THERMOPHYSICAL PROPERTIES OF HCFC ALTERNATIVES

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ABSTRACT

Numerous fluids and fluid mixtures have been identified as promising alternatives to the HCFC refrigerants, but, for many of them, reliable thermodynamic data do not exist. In particular, reliable thermodynamic properties data and models are needed to predict the performance of the new refrigerants in heating and cooling equipment and to design and optimize equipment to be reliable and energy efficient. The objective of this project is to measure, with high accuracy, selected thermodynamic properties data for two pure refrigerants and nine refrigerant blends; these data will be used to fit equations of state and other property models which can be used in equipment design. The new data will fill in gaps in the existing data and resolve problems and differences that exist in and between existing data sets. Most of the studied fluids and blends are potential replacements for HCFC-22 and/or R502; in addition, one pure fluid and one blend are potential replacements for CFC-13 in low temperature refrigeration applications.

SCOPE

This project involves the measurement of primary thermodynamic data for eight binary mixtures and one ternary mixture (R125/134a; R32/143a; R125/143a; R143a/134a; R32/290; R125/290; R290/134a; R41/744; and R32/125/134a). These data will consist of simultaneous measurements of the coexisting liquid and vapor densities and coexisting liquid and vapor compositions as well as the bubble point pressures over wide ranges of temperature and composition. These data will be used to determine the mixing parameters, including any temperature and/or composition dependence, for the Carnahan-Starling-DeSantis (CSD) equation of state and the extended corresponding states (ECS) model. Primary data will also be measured for the pure fluid HFC-41. These measurements will include the determination of vapor pressure; liquid density; liquid, two-phase, and ideal gas heat capacities; vapor sound speeds and virial coefficients; and a determination of the critical point parameters. These data will cover wide ranges of temperature and pressure and will be used (together with available literature data) to fit equations of state and other models of the thermodynamic properties. The original proposal called for similar measurements of primary data for HFC-245ca; since work on this fluid has been funded by another sponsor, comprehensive mixture data for the binary system R125/143a will be substituted as recommended by the MCLR Advisory Committee. During the past quarter, we have carried out the following tasks: (a) detailed analysis of vapor-liquid equilibria and density data including comparisons with all available data from independent sources, (b) performance tests on the existing VLE apparatus,

(c) automation of data comparisons to REFPROP, (d) continued development of the new VLE apparatus that will provide improved, state-of-the-art accuracy in temperature and composition determination, (e) comprehensive isochoric PVT measurements on an equimolar mixture of HFC-143a and HFC-125 from 200 to 400 K (-100 to 260°F) up to 35 MPa (5100 psia), (f) acquisition and analysis of HFC-41 sample, and (g) vapor pressure and density measurements on HFC-41 from 275 to 315 K (35 to 107°F). The performance tests on the VLE apparatus included evaluation of the effects of adsorption, of heats of vaporization, of phase envelope widths, and of the slopes of the density versus temperature curves on the quality of the measurements. Since the existing VLE apparatus had been primarily used for measurement on hydrocarbons in the past, a discussion of the differences involved with measurements on refrigerants will be presented.

SIGNIFICANT RESULTS

Primary mixture data for binary mixtures of relatively volatile components (R125/134a; R32/143a; R125/143a; R143a/134a; R32/290; R125/290; R134a/290)

In previous reports, we have presented the coexisting densities at the same temperature as the equilibrium cell by making adjustments to the raw data from the liquid and vapor densimeters. (To ensure single-phase conditions in the densimeters, the liquid densimeter is held at a temperature below the bubble point temperature of the equilibrium cell and the vapor densimeter is held at a temperature above that of the equilibrium cell.) However, we have found for refrigerant systems that these adjustments are larger than the experimental uncertainty. To provide the most accurate data for equation-of-state development for mixtures, it is imperative to report the raw data without adjustments, that is, the single-phase PVT_x and PVT_y data. For all of the mixtures studied so far, we are providing tables of VLE, PVT_x, and PVT_y data in this report.

We have examined the data in several ways to determine its reliability. Normally the data are compared to other data in the literature using an equation of state as a baseline. Even if the equation of state does not represent the data accurately, an evaluation of the trends of the data should be evident. In the case of the refrigerant mixtures, the best available data source is the International Energy Agency (IEA) Annex 18 database. This database contains data from laboratories from many countries that are working together to determine the properties of the alternative refrigerants. Much of the data from the Annex 18 database is preliminary and/or unpublished; it may be updated before publication. The database contains data on R32/134a, R32/125, and R32/125/134a mixtures. However, it is not advisable to rely on comparisons to the database as our only test of the reliability of the measurements.

The data comparisons have revealed considerable scatter for most of the sources of refrigerant VLE data (both large scatter within the data of a given laboratory and scatter between the data of different laboratories). The measured vapor compositions showed the most scatter, especially at the lower temperatures. Our results for bubble point pressures and liquid densities were in much better agreement with other laboratories. Past work on hydrocarbon mixtures and other systems has shown good agreement between these same laboratories. Clearly, these refrigerant mixtures present some new difficulties. We are investigating several possible sources of error, including composition determination and sensitivity of the measured pressure and composition to temperature gradients within the apparatus.

The tests of the composition measurement technique were described in the previous progress report. Briefly, the entire apparatus was filled with either single-phase liquid or vapor of known composition. The compositions of both liquid and vapor which were sampled and analyzed with the gas chromatograph were within the expected experimental error of the known standard.

A comparison of the different data sets revealed much larger differences for our data along the lower-temperature isotherms. The vapor compositions at the low temperatures for the R32/134a and R32/125 systems are systematically high in the more volatile component (HFC-32) compared to other authors. We first suspected this to be a result of adsorption of HFC-32 onto the stainless steel sampling cylinders used by the other authors (we use copper sampling lines and direct injection into a gas chromatograph to avoid such effects). However, after checking the thermodynamic consistency of our data, we came to the conclusion that the vapor compositions we were measuring at the lowest temperatures were less precise than those at higher temperatures. The only operational difference in the apparatus at the lower temperatures is that a refrigerator is used to cool the apparatus below 310 K (98°F). We speculated that this might give rise to temperature gradients (cold spots) which would partially condense the less-volatile component out of the vapor, resulting in the observed enrichment of HFC-32 in the vapor actually being sampled.

We tested the temperature gradient hypothesis by varying the applied refrigeration power with the system filled with the R32/125/134a ternary. The results of these tests are presented in Figures 1 and 2. Refrigeration provides cooling for the system and electric heat is applied to fine-tune the total energy flow and maintain a constant temperature. Increased refrigeration power would require increased heat input to maintain a given temperature and should result in increased temperature gradients. A number of laboratories have measured the R32/125/134a system with scatter as large as 8% in bubble point pressures; by varying the temperature gradients, we could match the data of any of the other laboratories. In Figure 1, our "normal" measurements are shown as open squares; they exhibit modest scatter about the baseline. With purposefully induced, large temperature gradients (shown as filled squares) the scatter increases tremendously. The measured vapor compositions can also be affected by temperature gradients. Figure 2 compares the vapor compositions of Higashi (Iwaki Meisei University, private communication) and Kleemiss (University of Hannover, private communication) with predictions from REFPROP. Some of the problems with the vapor composition measurements can be seen in these plots. The data show more scatter than would be expected. The compositions vary by an average of ± 0.02 mole fraction and exhibit a maximum deviation of 0.05 mole fraction. These tests confirm temperature gradients within our system as a problem and also suggest that we are not the only lab to experience such problems for the refrigerant blends.

The great sensitivity of the refrigerant mixtures to temperature gradients was somewhat of a surprise. This same apparatus had been applied to hydrocarbon mixtures and other systems over many years with excellent results (including excellent agreement with other laboratories). The sensitivity of the refrigerants can be traced to two features of these systems. First, the heats of vaporization of the refrigerant blends are much lower than those of the hydrocarbons; this means that a much greater quantity of vapor will be condensed for a given heat flow associated with a cold spot in the vapor space. Second, and most significant, the dew-bubble envelope of the near-azeotropes being investigated is quite narrow compared to the hydrocarbon systems studied previously. With such narrow envelopes, a small change in temperature can give rise to a large change in composition.

Table 1 summarizes the calculated heats of vaporization and the phase envelope widths at a composition of 0.5 mass fraction at 298 K (77°F) for several hydrocarbon and refrigerant binaries and one composition of the R32/125/134a ternary mixture. The heats of vaporization and the phase envelope widths for R32/134a and R32/125 are significantly smaller than for the hydrocarbon systems and, as a result, showed the most scatter. The heats of vaporization of R32/290 and R134a/290 are larger than those for the R32/134a system, but are smaller than those for the hydrocarbon systems and, not surprisingly, showed much less scatter. It is apparent that the ternary system of R32/125/134a has one of the lowest heats of vaporization and narrowest phase envelopes. As a result, measurements on this system showed the greatest sensitivity to temperature gradients. From Table 1 we can determine which of the other systems may be sensitive to temperature gradients. The low temperature data for the R32/143a and R125/290 systems may be affected by temperature gradients and should be verified in the new apparatus.

To resolve the problems encountered at the lower temperatures, we will repeat the lowest three isotherms for the R32/125 and R32/134a systems on the new VLE apparatus. This new apparatus has similar capabilities compared to the existing system, but will cover a wider temperature range and is in a well-stirred liquid bath, which should reduce temperature gradients to the level of 10 mK (0.02°F). The placement of the densimeters has also been designed to minimize the potential problems of droplets in the vapor densimeter and of bubbles in the liquid densimeter.

The remaining systems to be measured all have heats of vaporization that are as small or smaller than those for the R32/125 system. Since the new VLE apparatus will have temperature gradients on the order of ± 10 mK ($\pm 0.02^\circ\text{F}$) and does not require temperature gradients in order for the densimeters to function properly, all remaining measurements will be performed on the new apparatus.

Because of our analysis of the sensitivity of the VLE results to temperature gradients in the existing VLE apparatus, we have increased the priority of completing the new apparatus. It will allow us to verify some of the data we have already taken, and to complete the remaining systems. We have redesigned the electrical connections on the densimeters to reduce the noise and obtain a better signal. We have completed a series of leak tests and data acquisition tests. We have completed the wiring for the temperature control systems. We are in the process of testing the pump and densimeter operations with propane. We will then test the sampling valves and lines with R32/125 mixtures. We will then complete the final calibrations of the densimeters, pressure transducers, and platinum resistance thermometers.

While the construction of the new apparatus was under way, we compared the data we have taken to other datasets using REFPROP as a baseline. This gave us an indication of how many other laboratories may have encountered the same difficulties that have been discussed in this report.

The experimental data for the R32/134a system are presented in Tables 2 through 4. Comparisons with other data sets using REFPROP as a baseline are presented in Figures 3 through 7. These comparisons were discussed in detail in the last report, but we will review them again based on new performance tests evaluating the effects of temperature gradients. In Figure 3, two sets of bubble point pressure data show relatively large deviations compared to the other data for results away from the critical region. The data point of Higashi [Iwaki Meisei University, private communication] at 280 K (44°F) is approximately 10% higher than the other data, and the data of Fujiwara *et al.* [Fujiwara *et al.*, 13th Japan Symposium

Thermophysical Properties A116:61 (1992)] at 273 K (32°F) are 1 to 5% lower than the other results.

In Figure 4, the liquid densities of Higashi, of Widiatmo *et al.* [Widiatmo, J.V., Sato, H., and Watanabe, K. Fluid Phase Equilibria 99:199 (1994)], and of this work are presented for the R32/134a system. The data of Widiatmo *et al.* and this work are in agreement within 0.7% in the region of overlap. The data of Higashi show considerably larger deviations in the critical region compared to our results. The lower temperature data of Higashi show approximately the same deviations as our data.

Figure 5 shows the vapor density deviations of Higashi and of our work for the R32/134a system. Our vapor densities show a very systematic deviation with temperature when compared to REFPROP. Higashi's lower temperature vapor density data are in agreement with our data, but their data in the critical region show larger deviations.

Figure 6 shows vapor composition deviations of data from the Annex 18 database using REFPROP as a baseline with the liquid composition and the temperature as the fixed variables for the R32/134a system. The use of the liquid composition as an independent variable produces more scatter in the vapor composition comparisons, since the liquid composition has the same uncertainty in the measurement as the vapor composition. Our vapor compositions are higher at the lower temperatures than the other data sets. It is expected that these differences are caused by larger temperature gradients at the lower temperatures. The lower three isotherms will be repeated in the new apparatus.

With the temperature and pressure as the fixed variables, the composition deviations using REFPROP as a baseline are shown in Figure 7. The liquid and vapor compositions of Fujiwara *et al.* are higher than the other data sets. Our vapor compositions for the lowest three isotherms are higher than the other data as seen in the previous figure.

The data for the R32/125 system are presented in Tables 5 through 7. The deviation plots comparing the data from the Annex 18 database using REFPROP as a baseline are presented in Figures 8 through 12. Bubble point pressures are compared in Figure 8. With the exception of the critical region and the data of Fujiwara *et al.*, the data agree within $\pm 1.5\%$.

Figure 9 shows the comparisons of the R32/125 liquid density data from Higashi (Iwaki Meisei University, private communication), from Widiatmo *et al.* (Widiatmo, J.V., Sato, H., Watanabe, K., *High Temperatures-High Pressures*, 25:677 [1993]), and from this work. The results are similar to those for the R32/134a system where Widiatmo *et al.* and this work are in agreement, and the data of Higashi show significantly more scatter.

