293	0.7665
350	0.3224	0.7595
400	0.2518	0.6780
450	0.2007	0.6080
500	0.1621	0.5455
550	0.1323	0.4896
600	0.1083	0.4375
650	0.08869	0.3880
700	0.07174	0.3380
750	0.05711	0.2883
800	0.04430	0.2385
823.2[b]	0.03913	0.2168

b Bubble-point pressure

d Dew-point pressure

TABLE X.

VOLUMETRIC DATA FOR A TWO-PHASE MIXTURE OF PROPANE AND BENZENE WITH 39.48 MOLE PER CENT PROPANE

100°F.		
Pressure lb./sq.in. abs.	V	Z
30	0.1292	0.3648
40	0.7603	0.3275
50	0.5315	0.2862
60	0.3722	0.2405
70	0.2507	0.1890
80	0.1459	0.1257
90	0.05757	0.05580
94.4[b]	0.02195	0.02231

160°F.		
Pressure lb./sq.in. abs.	V	Z
60	0.6772	0.3952
80	0.4303	0.3348
100	0.2959	0.2878
120	0.1934	0.2257
140	0.1219	0.1660
160	0.06169	0.09600
174.3[b]	0.02328	0.03946

220 F.		
Pressure lb./sq.in. abs.	V	Z
120	0.3799	0.4042
160	0.2278	0.3232
200	0.1390	0.2465
240	0.07810	0.1662
280	0.03243	0.08051
282.3[b]	0.02492	0.06238

280 F.		
Pressure lb./sq.in. abs.	V	Z
113.0[d]	0.9484	0.8732
120	0.8069	0.7890
160	0.3931	0.5579
200	0.2766	0.4507
240	0.1929	0.3772
280	0.1381	0.3150
320	0.09880	0.2576
360	0.06822	0.2001
400	0.04427	0.1443
435.8[b]	0.02695	0.09570

b Bubble-point pressure

d Dew-point pressure

TABLE X. (Cont'd.)

340°F.			400°F.		
Pressure lb./sq.in. abs.	V	Z	Pressure lb./sq.in. abs.	V	Z
223.1[d]	0.4805	0.8079	410.3[d]	0.2478	0.7128
250	0.3607	0.6795	450	0.1940	0.6120
300	0.2380	0.5380	500	0.1481	0.5193
350	0.1684	0.4442	550	0.1167	0.4500
400	0.1233	0.3717	600	0.09331	0.3925
450	0.09188	0.3116	650	0.07547	0.3439
500	0.06820	0.2570	700	0.06083	0.2985
550	0.04941	0.2048	750	0.04884	0.2568
600	0.03379	0.1528	800	0.03851	0.2160
615.2[b]	0.03010	0.1396	814.3[b]	0.03600	0.2055

b Bubble-point pressure

d Dew-point pressure

TABLE XI.

VOLUMETRIC DATA FOR A TWO-PHASE MIXTURE OF PROPANE AND BENZENE WITH 19.56 MOLE PER CENT PROPANE

100°F.		
Pressure lb./sq.in. abs.	V	Z
45	0.1303	0.06975
50	0.08154	0.04850
55	0.04244	0.02777
60	0.02208	0.01576
60.6[b]	0.02020	0.01456

160°F.		
Pressure lb/sq.in. abs.	V	Z
75	0.1243	0.1002
80	0.1019	0.08760
85	0.08157	0.07450
90	0.06332	0.06123
95	0.04203	0.04290
100	0.03312	0.03559
105	0.02446	0.02760
107.3[b]	0.02123	0.02448

220°F.		
Pressure lb./sq.in. abs.	V	Z
120	0.1097	0.1289
130	0.08630	0.1099
140	0.06672	0.09150
150	0.04988	0.07330
160	0.03633	0.05695
170	0.02493	0.04152
172.6[b]	0.02231	0.03772

280°F.		
Pressure lb./sq.in. abs.	V	Z
180	0.1084	0.1757
200	0.07933	0.1428
220	0.05676	0.1124
240	0.03935	0.08501
260	0.02568	0.06010
263.1[b]	0.02380	0.05636

b Bubble-point pressure

TABLE XI. (Cont'd.)

340°F.			400°F.		
Pressure lb./sq.in. abs.	V	Z	Pressure lb./sq.in. abs.	V	Z
260	0.1128	0.2442	380	0.1081	0.3182
280	0.08991	0.2096	400	0.09151	0.2835
300	0.07159	0.1788	420	0.07756	0.2523
320	0.05638	0.1502	440	0.06568	0.2238
340	0.04518	0.1279	460	0.05538	0.1973
360	0.03487	0.1045	480	0.04673	0.1737
380	0.02671	0.08450	500	0.03938	0.1525
383.7[b]	0.02575	0.08226	520	0.03300	0.1329
			536.6[b]	0.02852	0.1185

460°F.		
Pressure lb./sq.in. abs.	V	Z
520	0.1245	0.4687
540	0.1075	0.4202
560	0.09353	0.3792
580	0.08228	0.3455
600	0.07270	0.3158
620	0.06416	0.2880
640	0.05657	0.2621
660	0.04985	0.2382
680	0.04394	0.2163
700	0.03870	0.1961
720.8[b]	0.03369	0.1758

b Bubble-point pressure