Figure 10 shows vapor density comparisons of Higashi and this work for the R32/125 system. Both data sets show similar scatter and a systematic trend with temperature compared to REFPROP.

Figure 11 shows comparisons of the vapor compositions with the liquid composition and the temperature as the fixed variables for the R32/125 system. This system is very sensitive to temperature gradients, and we will be repeating the low temperature points and also those at the lowest R32 compositions in the new VLE apparatus.

Figure 12 shows the composition deviations for the R32/125 system when temperature and pressure are the independent variables. This information shows that the model may need

to be adjusted because, at 300 K (80°F), the liquid composition deviations of Higashi go from being negative to positive. The vapor compositions are in closer agreement with the model at the R32-rich end of the isotherms, but show larger scatter at the R32-lean end of the isotherms. A thermodynamic consistency test on these data will show how much of these deviations result from the model and how much are caused by temperature gradients.

The data for the R32/290 system are presented in Tables 8 through 10. The data for the R125/290 system are presented in Tables 11 through 13. The data for the R134a/290 system are presented in Tables 14 through 16. Deviation plots for the R134a/290 system comparing the data to REFPROP are presented in Figures 13 through 15. There are no published data for the R32/290 or R125/290 systems. We performed comparisons for these two systems to the predictions of REFPROP and observed smooth systematic trends. Since REFPROP has not yet been optimized for these two systems, we will not present any deviation plots at this time.

There is a limited quantity of VLE data available for comparison for the R134a/290 system. In Figure 13 the bubble point pressures for R134a/290 show very systematic trends in composition and temperature implying that the data are smooth. For the R134a/290 system presented in Figure 13, the data from Kleiber [M. Kleiber, *Fluid Phase Equilibria*, 92:149-194(1994)], from Jadot and Frere [R. Jadot and M. Frere, *High Temperature and High Pressure*, 25:491 (1993)], and from this work are in general agreement. The vapor composition comparisons are presented in Figure 14. Again, systematic temperature and composition trends are observed implying that the data are smooth; the model needs to be evaluated and optimized. In Figure 14, the R134a/290 vapor composition data from Kleiber, from Jadot and Frere, and from this work are in general agreement. These systems do not show the large vapor composition scatter that was exhibited by the R32/134a system. The R134a/290 system has much larger heats of vaporization and phase envelope widths, which make the measurements less sensitive to temperature gradients. In Figure 15, the temperature and pressure are used as the independent variables for comparisons of liquid and vapor compositions. Both the liquid and vapor compositions are in general agreement, but quantitative comparisons cannot be made until the model is optimized to the experimental data for this system.

Critical lines are needed to develop accurate models and to carry out thermodynamic consistency tests for mixtures at higher temperatures. The high temperature data have been used to estimate the critical lines using a novel method based on a pseudo-pure-fluid theory developed by Van Poolen (report in preparation). Critical line estimations have been completed for R32/134a, R32/125, R32/290, and R134a/290 and are in progress for R125/290 and R32/143a. These critical line predictions will be compared to the limited data available for these systems in the next progress report.

To resolve the problems encountered at the lower temperatures, we will repeat the lowest three isotherms for the R32/125 and R32/134a systems on the new VLE apparatus. Then measurements on the ternary mixture of R32/125/134a will be initiated. Finally, the R143a/134a and R125/143a systems will be measured in the new apparatus. We will also repeat some low temperature measurements on the R32/143a and R125/290 systems to verify the data we have already taken on these systems.

Primary mixture data for a ternary mixture of relatively volatile components (R32/125/134a)

The gas chromatograph calibration for this ternary system is similar to that required for the constituent binaries. For this system, three standard reference ternary mixtures, in addition to the six standard reference binary mixtures of the constituent binaries, will be used for the calibration procedure. These standard reference mixtures have been prepared. We have measured the bubble point pressures and liquid densities for a ternary mixture of 0.346 HFC-32 + 0.300 HFC-125 + 0.354 HFC-134a (mole fractions) from 244 to 346 K (-20 to 163°F) for a project supported by ICI. These data will be included in our analysis of the ternary system. The Annex 18 database has provided data for this system from other sources. In the previous section some results for this system are discussed. VLE and coexisting density measurements on this system will be carried out with the new apparatus.

Primary mixture data for a binary mixture of very low boiling components (R41/744)

As mentioned in the previous report, this system will be measured in a low temperature VLE apparatus that was recently used for measurements on mixtures of oxygen, nitrogen, and argon. This apparatus does not measure coexisting densities, but operates at much lower temperatures; has a vapor recirculation loop and measures the dew- and bubble-point pressures and the vapor and liquid compositions; and can operate at temperatures from 70 to 300 K (-334 to 80°F). A new column will be installed in the gas chromatograph (GC) to separate the peaks for this system. We have high purity R744 available. A pure sample of HFC-41 has finally been obtained after extensive communications with prospective vendors. Standard reference mixtures will be prepared for the GC calibration.

Comprehensive data for the R143a/125 mixture

An isochoric PVT apparatus has been used to measure the density of 0.50004 HFC-143a + 0.49996 HFC-125 (mole fraction) at 281 points in the temperature range from 200 to 400 K (-100 to 260°F) with pressures up to 35 MPa (5100 psi). The measurements were carried out on a total of 15 runs at different filling densities. Depending on the steepness of each PVT isochore and the proximity of the pressure measurement to the saturation curve, temperature spacing was varied from 1 to 4 K (1.8 to 7.2°F). These data are in the dense liquid and compressed gas phases. The pressures, temperatures, and densities are presented in Tables 17 and 18, and the locations of the measurements are shown in Figure 16. During the next quarter, C_p measurements will be carried out on this mixture composition.

Primary data for a very low-boiling fluid (HFC-41)

A high purity sample of HFC-41 has been obtained during this reporting period. The sample quantity obtained is sufficient (approximately 4 kg (9 lb)) to carry out the various proposed measurements of its thermophysical properties. To confirm the expected high purity, small volumes were withdrawn for analysis by a battery of gas chromatographic - mass spectrometric methods. Four methods were selected to give special emphasis to finding the presence of diethyl ether, organic substances, halocarbon substances, heavy contaminants, air, and water. No diethyl ether, light organic, or halocarbon impurities were found. In the vapor phase we found a quantity of air which is removable by freezing/thawing cycles under vacuum.

A trace (< 1 ppm) amount of dodecane was the only heavy contaminant found in the liquid phase. These analyses have revealed the high purity (0.999 + mole fraction) of our sample.

We have completed coexisting density and vapor pressure measurements for pure HFC-41. The data were taken at temperatures from 275 to 315 K (35 to 107°F). These data are being analyzed and will be used for critical parameter predictions using a technique developed by Van Poolen (submitted to Fluid Phase Equilibria). These experimental data and critical point parameter predictions will be compared to all data available for this system. Other property measurements on HFC-41 will be initiated during the next quarter.

COMPLIANCE WITH AGREEMENT

NIST has complied with all terms of the grant agreement modulo small shifts in the estimated level of effort from one property and/or fluid to another.

PRINCIPAL INVESTIGATOR EFFORT

Dr. W.M. Haynes is the NIST Principal Investigator for the MCLR program. During the second quarter of calendar year 1995, Dr. Haynes devoted approximately one week to planning this project, monitoring and reviewing the research, and preparing the report. The project involves multiple researchers and capabilities in Boulder, CO.

Figure 1: Comparison of bubble point pressures for the R32/125/134a system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 2: Comparison of vapor compositions for the R32/125/134a system; the baseline is an extended corresponding states (ECS) model.

Figure 3: Comparison of bubble point pressures for the R32/134a system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 4: Comparison of liquid densities for the R32/134a system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 5: Comparison of vapor densities for the R32/134a system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 6: Comparison of vapor compositions for the R32/134a system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 7: Comparison of compositions for the R32/134a system; the baseline is an extended corresponding states (ECS) model from REFPROP, and temperature and pressure are the independent variables.

Figure 8: Comparison of bubble point pressures for the R32/125 system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 9: Comparison of liquid densities for the R32/125 system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 10: Comparison of vapor densities for the R32/125 system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 11: Comparison of vapor compositions for the R32/125 system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure 12: Comparison of compositions for the R32/125 system; the baseline is an extended corresponding states (ECS) model from REFPROP, and temperature and pressure are the independent variables.

Figure 13: Comparison of bubble point pressures for the R134a/290 system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure14: Comparison of vapor compositions for the R134a/290 system; the baseline is an extended corresponding states (ECS) model from REFPROP.

Figure15: Comparison of compositions for the R134a/290 system; the baseline is an extended corresponding states (ECS) model from REFPROP, and temperature and pressure are the independent variables.

Figure 16: Locus of PVT data for 0.50004 HFC-143a + 0.49996 HFC-125 mixture.

APPENDIX A:
TABLES OF THERMOPHYSICAL PROPERTIES DATA

Table 1. Heats of Vaporization and Phase Envelope Widths (Vapor composition-Liquid composition) for Refrigerant and Hydrocarbon Mixtures at 298 K (77°F)).

Mixture	Liquid Composition Mass Fraction	Heat of Vaporization kJ/kg	Phase Envelope Width Mass Fraction
R32/134a	0.5/0.5	262	0.173
R32/125	0.5/0.5	196	0.027
R125/134a	0.5/0.5	147	0.138
R32/125/134a	0.2/0.4/0.4	185	0.074/0.066
R32/290	0.5/0.5	292	0.111
R125/290	0.5/0.5	196	0.071
R134a/290	0.5/0.5	223	0.040
R32/143a	0.5/0.5	225	0.044
R143a/134a	0.5/0.5	131	0.122
R125/143a	0.5/0.5	143	0.010
Propane/n-Butane	0.5/0.5	300	0.263
n-Butane/n-Pentane	0.5/0.5	326	0.270

Table 2. Vapor-Liquid Equilibria Data for R32/134a Mixtures from 279 to 352 K (43 to 206°F). (* Indicates vapor compositions that need verification)

	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction
A-3	0	280.39	0.3791	0	0	45.0	55.0	0
	0.216	280.03	0.5234	0.454*	0.123	44.4	75.9	0.298*
	0.366	279.76	0.6212	0.600*	0.227	43.9	90.1	0.433*
	0.519	279.85	0.6980	0.782*	0.355	44.1	101.2	0.647*
	0.752	279.72	0.8474	0.910*	0.607	43.8	122.9	0.838*
	1	280.00	1.0061	1	1	44.3	145.9	1
	0	294.69	0.5962	0	0	70.8	86.5	0
	0.214	294.10	0.7911	0.419*	0.122	69.7	114.7	0.269*
	0.566	294.67	1.0901	0.736*	0.399	70.7	158.1	0.587*
	0.639	294.15	1.1838	0.831*	0.474	69.8	171.7	0.715*
	0.731	294.29	1.2826	0.874*	0.581	70.0	186.0	0.780*
	0.807	294.11	1.3805		0.681	69.7	200.2	0.868*
	1	295.48	1.5748	1	1	72.2	228.4	1
	0	309.31	0.9130	0	0	97.1	132.4	0
	0.161	309.35	1.1161		0.089	97.2	161.9	
	0.214	309.22	1.1917	0.379*	0.122	96.9	172.8	0.237*
	0.291	309.33	1.2609		0.173	97.1	182.9	
	0.498	309.38	1.5359	0.668*	0.336	97.2	222.8	0.506*
	0.571	309.32	1.6370	0.728*	0.404	97.1	237.4	0.577*
	0.789	309.79	1.9418	0.893*	0.656	98.0	281.6	0.727*
	0.873	309.36	2.0846	0.936*	0.778	97.2	302.3	0.882*
	1	309.99	2.2940	1	1	98.3	332.7	1
	0	324.50	1.3670	0	0	124.4	198.3	0
	0.130	324.53	1.5871	0.220	0.071	124.5	230.2	0.126
	0.236	325.10	1.8025	0.373	0.136	125.5	261.4	0.233
	0.387	325.22	2.0438	0.527	0.244	125.7	296.4	0.362
	0.658	325.17	2.5599	0.765	0.495	125.6	371.3	0.624
	0.815	325.12	2.8702	0.879	0.692	125.5	416.3	0.787
	0.923	325.14	3.1150	0.956	0.859	125.6	451.8	0.917
	1	324.99	3.2791	1	1	125.3	475.6	1
	0	340.16	1.9863	0	0	152.6	288.1	0
	0.140	340.06	2.3016	0.227	0.077	152.4	333.8	0.130

Table 2. Vapor-Liquid Equilibria Data for R32/134a Mixtures from 280 to 370 K (44 to 206°F). (* indicates vapor compositions that need verification) (continued)

A-4	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction
	0.241	340.00	2.5290	0.352	0.139	152.3	366.8	0.217
	0.461	339.86	3.0168	0.577	0.304	152.1	437.6	0.410
	0.592	339.97	3.3471	0.693	0.425	152.3	485.5	0.535
	0.760	339.89	3.8139	0.838	0.618	152.1	553.2	0.725
	0.924	339.90	4.2883	0.947	0.861	152.2	622.0	0.901
	1	339.98	4.5611	1	1	152.3	661.5	1
	0	355.02	2.7471	0	0	179.4	398.4	0
	0.214	354.64	3.3142	0.282	0.122	178.7	480.7	0.167
	0.262	354.81	3.4585	0.340	0.153	179.0	501.6	0.208
	0.541	354.69	4.4486	0.643	0.375	178.8	645.2	0.479
	0.541	354.69	4.4528	0.643	0.375	178.8	645.8	0.479
	0.662	354.72	5.1083	0.799	0.500	178.8	740.9	0.670
	0.717	354.93	5.3146	0.831	0.564	179.2	770.8	0.715
	0	359.85	3.0665	0	0	188.1	444.8	0
	0.192	359.92	3.5563	0.410	0.108	188.2	515.8	0.139
	0.243	359.70	3.7289	0.120	0.141	187.8	540.8	0.188
	0.358	359.70	4.0918	0.300	0.221	187.8	593.5	0.278
	0	364.68	3.3856	0	0	196.8	491.0	0
	0.226	365.14	4.1254	0.286	0.130	197.6	598.3	0.170
	0.376	365.02	4.7244	0.452	0.235	197.4	685.2	0.296
	0.586	365.17	5.4938	0.591	0.419	197.6	796.8	0.424
	0	369.94	3.7667	0	0	206.2	546.3	0
	0.085	369.77	4.0862	0.139	0.045	205.9	592.7	0.076
	0.247	369.73	4.5524	0.251	0.143	205.8	660.3	0.146

Table 3. Near-Saturation Liquid Densities for R32/134a Mixtures from 279 to 370 K (43 to 206°F).

	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³		x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
A-5	0	280.39	0.3791	1268.5		0	45.0	55.0	79.12
	0.216	279.63	0.5234	1234.7		0.123	43.7	75.9	77.01
	0.366	279.40	0.6212	1197.5		0.227	43.2	90.1	74.69
	0.519	279.45	0.6980	1169.8		0.355	43.3	101.2	72.96
	0.752	279.42	0.8474	1108.9		0.607	43.3	122.9	69.16
	1	280.00	1.0061	1029.5		1	44.3	145.9	64.21
	0	294.69	0.0596	1217.7		0	70.8	8.6	75.95
	0.214	293.49	0.7911	1180.6		0.122	68.6	114.7	73.64
	0.566	293.03	1.0901	1106.8		0.399	67.8	158.1	69.03
	0.639	292.87	1.1838	1088.3		0.474	67.5	171.7	67.88
	0.731	291.67	1.2826	1060.3		0.581	65.3	186.0	66.13
	0.807	292.92	1.3805	1036.9		0.681	67.6	200.2	64.67
	1	295.48	1.5748	971.2		1	72.2	228.4	60.58
	0	309.31	0.9130	1161.7		0	97.1	132.4	72.46
	0.161	309.54	1.1161	1130.6		0.089	97.5	161.9	70.52
	0.214	308.45	1.1917	1124.7		0.122	95.5	172.8	70.15
	0.291	309.54	1.2609	1111.0		0.173	97.5	182.9	69.30
	0.498	309.61	1.5359	1062.8		0.336	97.6	222.8	66.29
	0.571	309.59	1.6370	1045.8		0.404	97.6	237.4	65.23
	0.789	309.69	1.9418	987.3		0.656	97.8	281.6	61.58
	0.873	309.33	2.0846	958.7		0.778	97.1	302.3	59.80
	1	309.99	2.2940	908.4		1	98.3	332.7	56.66
	0	324.50	1.3670	1094.9		0	124.4	198.3	68.29
	0.130	324.62	1.5871	1070.3		0.071	124.7	230.2	66.76
	0.236	325.14	1.8025	1040.6		0.136	125.6	261.4	64.90
	0.387	325.25	2.0438	1014.0		0.244	125.8	296.4	63.25
	0.658	325.22	2.5599	944.2		0.495	125.7	371.3	58.89
	0.815	325.20	2.8702	900.4		0.692	125.7	416.3	56.16
	0.928	325.17	3.1150	858.0		0.859	125.6	451.8	53.52
	1	324.99	3.2791	829.1		1	125.3	475.6	51.71
	0	340.16	1.9863	1013.2		0	152.6	288.1	63.20
	0.140	339.77	2.3016	983.2		0.077	151.9	333.8	61.32
	0.241	340.05	2.5290	963.6		0.139	152.4	366.8	60.10

Table 3. Near-Saturation Liquid Densities for R32/134a Mixtures from 279 to 370 K (43 to 206°F). (continued)

A-6	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0.461	339.67	3.0168	910.8	0.304	151.7	437.6	56.81
	0.592	339.68	3.3471	867.3	0.425	151.8	485.5	54.10
	0.760	339.65	3.8139	816.0	0.618	151.7	553.2	50.90
	0.924	339.82	4.2883	754.4	0.861	152.0	622.0	47.05
	1	339.98	4.5611	718.7	1	152.3	661.5	44.83
	0	355.02	2.7471	914.4	0	179.4	398.4	57.03
	0.214	354.51	3.3142	862.1	0.122	178.4	480.7	53.77
	0.262	354.51	3.4585	850.3	0.153	178.4	501.6	53.03
	0.541	354.51	4.4486	753.8	0.375	178.4	645.2	47.02
	0.541	354.51	4.4528	754.1	0.375	178.4	645.8	47.03
	0.662	354.46	5.1083	700.5	0.500	178.4	740.9	43.69
	0.717	354.67	5.3146	674.8	0.564	178.7	770.8	42.09
	0	359.85	3.0665	870.3	0	188.1	444.8	54.28
	0.192	359.54	3.5563	826.8	0.108	187.5	515.8	51.57
	0.243	359.39	3.7289	815.9	0.141	187.2	540.8	50.89
	0.358	359.31	4.0918	772.5	0.221	187.1	593.5	48.18
	0	364.68	3.3856	818.5	0	196.8	491.0	51.05
	0.226	364.73	4.1254	751.1	0.130	196.8	598.3	46.85
	0.376	364.68	4.7244	686.1	0.235	196.8	685.2	42.79
	0.586	364.68	5.4938	566.6	0.419	196.8	796.8	35.34
	0	369.94	3.7667	743.6	0	206.2	546.3	46.38
	0.085	369.40	4.0862	735.6	0.045	205.2	592.7	45.88
	0.247	369.34	4.5524	671.8	0.143	205.1	660.3	41.90

Table 4. Near-Saturation Vapor Densities for R32/134a Mixtures from 280 to 370 K (44 to 206 °F).

A-7	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction	Vapor Density lb/ft ³
	280.39	0.3791	0	18.2	45.0	55.0	0	1.14
	280.11	0.5234	0.454	19.4	44.5	75.9	0.298	1.21
	279.93	0.6212	0.600	21.3	44.2	90.1	0.433	1.33
	279.96	0.6980	0.782	22.5	44.3	101.2	0.647	1.40
	279.78	0.8474	0.910	25.0	43.9	122.9	0.838	1.56
	280.00	1.0061	1	27.4	44.3	145.9	1	1.71
	294.69	0.5962	0	29.0	70.8	86.5	0	1.81
	294.10	0.7911	0.419	31.5	69.7	114.7	0.269	1.96
	294.72	1.0901	0.736	36.5	70.8	158.1	0.587	2.28
	294.72	1.1838	0.831	37.7	70.8	171.7	0.715	2.35
	294.92	1.2826	0.874	39.4	71.2	186.0	0.780	2.46
	295.48	1.5748	1	44.6	72.2	228.4	0.868	2.78
	309.31	0.9130	0	45.3	97.1	132.4	0	2.83
	309.36	1.1917	0.379	49.3	97.2	172.8	0.237	3.08
	309.52	1.5359	0.668	55.9	97.5	222.8	0.506	3.49
	309.39	1.6370	0.728	57.4	97.2	237.4	0.577	3.58
	310.27	1.9418	0.893	62.1	98.8	281.6	0.727	3.87
	309.47	2.0846	0.936	64.5	97.4	302.3	0.882	4.02
	309.99	2.2940	1	66.6	98.3	332.7	1	4.15
	324.50	1.3670	0	71.3	124.4	198.3	0	4.45
	324.67	1.5871	0.220	74.6	124.7	230.2	0.126	4.65
	325.43	1.8025	0.373	79.7	126.1	261.4	0.233	4.97
	325.48	2.0438	0.527	84.1	126.2	296.4	0.362	5.25
	325.48	2.5599	0.765	93.9	126.2	371.3	0.624	5.86
	325.45	2.8702	0.879	99.7	126.1	416.3	0.787	6.22
	325.35	3.1150	0.956	103.4	126.0	451.8	0.917	6.45
	324.99	3.2791	1	103.6	125.3	475.6	1	6.46
	340.16	1.9863	0	109.7	152.6	288.1	0	6.84
	340.30	2.3016	0.227	114.3	152.9	333.8	0.130	7.13
	340.01	2.5290	0.352	119.5	152.3	366.8	0.217	7.45
	340.17	3.0168	0.577	130.2	152.6	437.6	0.410	8.12
	340.08	3.3471	0.693	139.0	152.5	485.5	0.535	8.67
	340.04	3.8139	0.838	151.0	152.4	553.2	0.725	9.42

Table 4. Near-Saturation Vapor Densities for R32/134a Mixtures from 280 to 370 K (44 to 206 °F). (continued)

A-8	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction	Vapor Density lb/ft ³
	340.08	4.2883	0.947	165.9	152.5	622.0	0.901	10.35
	339.98	4.5611	1	170.1	152.3	661.5	1	10.61
	355.02	2.7471	0	168.5	179.4	398.4	0	10.51
	355.00	3.3142	0.282	183.1	179.3	480.7	0.167	11.42
	355.10	3.4585	0.340	188.8	179.5	501.6	0.208	11.78
	355.00	4.4486	0.643	231.2	179.3	645.2	0.479	14.42
	355.00	4.5280	0.643	230.7	179.3	656.7	0.479	14.39
	354.89	5.1083	0.799	275.9	179.1	740.9	0.670	17.21
	355.10	5.3146	0.831	301.9	179.5	770.8	0.715	18.83
	359.85	3.0665	0	192.7	188.1	444.8	0	12.02
	360.17	3.5563	0.241	214.6	188.6	515.8	0.139	13.39
	359.85	3.7289	0.312	216.2	188.1	540.8	0.188	13.48
	359.67	4.0918	0.430	235.5	187.7	593.5	0.278	14.69
	364.68	3.3856	0	235.3	196.8	491.0	0	14.68
	365.35	4.1254	0.286	275.4	198.0	598.3	0.170	17.18
	365.27	4.7244	0.452	331.0	197.8	685.2	0.296	20.65
	365.33	5.9380	0.591	536.7	197.9	861.2	0.419	33.48
	369.94	3.7667	0	305.1	206.2	546.3	0	19.03
	370.00	4.0862	0.139	322.5	206.3	592.7	0.072	20.11
	369.94	4.5524	0.251	520.3	206.2	660.3	0.143	32.45

Table 5. Vapor-Liquid Equilibria Data for R32/125 Mixtures from 280 to 352 K (43 to 173°F). (* Indicates vapor compositions that need verification)

x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction
0	280.29	0.8302	0	0	44.9	120.4	0
0.250	279.89	0.8956	0.335*	0.126	44.1	129.9	0.179*
0.494	279.52	0.9459	0.520*	0.297	43.5	137.2	0.319*
0.797	280.02	1.0116	0.831*	0.630	44.4	146.7	0.681*
0.875	280.01	1.0185	0.908*	0.752	44.3	147.7	0.811*
0.956	279.59	1.0130	0.946	0.904	43.6	146.9	0.884
1	280.00	1.0076	1	1	44.3	146.1	1
0	295.23	1.2720	0	0	71.7	184.5	0
0.237	294.35	1.3483	0.324*	0.119	70.2	195.6	0.172*
0.460	294.08	1.4293	0.570*	0.270	69.7	207.3	0.365*
0.801	293.98	1.5001	0.809*	0.636	69.5	217.6	0.647*
0.801	293.89	1.5000	0.824*	0.636	69.3	217.6	0.670*
0.890	293.92	1.5173	0.875*	0.778	69.4	220.1	0.752*
0.947	293.95	1.5248	0.945	0.886	69.4	221.2	0.882
1	293.99	1.5152	1	1	69.5	219.8	1
0	310.61	1.8904	0	0	99.4	274.2	0
0.270	309.81	2.0086	0.333*	0.138	98.0	291.3	0.178*
0.509	310.95	2.2266	0.564*	0.310	100.0	322.9	0.359*
0.745	310.49	2.2991	0.793*	0.559	99.2	333.5	0.624*
0.803	310.66	2.3219	0.847*	0.639	99.5	336.8	0.706*
0.873	309.84	2.2955	0.881*	0.749	98.0	332.9	0.762*
0.916	310.03	2.3018	0.910	0.825	98.4	333.9	0.814
0.952	309.95	2.3077	0.940	0.896	98.2	334.7	0.872
1	310.51	2.3288	1	1	99.2	337.8	1
0	324.89	2.6390	0	0	125.1	382.8	0
0.323	324.98	2.9688	0.396	0.171	125.3	430.6	0.221
0.456	325.59	3.1280	0.551	0.266	126.4	453.7	0.347
0.755	325.36	3.2704	0.780	0.572	126.0	474.3	0.606
0.804	325.80	3.3027	0.816	0.640	126.8	479.0	0.658
0.867	325.53	3.3238	0.870	0.739	126.3	482.1	0.744
0.916	325.47	3.3148	0.915	0.825	126.2	480.8	0.823
1	325.49	3.3179	1	1	126.2	481.2	1
0	339.38	3.6291	0	0	151.2	526.4	0

Table 5. Vapor-Liquid Equilibria Data for R32/125 Mixtures from 280 to 352 K (43 to 173 °F). (* Indicates vapor compositions that need verification) (continued)

x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction
0.312	339.70	4.0556	0.392	0.164	151.8	588.2	0.218
0.485	340.17	4.3077	0.570	0.290	152.6	624.8	0.365
0.744	340.72	4.5808	0.796	0.557	153.6	664.4	0.628
0.873	340.44	4.6058	0.876	0.749	153.1	668.0	0.754
0.898	340.19	4.5947	0.898	0.792	152.7	666.4	0.792
0.916	340.12	4.5977	0.913	0.825	152.6	666.8	0.820
1	340.08	4.5717	1	1	152.5	663.1	1
0.426	343.20	4.5638	0.476	0.243	158.1	661.9	0.282
0.746	343.81	4.8966	0.797	0.560	159.2	710.2	0.630
0.874	343.33	4.9014	0.873	0.750	158.3	710.9	0.749
0.900	343.25	4.9048	0.898	0.796	158.2	711.4	0.792
1	343.28	4.8904	1	1	158.2	709.3	1
0.745	346.64	5.2032	0.788	0.559	164.3	754.7	0.617
0.828	346.63	5.2352	0.828	0.676	164.3	759.3	0.676
0.914	346.27	5.2326	0.902	0.822	163.6	758.9	0.800
0.870	346.26	5.2171	0.874	0.744	163.6	756.7	0.750
1	346.13	5.1922	1	1	163.4	753.1	1
0.870	349.32	5.4924	0.872	0.744	169.1	796.6	0.747
0.910	349.14	5.5548	0.899	0.814	168.8	805.7	0.794
1	349.18	5.5388	1	1	168.9	803.3	1
1	351.54	5.8302	1	1	173.1	845.6	1

Table 6. Near-Saturation Liquid Densities for R32/125 Mixtures from 279 to 352 K (43 to 173°F).

A-11	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0	280.29	0.8302	1284.2	0	44.9	120.4	80.10
	0.250	279.24	0.8956	1245.9	0.126	43.0	129.9	77.71
	0.494	279.19	0.9459	1203.2	0.297	42.9	137.2	75.05
	0.797	279.55	1.0116	1114.2	0.630	43.5	146.7	69.49
	0.875	279.60	1.0185	1092.3	0.752	43.6	147.7	68.13
	0.956	279.01	1.0130	1060.9	0.904	42.5	146.9	66.17
	1	280.00	1.0076	1003.0	1	44.3	146.1	62.56
	0	295.23	1.2720	1206.6	0	71.7	184.5	75.26
	0.237	293.75	1.3483	1174.8	0.119	69.1	195.6	73.27
	0.460	293.54	1.4293	1137.0	0.270	68.7	207.3	70.92
	0.801	293.34	1.5001	1057.0	0.636	68.3	217.6	65.93
	0.801	293.18	1.5000	1055.3	0.636	68.1	217.6	65.82
	0.890	293.26	1.5173	1030.6	0.778	68.2	220.1	64.28
	0.947	293.46	1.5248	1003.7	0.886	68.6	221.2	62.60
	1	293.99	1.5152	980.5	1	69.5	219.8	61.16
	0	310.61	1.8904	1107.8	0	99.4	274.2	69.10
	0.270	309.82	2.0086	1083.6	0.138	98.0	291.3	67.59
	0.509	310.88	2.2266	1032.2	0.310	99.9	322.9	64.38
	0.745	310.49	2.2991	980.8	0.559	99.2	333.5	61.17
	0.803	310.65	2.3219	969.5	0.639	99.5	336.8	60.47
	0.873	309.56	2.2955	954.6	0.749	97.5	332.9	59.54
	0.916	309.72	2.3018	941.1	0.825	97.8	333.9	58.70
	0.952	309.51	2.3077	927.7	0.896	97.5	334.7	57.86
	1	310.51	2.2388	905.9	1	99.2	324.7	56.50
	0	324.89	2.6390	984.4	0	125.1	382.8	61.40
	0.323	324.96	2.9688	950.3	0.171	125.3	430.6	59.27
	0.456	325.46	3.1280	925.7	0.266	126.2	453.7	57.74
	0.755	325.38	3.2704	883.0	0.572	126.0	474.3	55.07
	0.804	325.53	3.3027	870.6	0.640	126.3	479.0	54.30
	0.867	325.35	3.3238	859.8	0.739	126.0	482.1	53.63
	0.916	325.33	3.3148	851.6	0.825	125.9	480.8	53.12
	1	325.49	3.3179	828.5	1	126.2	481.2	51.68
	0	339.38	3.6291	571.9	0	151.2	526.4	35.67

Table 6. Near-Saturation Liquid Densities for R32/125 Mixtures from 279 to 352 K (43 to 173°F). (continued)

A-12	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0.312	339.68	4.0556	697.5	0.164	151.8	588.2	43.50
	0.485	339.95	4.3077	724.2	0.290	152.2	624.8	45.17
	0.744	340.32	4.5808	723.6	0.557	152.9	664.4	45.13
	0.873	340.27	4.6058	722.0	0.749	152.8	668.0	45.03
	0.898	339.98	4.5940	724.5	0.792	152.3	666.4	45.19
	0.916	339.98	4.5977	723.9	0.825	152.3	666.8	45.15
	1	340.08	4.5717	715.7	1	152.5	663.1	44.64
	0.426	342.98	4.5638	652.8	0.243	157.7	661.9	40.72
	0.746	343.32	4.8966	673.8	0.560	158.3	710.2	42.03
	0.874	343.16	4.9014	680.5	0.750	158.0	710.9	42.44
	0.900	343.00	4.9048	679.9	0.796	157.7	711.4	42.41
	1	343.28	4.8904	684.4	1	158.2	709.3	42.69
	0.745	346.20	5.2032	613.2	0.559	163.5	754.7	38.25
	0.828	346.20	5.2352	618.4	0.676	163.5	759.3	38.57
	0.914	345.99	5.2326	637.3	0.822	163.1	758.9	39.75
	0.870	346.04	5.2171	627.4	0.744	163.2	756.7	39.13
	1	346.13	5.1922	643.9	1	163.4	753.1	40.16
	0.870	349.00	5.4924	556.3	0.744	168.5	796.6	34.70
	0.910	348.84	5.5548	573.1	0.814	168.2	805.7	35.75
	1	349.18	5.5388	589.1	1	168.9	803.3	36.74
	1	351.54	5.8302	428.5	1	173.1	845.6	26.73

Table 7. Near-Saturation Vapor Densities for R32/125 Mixtures from 280 to 352 K (44 to 173°F).

A-13	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction	Vapor Density lb/ft ³
	280.29	0.8302	0	52.2	44.9	120.4	0	3.26
	280.44	0.8956	0.335	46.1	45.1	129.9	0.179	2.88
	279.73	0.9459	0.520	41.5	43.8	137.2	0.319	2.59
	280.37	1.0116	0.831	34.9	45.0	146.7	0.681	2.18
	280.39	1.0185	0.908	31.7	45.0	147.7	0.811	1.98
	280.09	1.0130	0.946	30.4	44.5	146.9	0.884	1.90
	280.00	1.0076	1	27.4	44.3	146.1	1	1.71
	295.23	1.2720	0	84.7	71.7	184.5	0	5.28
	295.03	1.3483	0.324	72.9	71.4	195.6	0.172	4.55
	295.92	1.4293	0.570	63.9	73.0	207.3	0.365	3.99
	294.49	1.5001	0.809	53.6	70.4	217.6	0.647	3.34
	294.31	1.5173	0.875	49.8	70.1	220.1	0.752	3.11
	294.72	1.5248	0.945	46.5	70.8	221.2	0.882	2.90
	293.99	1.5152	1	41.1	69.5	219.8	1	2.56
	310.61	1.8904	0	133.3	99.4	274.2	0	8.31
	310.35	2.0089	0.333	116.2	99.0	291.4	0.178	7.25
	311.31	2.2266	0.564	108.6	100.7	322.9	0.359	6.77
	311.10	2.2991	0.793	89.4	100.3	333.5	0.624	5.58
	311.33	2.3219	0.847	84.6	100.7	336.8	0.706	5.28
	310.53	2.2955	0.881	80.7	99.3	332.9	0.762	5.03
	310.81	2.3018	0.910	76.6	99.8	333.9	0.814	4.78
	310.68	2.3077	0.940	71.7	99.6	334.7	0.872	4.47
	310.51	2.3288	1	68.6	99.2	337.8	1	4.28
	324.89	2.6390	0	213.2	125.1	382.8	0	13.30
	325.56	2.9688	0.396	183.6	126.3	430.6	0.221	11.45
	326.03	3.1280	0.551	171.4	127.2	453.7	0.347	10.69
	326.10	3.2704	0.780	143.0	127.3	474.3	0.606	8.92
	326.21	3.3027	0.816	138.9	127.5	479.0	0.658	8.66
	326.10	3.3238	0.870	130.1	127.3	482.1	0.744	8.11
	326.08	3.3148	0.915	121.9	127.3	480.8	0.823	7.60
	325.49	3.3179	1	104.2	126.2	481.2	1	6.50
	339.38	3.6291	0	571.9	151.2	526.4	0	35.67
	340.27	4.0556	0.392	318.4	152.8	588.2	0.218	19.86

Table 7. Near-Saturation Vapor Densities for R32/125 Mixtures from 280 to 352 K (44 to 173°F). (continued)

Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction	Vapor Density lb/ft ³
340.65	4.3077	0.570	299.0	153.5	624.8	0.365	18.65
341.11	4.5808	0.796	263.9	154.3	664.4	0.628	16.46
341.14	4.6058	0.876	221.1	154.4	668.0	0.754	13.79
340.80	4.5947	0.898	213.3	153.8	666.4	0.792	13.30
340.80	4.5977	0.913	197.8	153.8	666.8	0.820	12.34
340.08	4.5717	1	172.8	152.5	663.1	1	10.78
343.72	4.5638	0.476	440.1	159.0	661.9	0.282	27.45
344.11	4.8966	0.797	326.4	159.7	710.2	0.630	20.36
343.98	4.9014	0.873	265.9	159.5	710.9	0.749	16.58
343.88	4.9048	0.898	250.2	159.3	711.4	0.792	15.61
343.28	4.8904	1	196.6	158.2	709.3	1	12.26
347.02	5.2032	0.788	421.4	165.0	754.7	0.617	26.28
347.05	5.2352	0.828	400.3	165.0	759.3	0.676	24.97
346.84	5.2326	0.902	297.1	164.6	758.9	0.800	18.53
346.89	5.2171	0.874	320.6	164.7	756.7	0.750	20.00
349.90	5.4924	0.872	357.8	170.1	796.6	0.747	22.32
349.75	5.5548	0.899	382.2	169.9	805.7	0.794	23.84
349.18	5.5388	1	276.1	168.9	803.3	1	17.22
351.54	5.8302	1	428.5	173.1	845.6	1	26.73

Table 8. Vapor-Liquid Equilibria Data for R32/290 Mixtures from 280 to 365 K (44 to 197°F). (LL Indicates liquid-liquid immiscibility.)

x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction
0	280.00	0.5798	0	0	44.3	84.1	0
0.348	280.66	1.2545	0.655	0.386	45.5	182.0	0.691
0.366	280.25	1.2598	0.643	0.405	44.8	182.7	0.680
LL	280.32	1.2837	0.687	LL	44.9	186.2	0.721
LL	280.39	1.2928	0.687	LL	45.0	187.5	0.721
LL	280.37	1.2988	0.686	LL	45.0	188.4	0.720
0.843	280.26	1.2621	0.739	0.864	44.8	183.1	0.770
0.907	280.33	1.2424	0.770	0.920	44.9	180.2	0.798
0.935	280.31	1.2262	0.790	0.944	44.9	177.8	0.816
0.978	280.49	1.1349	0.890	0.981	45.2	164.6	0.905
0.978	280.42	1.1340	0.890	0.981	45.1	164.5	0.905
0.997	281.53	1.1196	0.910	0.997	47.1	162.4	0.923
0.997	281.44	1.1169	0.910	0.997	46.9	162.0	0.923
1	280.00	1.0059	1	1	44.3	145.9	1
0	294.80	0.8731	0	0	71.0	126.6	0
0.135	295.93	1.5334	0.437	0.156	73.0	222.4	0.478
0.337	294.46	1.7667	0.622	0.375	70.4	256.2	0.660
0.445	294.80	1.8464	1	0.486	71.0	267.8	1
LL	294.70	1.8825	0.700	LL	70.8	273.0	0.734
0.857	293.15	1.7775	0.778	0.876	68.0	257.8	0.805
0.857	293.01	1.7725	0.778	0.876	67.7	257.1	0.805
0.935	295.82	1.6809	0.869	0.944	72.8	243.8	0.887
1	295.48	1.5748	1	1	72.2	228.4	1
0	309.49	1.2593	0	0	97.4	182.6	0
0.112	310.81	1.9159	0.337	0.130	99.8	277.9	0.375
0.127	310.16	1.9374	0.347	0.146	98.6	281.0	0.385
0.306	310.24	2.4462	0.428	0.342	98.8	354.8	0.469
0.306	310.25	2.4483	0.428	0.342	98.8	355.1	0.469
0.667	310.08	2.7672	0.694	0.703	98.5	401.3	0.728
0.667	310.10	2.7674	0.694	0.703	98.5	401.4	0.728
0.707	310.79	2.7792	0.713	0.740	99.8	403.1	0.746
0.707	310.84	2.7808	0.713	0.740	99.8	403.3	0.746
0.833	310.32	2.7216	0.795	0.855	98.9	394.7	0.821

Table 8. Vapor-Liquid Equilibria Data for R32/290 Mixtures from 280 to 365 K (44 to 197°F). (LL indicates liquid-liquid immiscibility.) (continued)

x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction
0.930	309.83	2.5130	0.887	0.940	98.0	364.5	0.903
1	309.98	2.2939	1	1	98.3	332.7	1
0	324.69	1.7749	0	0	124.8	257.4	0
0.112	325.13	2.5487	0.290	0.130	125.6	369.7	0.325
0.341	325.07	3.3527	0.486	0.379	125.4	486.3	0.527
0.559	324.39	3.7244	0.604	0.599	124.2	540.2	0.643
0.808	324.76	3.7944	0.761	0.832	124.9	550.3	0.790
0.914	325.22	3.6340	0.860	0.926	125.7	527.1	0.879
0.914	325.23	3.6377	0.860	0.926	125.7	527.6	0.879
1	324.98	3.2791	1	1	125.3	475.6	1
0	341.17	2.4926	0	0	154.4	361.5	0
0.163	340.31	3.6602	0.302	0.187	152.9	530.9	0.338
0.163	340.31	3.6602	0.302	0.187	152.9	530.9	0.338
0.202	340.09	3.8843	1	0.230	152.5	563.4	1
0.224	340.33	4.0037	0.366	0.254	152.9	580.7	0.405
0.255	340.30	4.1667	0.397	0.288	152.9	604.3	0.437
0.255	340.31	4.1670	0.397	0.288	152.9	604.4	0.437
0.430	340.01	4.8108	1	0.471	152.4	697.7	1
0.517	339.61	5.1089	0.572	0.558	151.6	741.0	0.612
0.711	339.66	5.2394	0.730	0.744	151.7	759.9	0.761
0.873	339.62	5.1400	0.801	0.890	151.7	745.5	0.826
0.918	339.74	4.9526	0.876	0.930	151.9	718.3	0.893
0.918	339.76	4.9526	0.876	0.930	151.9	718.3	0.893
1	339.96	4.5609	1	1	152.3	661.5	1
0	354.40	3.2110	0	0	178.2	465.7	0
0.211	354.00	4.7874	0.275	0.240	177.5	694.4	0.309
0.091	354.56	3.8431	0.137	0.106	178.5	557.4	0.158
0	360.14	3.5660	0	0	188.6	517.2	0
0.072	359.89	4.2840	0.099	0.084	188.1	621.3	0.115
0.223	360.02	5.2367	0.232	0.253	188.4	759.5	0.263
0	365.03	3.1197	0	0	197.4	452.5	0
0.172	364.78	5.2738	0.182	0.197	196.9	764.9	0.208

Table 9. Near-Saturation Liquid Densities for R32/290 Mixtures from 278 to 365 K (42 to 197°F).

A-17	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0	280.00	0.5798	519.2	0	44.3	84.1	32.38
	0.348	279.63	1.2545	620.6	0.386	43.7	182.0	38.71
	0.366	279.01	1.2598	650.1	0.405	42.6	182.7	40.55
	0.843	278.55	1.2621	849.5	0.864	41.7	183.1	52.99
	0.907	278.52	1.2424	886.4	0.920	41.7	180.2	55.29
	0.935	278.47	1.2262	908.5	0.944	41.6	177.8	56.67
	0.978	279.32	1.1340	983.6	0.981	43.1	164.5	61.35
	0.978	279.52	1.1349	981.8	0.981	43.5	164.6	61.24
	0.997	279.60	1.1169	999.1	0.997	43.6	162.0	62.32
	0.997	279.65	1.1196	999.6	0.997	43.7	162.4	62.35
	1	280.00	1.0059	1029.0	1	44.3	145.9	64.18
	0	294.80	0.8731	497.5	0	71.0	126.6	31.03
	0.135	293.75	1.5334	532.8	0.486	69.1	222.4	33.23
	0.337	292.98	1.7667	590.6	0.677	67.7	256.2	36.84
	0.445	294.04	1.8464	615.6	0.796	69.6	267.8	38.39
	0.857	291.74	1.7725	855.7	0.156	65.5	257.1	53.37
	0.857	291.92	1.7775	855.4	0.375	65.8	257.8	53.35
	0.935	293.83	1.6809	900.7	0.944	69.2	243.8	56.18
	1	295.48	1.5748	971.2	1	72.2	228.4	60.58
	0	309.49	1.2593	473.7	0	97.4	182.6	29.55
	0.112	310.50	1.9159	488.9	0.146	99.2	277.9	30.49
	0.127	310.16	1.9374	492.4	0.342	98.6	281.0	30.71
	0.306	310.32	2.4483	529.5	0.342	98.9	355.1	33.03
	0.306	310.32	2.4462	529.7	0.656	98.9	354.8	33.04
	0.618	310.32	2.7100	596.4	0.703	98.9	393.1	37.20
	0.667	310.35	2.7674	628.1	0.703	99.0	401.4	39.18
	0.667	310.40	2.7672	628.1	0.740	99.1	401.3	39.18
	0.707	310.56	2.7808	658.8	0.740	99.3	403.3	41.09
	0.707	310.53	2.7792	658.8	0.855	99.3	403.1	41.09
	0.833	310.48	2.7216	753.4	0.940	99.2	394.7	46.99
	0.930	307.24	2.5130	848.3	0.130	93.4	364.5	52.91
	1	309.98	2.2939	908.4	1	98.3	332.7	56.66
	0	324.69	1.7749	445.7	0	124.8	257.4	27.80

Table 9. Near-Saturation Liquid Densities for R32/290 Mixtures from 278 to 365 K (42 to 197°F). (continued)

A-18	x(R32) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	xX(R32) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0.112	325.03	2.5487	458.7	0.130	125.4	369.7	28.61
	0.341	325.03	3.3527	489.7	0.379	125.4	486.3	30.54
	0.559	324.90	3.7244	540.4	0.599	125.2	540.2	33.70
	0.808	325.24	3.7944	650.6	0.832	125.8	550.3	40.58
	0.914	325.39	3.6340	734.6	0.926	126.0	527.1	45.82
	0.914	325.39	3.6377	734.3	0.926	126.0	527.6	45.80
	1	324.98	3.2791	829.1	1	125.3	475.6	51.71
	0	341.17	2.4926	408.8	0	154.4	361.5	25.50
	0.163	340.31	3.6602	421.0	0.187	152.9	530.9	26.26
	0.163	339.68	3.6602	421.0	0.187	151.8	530.9	26.26
	0.202	339.76	3.8843	421.7	0.230	151.9	563.4	26.30
	0.224	340.33	4.0037	423.3	0.254	152.9	580.7	26.40
	0.255	340.31	4.1670	423.2	0.288	152.9	604.4	26.39
	0.255	339.70	4.1667	423.1	0.288	151.8	604.3	26.39
	0.430	339.78	4.8108	430.1	0.471	151.9	697.7	26.83
	0.517	339.31	5.1089	441.2	0.558	151.1	741.0	27.52
	0.711	339.34	5.2394	474.7	0.744	151.1	759.9	29.61
	0.873	339.47	5.1400	551.5	0.890	151.4	745.5	34.40
	0.918	339.49	4.9526	618.8	0.930	151.4	718.3	38.59
	0.918	339.76	4.9526	618.6	0.930	151.9	718.3	38.58
	1	339.96	4.5609	718.7	1	152.3	661.5	44.83
	0	354.40	3.2110	369.0	0	178.2	465.7	23.02
	0.211	353.56	4.7874	326.2	0.240	176.7	694.4	20.35
	0.091	354.00	3.8431	366.5	0.106	177.5	557.4	22.86
	0	360.14	3.5660	345.2	0	188.6	517.2	21.53
	0.072	358.57	4.2840	348.9	0.084	185.8	621.3	21.76
	0.223	358.73	5.2367	300.6	0.253	186.0	759.5	18.75
	0	365.03	3.1197	317.2	0	197.4	452.5	19.78
	0.172	363.46	5.2738	272.0	0.197	194.6	764.9	16.97

Table 10. Near-Saturation Vapor Densities for R32/290 Mixtures from 280 to 366 K (44 to 198 °F).

A-19	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction	Vapor Density lb/ft ³
	280.00	0.5798	0	12.5	44.3	84.1	0	0.78
	280.39	1.2598	0.643	33.3	45.0	182.7	0.680	2.08
	280.93	1.2545	0.655	33.0	46.0	182.0	0.691	2.06
	280.91	1.2988	0.686	34.6	46.0	188.4	0.720	2.16
	280.67	1.2837	0.687	34.4	45.5	186.2	0.721	2.15
	280.91	1.2928	0.687	34.6	46.0	187.5	0.721	2.16
	280.16	1.2698	0.705	34.2	44.6	184.2	0.738	2.13
	280.55	1.2890	0.722	34.7	45.3	187.0	0.754	2.16
	280.83	1.2689	0.735	34.3	45.8	184.0	0.766	2.14
	280.19	1.2621	0.739	34.1	44.7	183.1	0.770	2.13
	280.42	1.2424	0.770	34.0	45.1	180.2	0.798	2.12
	280.39	1.2262	0.790		45.0	177.8	0.816	
	280.34	1.1340	0.890	31.0	44.9	164.5	0.900	1.93
	280.47	1.1349	0.890	31.2	45.2	164.6	0.905	1.95
	281.37	1.1169	0.910	28.1	46.8	162.0	0.923	1.75
	281.45	1.1196	0.910	28.1	46.9	162.4	0.923	1.75
	280.00	1.0059	1	27.4	44.3	145.9	1	1.71
	294.80	0.8731	0	19.2	71.0	126.6	0	1.20
	295.99	1.5334	0.437	38.1	73.1	222.4	0.478	2.37
	295.01	1.7667	0.622	47.0	71.3	256.2	0.660	2.93
	295.27	1.8793	0.692	51.7	71.8	272.6	0.726	3.22
	295.42	1.8825	0.700	52.4	72.1	273.0	0.734	3.27
	295.26	1.8838	0.703	52.4	71.8	273.2	0.736	3.27
	294.49	1.7725	0.778		70.4	257.1	0.805	
	294.49	1.7775	0.778		70.4	257.8	0.805	
	296.04	1.6809	0.869	50.5	73.2	243.8	0.887	3.15
	295.48	1.5748	1	44.6	72.2	228.4	1	2.78
	309.49	1.2593	0	28.1	97.4	182.6	0	1.75
	311.47	1.9159	0.337	46.8	101.0	277.9	0.375	2.92
	310.16	1.9374	0.347	47.6	98.6	281.0	0.385	2.97
	310.51	2.4462	0.428	66.6	99.3	354.8	0.469	4.15
	310.54	2.4483	0.428	66.9	99.3	355.1	0.469	4.17
	310.54	2.7100	0.637	78.9	99.3	393.1	0.674	4.92

Table 10. Near-Saturation Vapor Densities for R32/290 Mixtures from 280 to 366 K (44 to 198°F). (continued)

A-20	Temperature K	Pressure MPa	y(R32) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R32) Vapor Mass Fraction	Vapor Density lb/ft ³
	310.59	2.7674	0.694	82.5	99.4	401.4	0.728	5.15
	310.72	2.7672	0.694	82.2	99.6	401.3	0.728	5.13
	311.63	2.7808	0.713	82.0	101.3	403.3	0.746	5.12
	311.70	2.7792	0.713	81.8	101.4	403.1	0.746	5.10
	310.72	2.7216	0.795	81.3	99.6	394.7	0.821	5.07
	310.12	2.5130	0.887	73.0	98.6	364.5	0.903	4.55
	309.98	2.2939	1	66.6	98.3	332.7	1	4.15
	324.69	1.7749	0	40.9	124.8	257.4	0	2.55
	326.02	2.5487	0.290	64.2	127.2	369.7	0.325	4.00
	326.02	3.3527	0.486	97.6	127.2	486.3	0.527	6.09
	325.89	3.7244	0.604	119.5	126.9	540.2	0.643	7.46
	326.10	3.7944	0.761	126.1	127.3	550.3	0.790	7.87
	326.23	3.6340	0.860	118.1	127.5	527.1	0.879	7.37
	326.23	3.6377	0.860	118.1	127.5	527.6	0.879	7.37
	324.98	3.2791	1	103.6	125.3	475.6	1	6.46
	341.17	2.4926	0	61.0	154.4	361.5	0	3.80
	340.31	3.6602	0.302	105.2	152.9	530.9	0.338	6.56
	340.70	4.1667	0.302	103.2	153.6	604.3	0.338	6.44
	340.33	4.0037	0.366	122.7	152.9	580.7	0.405	7.65
	340.31	4.1670	0.397	128.6	152.9	604.4	0.437	8.02
	340.58	4.9526	0.397	128.7	153.4	718.3	0.437	8.03
	340.63	5.1089	0.572	222.4	153.5	741.0	0.612	13.87
	340.63	5.2394	0.730	237.9	153.5	759.9	0.761	14.84
	340.63	5.1400	0.801	217.8	153.5	745.5	0.826	13.58
	340.31	3.8843	0.876	198.5	152.9	563.4	0.893	12.38
	340.63	4.9526	0.876	198.5	153.5	718.3	0.893	12.38
	339.96	4.5609	1	170.1	152.3	661.5	1	10.61
	354.40	3.2110	0	87.0	178.2	465.7	0	5.43
	355.64	4.7874	0.137	113.3	180.5	694.4	0.158	7.07
	355.04	3.6602	0.275	178.9	179.4	530.9	0.309	11.16
	360.14	3.5660	0	104.6	188.6	517.2	0	6.52
	360.88	4.2840	0.232	225.7	189.9	621.3	0.263	14.08
	360.77	3.8431	0.099	161.8	189.7	557.4	0.115	10.09
	365.03	3.1197	0	127.4	197.4	452.5	0	7.95
	365.64	5.2367	0.182	221.5	198.5	759.5	0.208	13.82

Table 11. Vapor-Liquid Equilibria Data for R125/290 Mixtures from 280 to 364 K (44 to 196°F).

x(R125) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R125) Vapor Mole Fraction	x(R125) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R125) Vapor Mass Fraction
0	280.47	0.5902	0	0	45.2	85.6	0
0.204	280.83	0.9160	0.413	0.411	45.8	132.9	0.657
0.293	280.82	0.9788	0.511	0.530	45.8	142.0	0.740
0.293	280.87	0.9778	0.511	0.530	45.9	141.8	0.740
0.407	280.75	0.9952	0.562	0.651	45.7	144.3	0.777
0.434	280.74	1.0006	0.580	0.676	45.7	145.1	0.790
0.505	280.17	1.0022	0.624	0.735	44.6	145.4	0.819
0.505	280.82	1.0031	0.624	0.735	45.8	145.5	0.819
1	280.29	0.8302	1	1	44.9	120.4	1
0	294.80	0.8731	0	0	71.0	126.6	0
0.219	294.64	1.2988	0.389	0.433	70.7	188.4	0.634
0.219	294.74	1.3057	0.389	0.433	70.9	189.4	0.634
0.347	293.21	1.3328	0.478	0.591	68.1	193.3	0.714
0.347	293.92	1.3450	0.478	0.591	69.4	195.1	0.714
0.470	293.82	1.3979	0.520	0.707	69.2	202.7	0.747
0.568	293.23	1.4097	0.599	0.782	68.1	204.5	0.803
0.731	293.55	1.4348	0.609	0.881	68.7	208.1	0.809
1	295.23	1.2719	1	1	71.7	184.5	1
0	309.49	1.2593	0	0	97.4	182.6	0
0.263	310.74	1.8976	0.397	0.493	99.7	275.2	0.642
0.263	310.74	1.8969	0.397	0.493	99.7	275.1	0.642
0.294	310.83	1.9904	0.438	0.531	99.8	288.7	0.680
0.376	311.62	2.1058	0.470	0.621	101.2	305.4	0.707
0.376	311.82	2.1050	0.470	0.621	101.6	305.3	0.707
0.472	309.76	2.1013	0.548	0.709	97.9	304.8	0.767
0.529	309.83	2.0953	0.575	0.754	98.0	303.9	0.786
0.604	310.22	2.1401	0.620	0.806	98.7	310.4	0.816
1	310.61	1.8876	1	1	99.4	273.8	1
0	324.69	1.7749	0	0	124.8	257.4	0
0.263	324.85	2.5306	0.397	0.493	125.1	367.0	0.642
0.315	324.95	2.6308	0.423	0.556	125.2	381.6	0.666
0.483	325.61	2.9687	0.547	0.718	126.4	430.6	0.767

Table 11. Vapor-Liquid Equilibria Data for R125/290 Mixtures from 280 to 364 K (44 to 196°F). (continued)

x(R125) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R125) Vapor Mole Fraction	x(R125) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R125) Vapor Mass Fraction
0.574	325.61	3.0296	0.597	0.786	126.4	439.4	0.801
0.615	324.99	2.9781	0.603	0.813	125.3	431.9	0.805
0.730	324.60	2.9440	0.714	0.880	124.6	427.0	0.872
1	324.89	2.6364	1	1	125.1	382.4	1
0	341.17	2.4936	0	0	154.4	361.7	0
0.146	340.64	3.1476	0.225	0.318	153.5	456.5	0.441
0.243	340.57	3.4696	0.320	0.466	153.4	503.2	0.562
0.327	340.54	3.7372	0.391	0.569	153.3	542.0	0.636
0.501	340.55	4.0359	0.504	0.732	153.3	585.4	0.734
1	339.38	3.6290	1	1	151.2	526.3	1
0	347.99	2.8477	0	0	166.7	413.0	0
0.133	348.42	3.6146	0.198	0.295	167.5	524.3	0.402
0.166	348.54	3.6989	0.220	0.351	167.7	536.5	0.434
0.166	348.56	3.7004	0.220	0.351	167.7	536.7	0.434
0.353	348.40	4.3022	0.365	0.598	167.4	624.0	0.610
0	355.73	3.2967	0	0	180.6	478.1	0
0.098	356.42	3.8899	0.119	0.228	181.9	564.2	0.269
0.165	356.43	4.1753	0.188	0.350	181.9	605.6	0.387
0.165	356.43	4.1779	0.188	0.350	181.9	606.0	0.387
0	363.52	3.7920	0	0	194.7	550.0	0
0.003	363.78	3.8991	0.014	0.008	195.1	565.5	0.037
0.107	364.16	4.2993	0.126	0.246	195.8	623.6	0.282

Table 12. Near-Saturation Liquid Densities for R125/290 Mixtures from 280 to 364 K (44 to 195°F).

A-23	x(R125) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R125) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0	280.47	0.5902	518.0	0	45.2	85.6	32.31
	0.204	279.68	0.9160	675.3	0.411	43.8	132.9	42.12
	0.293	279.78	0.9788	790.2	0.530	43.9	142.0	49.29
	0.293	279.78	0.9778	793.7	0.530	43.9	141.8	49.50
	0.407	279.78	0.9952	861.3	0.651	43.9	144.3	53.72
	0.434	279.78	1.0006	883.6	0.676	43.9	145.1	55.11
	0.505	279.76	1.0031	896.3	0.735	43.9	145.5	55.90
	0.505	279.76	1.0022	897.6	0.735	43.9	145.4	55.98
	1	280.29	0.8302	1286.8	1	44.9	120.4	80.26
	0	294.80	0.8731	497.5	0	71.0	126.6	31.03
	0.219	293.24	1.2988	642.2	0.433	68.2	188.4	40.05
	0.219	293.37	1.3057	636.4	0.433	68.4	189.4	39.69
	0.347	292.70	1.3450	724.9	0.591	67.2	195.1	45.22
	0.347	292.16	1.3328	727.9	0.591	66.2	193.3	45.40
	0.470	293.52	1.3979	758.3	0.707	68.7	202.7	47.30
	0.568	292.72	1.4097	836.7	0.782	67.2	204.5	52.19
	0.731	293.19	1.4348	890.0	0.881	68.1	208.1	55.51
	1	295.23	1.2719	1208.1	1	71.7	184.5	75.35
	0	309.49	1.2593	473.7	0	97.4	182.6	29.55
	0.263	309.88	1.8976	613.9	0.493	98.1	275.2	38.29
	0.263	309.88	1.8969	614.1	0.493	98.1	275.1	38.30
	0.294	310.04	1.9904	643.7	0.531	98.4	288.7	40.15
	0.376	310.87	2.1058	675.9	0.621	99.9	305.4	42.16
	0.376	311.00	2.1050	675.3	0.621	100.1	305.3	42.12
	0.472	309.16	2.1013	733.7	0.709	96.8	304.8	45.76
	0.529	309.29	2.0953	759.8	0.754	97.0	303.9	47.39
	0.604	309.93	2.1401	805.4	0.806	98.2	310.4	50.23
	1	295.23	1.2719	1107.4	1	71.7	184.5	69.07
	0	309.49	1.2593	445.7	0	97.4	182.6	27.80
	0.263	323.89	2.5306	562.8	0.493	123.3	367.0	35.10
	0.315	323.89	2.6308	584.9	0.556	123.3	381.6	36.48
	0.483	325.08	2.9687	499.9	0.718	125.5	430.6	31.18
	0.574	325.08	3.0296	681.8	0.786	125.5	439.4	42.53

Table 12. Near-Saturation Liquid Densities for R125/290 Mixtures from 280 to 364 K (44 to 195°F). (LL indicates liquid-liquid immiscibility) (continued)

x(R125) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R125) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
0.615	324.04	2.9781	703.2	0.813	123.6	431.9	43.86
0.730	323.96	2.9440	774.1	0.880	123.5	427.0	48.28
1	324.89	2.6364	983.7	1	125.1	382.4	61.36
0	341.17	2.4936	408.8	0	154.4	361.7	25.50
0.146	339.94	3.1476	462.5	0.318	152.2	456.5	28.84
0.243	339.94	3.4696	484.7	0.466	152.2	503.2	30.23
0.327	339.91	3.7372	495.6	0.569	152.2	542.0	30.91
0.501	339.76	4.0359	534.2	0.732	151.9	585.4	33.32
1	339.38	3.6290	571.9	1	151.2	526.3	35.67
0	347.99	2.8477	389.9	0	166.7	413.0	24.32
0.133	347.81	3.6146	425.6	0.295	166.4	524.3	26.55
0.166	347.92	3.7004	427.1	0.351	166.6	536.7	26.64
0.166	347.89	3.6989	427.0	0.351	166.5	536.5	26.63
0.353	347.76	4.3022	369.6	0.598	166.3	624.0	23.05
0	355.73	3.2967	364.1	0	180.6	478.1	22.71
0.098	355.60	3.8899	304.7	0.228	180.4	564.2	19.01
0.165	355.68	4.1753	290.0	0.350	180.6	605.6	18.09
0.165	355.68	4.1779	285.0	0.350	180.6	606.0	17.77
0	363.52	3.7920	327.0	0	194.7	550.0	20.40
0.003	363.15	3.8991	327.2	0.008	194.0	565.5	20.41
0.107	363.25	4.2993	228.4	0.246	194.2	623.6	14.24

Table 13. Near-Saturation Vapor Densities for R125/290 Mixtures from 280 to 365 K (45 to 197°F).

A-25	Temperature K	Pressure MPa	y(R125) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R125) Vapor Mass Fraction	Vapor Density lb/ft ³
	280.47	0.5902	0	12.9	45.2	85.6	0	0.80
	281.16	0.9160	0.413	36.2	46.4	132.9	0.657	2.26
	281.16	0.9788	0.511	43.4	46.4	142.0	0.740	2.71
	281.14	0.9778	0.511	43.5	46.4	141.8	0.740	2.71
	281.14	0.9952	0.562	46.2	46.4	144.3	0.777	2.88
	281.06	1.0006	0.580	47.1	46.2	145.1	0.790	2.93
	281.09	1.0031	0.624	48.1	46.3	145.5	0.819	3.00
	281.06	1.0022	0.624	47.9	46.2	145.4	0.819	2.99
	280.29	0.8302	1	52.1	44.9	120.4	1	3.25
	294.80	0.8731	0	19.2	71.0	126.6	0	1.20
	295.21	1.3057	0.389	51.1	71.7	189.4	0.634	3.19
	295.24	1.2988	0.389	50.7	71.8	188.4	0.634	3.16
	293.69	1.3328	0.478	58.9	69.0	193.3	0.714	3.67
	294.18	1.3450	0.478	59.7	69.9	195.1	0.714	3.72
	294.54	1.3979	0.520	64.5	70.5	202.7	0.747	4.03
	293.98	1.4097	0.599	67.9	69.5	204.5	0.803	4.23
	294.23	1.4348	0.609	74.1	69.9	208.1	0.809	4.62
	295.23	1.2719	1	82.7	71.7	184.5	1	5.16
	309.49	1.2593	0	28.1	97.4	182.6	0	1.75
	311.58	1.8976	0.397	80.0	101.2	275.2	0.642	4.99
	311.58	1.8969	0.397	79.5	101.2	275.1	0.642	4.96
	311.7	1.9904	0.438	89.0	101.4	288.7	0.680	5.55
	312.56	2.1058	0.470	100.5	102.9	305.4	0.707	6.27
	312.69	2.1050	0.470	100.2	103.2	305.3	0.707	6.25
	310.44	2.1013	0.548	108.0	99.1	304.8	0.767	6.74
	310.62	2.0953	0.575	111.2	99.4	303.9	0.786	6.94
	311.24	2.1401	0.620	117.8	100.6	310.4	0.816	7.35
	310.61	1.8876	1	132.3	99.4	273.8	1	8.25
	324.69	1.7749	0	40.9	124.8	257.4	0	2.55
	326.10	3.0296	0.597	199.6	127.3	439.4	0.801	12.45
	326.20	2.9687	0.547	179.0	127.5	430.6	0.767	11.16
	325.73	2.6308	0.423	121.4	126.6	381.6	0.666	7.57
	325.65	2.5306	0.397	108.8	126.5	367.0	0.642	6.79

Table 13. Near-Saturation Vapor Densities for R125/290 Mixtures from 280 to 365 K (45 to 197°F). (continued)

Temperature K	Pressure MPa	y(R125) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R125) Vapor Mass Fraction	Vapor Density lb/ft ³
325.81	2.9781	0.603	192.4	126.8	431.9	0.805	12.00
325.68	2.9440	0.714	103.3	126.6	427.0	0.872	6.44
324.89	2.6364	1	209.5	125.1	382.4	1	13.07
341.17	2.4936	0	61.0	154.4	361.7	0	3.80
341.18	3.1476	0.225	125.4	154.4	456.5	0.441	7.82
341.10	3.4696	0.320	172.2	154.3	503.2	0.562	10.74
341.05	3.7372	0.391	240.4	154.2	542.0	0.636	14.99
341.02	4.0359	0.504	384.4	154.2	585.4	0.734	23.98
339.38	3.6290	1	571.9	151.2	526.3	1	35.67
347.99	2.8477	0	72.9	166.7	413.0	0	4.55
348.89	3.6146	0.198	153.9	168.3	524.3	0.402	9.60
349.08	3.7004	0.220	168.2	168.7	536.7	0.434	10.49
349.03	3.6989	0.220	167.9	168.6	536.5	0.434	10.47
348.93	4.3022	0.365	316.2	168.4	624.0	0.610	19.72
355.73	3.2967	0	907.0	180.6	478.1	0	56.57
356.85	3.8899	0.119	159.9	182.7	564.2	0.269	9.98
356.96	4.1753	0.188	203.0	182.9	605.6	0.387	12.66
356.93	4.1779	0.188	204.1	182.8	606.0	0.387	12.73
363.52	3.7920	0	118.8	194.7	550.0	0	7.41
364.43	3.8991	0.014	131.1	196.3	565.5	0.037	8.18
364.75	4.2993	0.126	173.1	196.9	623.6	0.282	10.80

Table 14. Vapor-Liquid Equilibria Data for R134a/290 Mixtures from 279 to 372 K (43 to 210°F). (LL Indicates liquid-liquid immiscibility)

x(R134a) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R134a) Vapor Mole Fraction	x(R134a) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R134a) Vapor Mass Fraction
0	279.22	0.5798	0	0	42.9	84.1	0
0.088	279.22	0.7051	0.275	0.183	42.9	102.3	0.508
LL	279.54	0.7156	0.342	LL	43.5	103.8	0.586
LL	279.88	0.7171	0.358	LL	44.1	104.0	0.603
LL	279.85	0.7173	0.358	LL	44.1	104.0	0.603
0.692	279.42	0.6749	0.437	0.839	43.3	97.9	0.679
0.774	279.29	0.6464	0.487	0.888	43.1	93.8	0.721
0.786	279.35	0.6475	0.474	0.895	43.2	93.9	0.710
0.972	279.73	0.4378	0.843	0.988	43.8	63.5	0.936
0.913	279.80	0.5349	0.656	0.960	44.0	77.6	0.838
0.972	279.60	0.4368	0.843	0.988	43.6	63.4	0.936
1	280.39	0.3790	1	1	45.0	55.0	1
0	294.99	0.8777	0	0	71.3	127.3	0
0.262	295.33	1.0669	0.308	0.451	71.9	154.7	0.548
LL	295.33	1.0632	0.354	LL	71.9	154.2	0.599
LL	293.98	1.0362	0.359	LL	69.5	150.3	0.604
LL	294.05	1.0334	0.359	LL	69.6	149.9	0.604
0.602	294.85	1.0315	0.494	0.778	71.1	149.6	0.727
0.727	295.17	0.9858	0.541	0.860	71.6	143.0	0.762
0.872	294.33	0.7901	0.724	0.940	70.1	114.6	0.877
0.872	294.33	0.7881	0.724	0.940	70.1	114.3	0.877
1	294.70	0.5962	1	1	70.8	86.5	1
0	309.99	1.2742	0	0	98.3	184.8	0
0.200	310.69	1.5343	0.267	0.366	99.6	222.5	0.498
0.337	310.57	1.5750	0.351	0.540	99.4	228.4	0.596
0.450	310.62	1.5625	0.423	0.654	99.4	226.6	0.666
0.570	310.84	1.5355	0.434	0.754	99.8	222.7	0.676
0.671	310.75	1.4975	0.518	0.825	99.7	217.2	0.745
0.748	310.83	1.4526	0.578	0.873	99.8	210.7	0.789
1	309.31	0.9102	1	1	97.1	132.0	1
0	324.99	1.7864	0	0	125.3	259.1	0
0.134	326.08	2.0764	0.190	0.264	127.3	301.2	0.390
0.364	325.13	2.2287	0.380	0.570	125.6	323.2	0.625
0.504	325.50	2.2012	0.444	0.702	126.2	319.3	0.685
0.603	325.92	2.1375	0.480	0.778	127.0	310.0	0.715

Table 14. Vapor-Liquid Equilibria Data for R134a/290 Mixtures from 279 to 372 K (43 to 210°F). (LL indicates liquid-liquid immiscibility) (continued)

x(R134a) Liquid Mole Fraction	Temperature K	Pressure MPa	y(R134a) Vapor Mole Fraction	x(R134a) Liquid Mass Fraction	Temperature °F	Pressure psia	y(R134a) Vapor Mass Fraction
0.720	326.03	2.0691	0.589	0.856	127.2	300.1	0.796
1	324.50	1.3642	1	1	124.4	197.9	1
0	339.98	2.4353	0	0	152.3	353.2	0
0.213	340.87	2.9553	0.258	0.385	153.9	428.6	0.486
0.290	341.15	3.0002	0.311	0.486	154.4	435.1	0.551
0.375	340.44	3.0021	0.377	0.581	153.1	435.4	0.622
0.457	340.35	3.0207	0.437	0.661	153.0	438.1	0.679
0.610	340.69	2.8719	0.555	0.784	153.6	416.5	0.772
0.706	340.49	2.7863	0.611	0.847	153.2	404.1	0.810
1	340.16	1.9837	1	1	152.6	287.7	1
0	354.98	3.2509	0	0	179.3	471.5	0
0.026	356.21	3.4207	0.025	0.058	181.5	496.1	0.065
0.175	356.19	3.9482	0.209	0.329	181.5	572.6	0.418
0.717	356.46	3.8141	0.660	0.854	182.0	553.2	0.841
0.778	356.50	3.6925	0.720	0.890	182.0	535.6	0.875
0.827	356.44	3.6077	0.755	0.917	181.9	523.3	0.893
0.842	356.45	3.6085	0.754	0.925	181.9	523.4	0.893
0.897	356.43	3.3510	0.837	0.953	181.9	486.0	0.933
0.897	356.44	3.3609	0.837	0.953	181.9	487.5	0.933
1	355.02	2.7447	1	1	179.4	398.1	1
0	366.17	3.9865	0	0	199.4	578.2	0
0.086	366.17	4.3829	0.089	0.179	199.4	635.7	0.210
0.160	366.42	4.5815	0.167	0.306	199.9	664.5	0.353
0.748	365.99	4.3760	0.739	0.873	199.1	634.7	0.885
0.748	366.39	4.3880	0.739	0.873	199.8	636.4	0.885
0.841	366.52	4.3228	0.798	0.924	200.1	627.0	0.915
0.903	366.12	4.0124	0.875	0.956	199.4	582.0	0.950
0.086	366.15	4.3831	0.089	0.179	199.4	635.7	0.210
0.816	371.52	4.6542	0.805	0.911	209.1	675.0	0.918
0.816	371.52	4.6542	0.805	0.911	209.1	675.0	0.918
1	371.97	3.8886	1	1	209.9	564.0	1

Table 15. Near-Saturation Liquid Densities for R134a/290 Mixtures from 278 to 372 K (40 to 210°F).

A-29	x(R134a) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R134a) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0	279.22	0.5798	519.2	0	42.9	84.1	32.38
	0.088	278.45	0.7051	674.6	0.183	41.5	102.3	42.08
	0.692	277.86	0.6749	937.7	0.839	40.5	97.9	58.49
	0.774	277.94	0.6464	1022.1	0.888	40.6	93.8	63.75
	0.786	278.04	0.6475	1019.5	0.895	40.8	93.9	63.59
	0.913	278.22	0.5349	1176.1	0.960	41.1	77.6	73.35
	0.972	278.22	0.4368	1240.7	0.988	41.1	63.4	77.38
	0.972	278.45	0.4378	1240.9	0.988	41.5	63.5	77.40
	1	280.39	0.3790	1271.1	1	45.0	55.0	79.28
	0	294.99	0.8777	497.2	0	71.3	127.3	31.01
	0.262	293.80	1.0669	654.4	0.451	69.2	154.7	40.82
	0.602	293.75	1.0315	871.6	0.778	69.1	149.6	54.37
	0.727	293.91	0.9858	982.4	0.860	69.4	143.0	61.28
	0.872	291.87	0.7901	1137.9	0.940	65.7	114.6	70.97
	0.872	291.85	0.7881	1138.5	0.940	65.7	114.3	71.01
	1	294.70	0.5962	1221.2	1	70.8	86.5	76.17
	0	309.99	1.2742	472.9	0	98.3	184.8	29.50
	0.200	309.52	1.5343	579.5	0.366	97.5	222.5	36.14
	0.337	309.49	1.5750	650.6	0.540	97.4	228.4	40.58
	0.450	309.47	1.5625	710.3	0.654	97.4	226.6	44.30
	0.570	309.52	1.5355	793.0	0.754	97.5	222.7	49.46
	0.671	309.49	1.4975	860.6	0.825	97.4	217.2	53.68
	0.748	309.49	1.4526	920.5	0.873	97.4	210.7	57.41
	1	309.31	0.9102	1165.0	1	97.1	132.0	72.66
	0	324.99	1.7864	445.0	0	125.3	259.1	27.76
	0.134	324.12	2.0764	511.1	0.264	123.7	301.2	31.88
	0.364	324.12	2.2287	621.2	0.570	123.7	323.2	38.75
	0.504	324.23	2.2012	698.8	0.702	123.9	319.3	43.59
	0.603	324.23	2.1375	759.7	0.778	123.9	310.0	47.38
	0.720	324.17	2.0691	837.0	0.856	123.8	300.1	52.20
	1	324.50	1.3642	1094.9	1	124.4	197.9	68.29
	0	339.98	2.4353	411.7	0	152.3	353.2	25.68
	0.213	338.45	2.9553	497.6	0.385	149.5	428.6	31.04
	0.290	338.73	3.0002	525.2	0.486	150.0	435.1	32.76
	0.375	338.63	3.0021	562.2	0.581	149.9	435.4	35.07
	0.457	338.63	3.0207	600.6	0.661	149.9	438.1	37.46

Table 15. Near-Saturation Liquid Densities for R134a/290 Mixtures from 278 to 372 K (40 to 210°F). (continued)

A-30	x(R134a) Liquid Mole Fraction	Temperature K	Pressure MPa	Liquid Density kg/m ³	x(R134a) Liquid Mass Fraction	Temperature °F	Pressure psia	Liquid Density lb/ft ³
	0.610	338.63	2.8719	697.7	0.784	149.9	416.5	43.52
	0.706	338.63	2.7863	760.9	0.847	149.9	404.1	47.46
	1	340.16	1.9837	1013.7	1	152.6	287.7	63.23
	0	354.98	3.2509	366.9	0	179.3	471.5	22.88
	0.026	355.79	3.4207	368.5	0.058	180.7	496.1	22.99
	0.175	355.71	3.9482	392.4	0.329	180.6	572.6	24.47
	0.717	355.84	3.8141	517.4	0.854	180.8	553.2	32.27
	0.778	355.86	3.6925	592.2	0.890	180.9	535.6	36.94
	0.827	355.84	3.6077	718.0	0.917	180.8	523.3	44.78
	0.842	355.86	3.6085	718.1	0.925	180.9	523.4	44.79
	0.897	355.94	3.3510	789.3	0.953	181.0	486.0	49.23
	0.897	355.89	3.3609	789.6	0.953	180.9	487.5	49.25
	1	355.02	2.7447	917.3	1	179.4	398.1	57.21
	0	366.17	3.9865	264.5	0	199.4	578.2	16.50
	0.086	365.47	4.3831	306.5	0.179	198.2	635.7	19.12
	0.160	365.60	4.5815	328.2	0.306	198.4	664.5	20.47
	0.748	365.55	4.3880	367.5	0.873	198.3	636.4	22.92
	0.086	365.55	4.3829	304.3	0.179	198.3	635.7	18.98
	0.748	365.47	4.3760	365.0	0.873	198.2	634.7	22.76
	0.841	365.67	4.3228	553.2	0.924	198.5	627.0	34.50
	0.903	365.55	4.0124	668.4	0.956	198.3	582.0	41.69
	0.852	370.98	4.5418	465.7	0.930	208.1	658.7	29.05
	0.816	370.79	4.6542	432.8	0.911	207.8	675.0	26.99
	1	371.97	3.8886	551.1	1	209.9	564.0	34.37

Table 16. Near-Saturation Vapor Densities for R134a/290 Mixtures from 279 to 372 K (43 to 211°F).

A-31	Temperature K	Pressure MPa	y(R134a) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R134a) Vapor Mass Fraction	Vapor Density lb/ft ³
	279.22	0.5798	0	12.5	42.9	84.1	0	0.78
	279.16	0.7051	0.275	22.2	42.8	102.3	0.508	1.39
	280.55	0.7156	0.342	23.7	45.3	103.8	0.586	1.48
	279.70	0.7171	0.358	23.4	43.8	104.0	0.603	1.46
	279.75	0.7173	0.358	23.5	43.9	104.0	0.603	1.47
	279.08	0.6749	0.437	23.7	42.7	97.9	0.679	1.48
	279.11	0.6475	0.474	23.4	42.7	93.9	0.710	1.46
	279.08	0.6464	0.487	23.3	42.7	93.8	0.721	1.45
	279.80	0.5349	0.656	21.1	44.0	77.6	0.838	1.32
	279.65	0.4368	0.843	19.0	43.7	63.4	0.936	1.19
	279.78	0.4378	0.843	19.0	43.9	63.5	0.936	1.18
	280.39	0.3790	1	18.2	45.0	55.0	1	1.14
	294.99	0.8777	0	19.3	71.3	127.3	0	1.20
	295.57	1.0669	0.308	36.1	72.4	154.7	0.548	2.25
	295.55	1.0632	0.354	36.1	72.3	154.2	0.599	2.25
	294.05	1.0334	0.359	36.2	69.6	149.9	0.604	2.26
	295.18	1.0362	0.359	36.2	71.7	150.3	0.604	2.25
	294.14	1.0285	0.370	35.8	69.8	149.2	0.615	2.24
	294.17	1.0290	0.370	36.0	69.8	149.2	0.615	2.25
	296.24	1.0374	0.402	36.5	73.6	150.5	0.647	2.28
	294.93	1.0407	0.418	36.4	71.2	150.9	0.662	2.27
	295.01	1.0315	0.494	37.8	71.3	149.6	0.727	2.36
	295.16	0.9858	0.541	38.3	71.6	143.0	0.762	2.39
	294.21	0.7881	0.724	32.6	69.9	114.3	0.877	2.04
	294.23	0.7901	0.724	32.8	69.9	114.6	0.877	2.04
	294.70	0.5962	1	28.9	70.8	86.5	1	1.80
	309.99	1.2742	0	28.4	98.3	184.8	0	1.77
	311.11	1.5343	0.267	48.4	100.3	222.5	0.498	3.02
	311.06	1.5750	0.351	53.9	100.2	228.4	0.596	3.36
	310.88	1.5625	0.423	56.0	99.9	226.6	0.666	3.50
	310.88	1.5355	0.434	58.0	99.9	222.7	0.676	3.62
	311.06	1.4975	0.518	58.6	100.2	217.2	0.745	3.66
	311.03	1.4526	0.578	58.8	100.2	210.7	0.789	3.67
	309.31	0.9102	1	45.1	97.1	132.0	1	2.81

Table 16. Near-Saturation Vapor Densities for R134a/290 Mixtures from 279 to 372 K (43 to 211°F). (continued)

Temperature K	Pressure MPa	y(R134a) Vapor Mole Fraction	Vapor Density kg/m ³	Temperature °F	Pressure psia	y(R134a) Vapor Mass Fraction	Vapor Density lb/ft ³
324.99	1.7864	0	41.1	125.3	259.1	0	2.56
326.54	2.0764	0.190	62.8	128.1	301.2	0.390	3.91
326.48	2.2287	0.380	82.2	128.0	323.2	0.625	5.13
326.56	2.2012	0.444	86.4	128.1	319.3	0.685	5.39
326.59	2.1375	0.480	86.3	128.2	310.0	0.715	5.38
326.59	2.0691	0.589	87.6	128.2	300.1	0.796	5.46
324.50	1.3642	1	71.0	124.4	197.9	1	4.43
339.98	2.4353	0	59.3	152.3	353.2	0	3.70
341.62	2.9553	0.258	107.4	155.2	428.6	0.486	6.70
342.12	3.0002	0.311	115.6	156.1	435.1	0.551	7.21
341.41	3.0021	0.377	123.5	154.9	435.4	0.622	7.70
341.46	3.0207	0.437		155.0	438.1	0.679	
341.44	2.8719	0.555	130.1	154.9	416.5	0.772	8.11
341.33	2.7863	0.611	130.5	154.7	404.1	0.810	8.14
340.16	1.9837	1	109.4	152.6	287.7	1	6.82
354.98	3.2509	0	88.7	179.3	471.5	0	5.53
357.01	3.4207	0.025	101.2	182.9	496.1	0.065	6.31
357.14	3.9482	0.209	180.0	183.2	572.6	0.418	11.22
356.98	3.8141	0.660	238.9	182.9	553.2	0.841	14.90
357.04	3.6925	0.720	232.4	183.0	535.6	0.875	14.50
357.04	3.6085	0.754	227.7	183.0	523.4	0.893	14.20
357.01	3.6077	0.755	228.0	182.9	523.3	0.893	14.22
357.04	3.3510	0.837	203.8	183.0	486.0	0.933	12.71
357.04	3.3609	0.837	204.4	183.0	487.5	0.933	12.75
355.02	2.7447	1	167.3	179.4	398.1	1	10.43
366.17	3.9865	0	140.3	199.4	578.2	0	8.75
366.78	4.3831	0.089	238.8	200.5	635.7	0.210	14.89
366.83	4.3829	0.089	238.1	200.6	635.7	0.210	14.85
366.93	4.5815	0.167	305.4	200.8	664.5	0.353	19.05
366.75	4.3760	0.739	325.6	200.5	634.7	0.885	20.31
366.88	4.3880	0.739	321.9	200.7	636.4	0.885	20.08
367.07	4.3228	0.798	349.4	201.0	627.0	0.915	21.80
366.80	4.0124	0.875	323.8	200.6	582.0	0.950	20.19
372.21	4.6542	0.805	377.9	210.3	675.0	0.918	23.57
372.45	4.5418	0.843	371.7	210.7	658.7	0.936	23.18
371.97	3.8886	1	327.1	209.9	564.0	1	20.40

Table 17. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in SI Units.

T	P	ρ
K	MPa	mol·dm ⁻³
200.002	3.7506	14.0768
200.999	4.9935	14.0736
202.001	6.2613	14.0711
203.000	7.5391	14.0690
204.001	8.8261	14.0670
205.001	10.1129	14.0651
206.000	11.4026	14.0633
206.999	12.6913	14.0617
207.998	13.9760	14.0600
208.999	15.2691	14.0584
210.000	16.5530	14.0569
212.000	19.1238	14.0539
213.998	21.6852	14.0509
216.001	24.2425	14.0481
218.002	26.7839	14.0453
220.001	29.3202	14.0425
222.001	31.8491	14.0398
224.001	34.3699	14.0371
218.001	3.8638	13.5662
218.999	4.9311	13.5635
219.999	6.0153	13.5612
220.999	7.1022	13.5592
222.000	8.1999	13.5573
224.000	10.3918	13.5540
226.001	12.5889	13.5509
228.001	14.7813	13.5479
230.000	16.9714	13.5451
232.000	19.1605	13.5423
234.000	21.3446	13.5396
235.999	23.5209	13.5370
238.001	25.6902	13.5344
239.999	27.8520	13.5318
241.998	30.0112	13.5293
244.002	32.1628	13.5268
246.000	34.3048	13.5243
232.002	3.7217	13.1451
233.002	4.6604	13.1425
233.998	5.6055	13.1403
235.000	6.5633	13.1384
236.000	7.5240	13.1366
237.000	8.4877	13.1349
238.000	9.4505	13.1334
238.999	10.4114	13.1319
240.000	11.3791	13.1304
242.001	13.3040	13.1276
244.001	15.2293	13.1249
246.000	17.1485	13.1222
248.001	19.0670	13.1197
250.001	20.9836	13.1171
252.000	22.8948	13.1147
253.999	24.8013	13.1122
256.002	26.7048	13.1098
258.000	28.5988	13.1074
260.000	30.4875	13.1050
262.000	32.3738	13.1027
263.999	34.2556	13.1003

Table 17. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in SI Units. (continued)

T K	P MPa	ρ mol·dm ⁻³
250.001	3.6410	12.5769
250.999	4.4309	12.5744
252.001	5.2340	12.5724
253.000	6.0320	12.5706
253.999	6.8381	12.5690
256.000	8.4547	12.5659
257.999	10.0704	12.5631
259.998	11.6861	12.5605
262.002	13.3063	12.5579
263.998	14.9208	12.5555
265.998	16.5348	12.5530
268.002	18.1484	12.5506
269.999	19.7557	12.5483
271.998	21.3602	12.5460
273.999	22.9642	12.5437
276.002	24.5672	12.5415
278.001	26.1621	12.5392
280.001	27.7544	12.5370
282.000	29.3470	12.5348
284.002	30.9361	12.5326
286.002	32.5217	12.5304
288.001	34.1018	12.5282
263.999	3.7705	12.1110
264.998	4.4605	12.1088
266.000	5.1538	12.1070
266.999	5.8503	12.1053
268.001	6.5504	12.1038
270.000	7.9488	12.1009
272.000	9.3522	12.0983
274.000	10.7530	12.0958
276.001	12.1586	12.0933
277.998	13.5561	12.0910
279.998	14.9587	12.0887
284.000	17.7592	12.0842
287.999	20.5526	12.0798
291.999	23.3373	12.0755
295.999	26.1108	12.0713
300.000	28.8753	12.0671
304.000	31.6335	12.0629
308.001	34.3803	12.0587
280.001	3.6831	11.5211
281.001	4.2625	11.5191
282.000	4.8396	11.5175
283.000	5.4219	11.5159
284.000	6.0052	11.5145
286.001	7.1726	11.5118
288.001	8.3444	11.5093
290.001	9.5156	11.5069
292.000	10.6859	11.5047
294.000	11.8569	11.5024
296.002	13.0286	11.5003
297.999	14.1973	11.4982
300.001	15.3698	11.4961
302.002	16.5391	11.4940
304.001	17.7094	11.4919
306.000	18.8757	11.4899

Table 17. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in SI Units. (continued)

T	P	ρ
K	MPa	mol·dm ⁻³
308.002	20.0449	11.4879
310.001	21.2109	11.4859
311.999	22.3755	11.4839
316.000	24.7019	11.4799
319.999	27.0204	11.4759
324.001	29.3345	11.4720
328.000	31.6369	11.4681
332.000	33.9380	11.4642
296.001	3.3401	10.8265
296.999	3.8033	10.8246
298.000	4.2701	10.8230
298.998	4.7359	10.8215
300.000	5.2037	10.8201
302.000	6.1457	10.8176
304.000	7.0887	10.8152
306.001	8.0369	10.8130
308.001	8.9843	10.8109
310.000	9.9300	10.8088
312.002	10.8795	10.8067
316.001	12.7777	10.8028
320.001	14.6770	10.7989
324.002	16.5700	10.7952
328.001	18.4665	10.7917
332.002	20.3606	10.7881
336.000	22.2523	10.7844
340.000	24.1464	10.7807
344.000	26.0347	10.7771
347.999	27.9191	10.7734
352.000	29.8009	10.7698
355.999	31.6740	10.7661
359.998	33.5435	10.7625
364.000	35.4096	10.7588
312.000	3.7918	10.0837
313.000	4.1628	10.0823
313.999	4.5353	10.0810
315.000	4.9070	10.0798
316.000	5.2799	10.0786
318.001	6.0293	10.0764
320.002	6.7805	10.0743
323.999	8.2885	10.0703
327.999	9.8011	10.0665
332.001	11.3174	10.0629
335.998	12.8365	10.0593
340.000	14.3596	10.0558
344.000	15.8825	10.0524
348.000	17.4077	10.0489
352.001	18.9314	10.0455
356.000	20.4540	10.0421
360.000	21.9768	10.0387
363.999	23.4986	10.0353
367.999	25.0183	10.0319
372.000	26.5365	10.0285
376.000	28.0523	10.0252
380.001	29.5659	10.0218
383.999	31.0747	10.0184
388.001	32.5831	10.0150
392.001	34.0861	10.0116

Table 17. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in SI Units. (continued)

T	P	ρ
K	MPa	mol·dm ⁻³
328.002	3.7130	9.0092
329.001	3.9760	9.0080
329.998	4.2397	9.0069
331.001	4.5041	9.0059
331.999	4.7706	9.0049
334.002	5.3040	9.0029
335.999	5.8395	9.0011
340.001	6.9193	8.9976
344.001	8.0054	8.9943
348.001	9.0986	8.9910
352.001	10.1956	8.9879
355.999	11.2964	8.9848
360.002	12.4010	8.9817
363.999	13.5094	8.9786
368.001	14.6199	8.9756
372.000	15.7311	8.9726
376.002	16.8436	8.9695
380.002	17.9569	8.9665
383.999	19.0718	8.9635
388.000	20.1849	8.9605
391.999	21.2995	8.9575
396.001	22.4140	8.9545
399.998	23.5269	8.9515
344.000	4.5684	7.7241
344.999	4.7457	7.7233
346.000	4.9244	7.7225
347.000	5.1033	7.7218
348.001	5.2827	7.7211
350.001	5.6438	7.7196
351.999	6.0069	7.7182
356.000	6.7392	7.7154
359.999	7.4781	7.7127
364.002	8.2235	7.7100
368.001	8.9734	7.7073
372.000	9.7269	7.7047
376.001	10.4834	7.7021
380.000	11.2428	7.6995
384.002	12.0050	7.6970
388.000	12.7683	7.6944
392.000	13.5340	7.6918
396.001	14.3007	7.6893
399.999	15.0681	7.6867
359.999	6.3326	7.0281
361.999	6.6333	7.0269
364.001	6.9356	7.0257
365.999	7.2384	7.0245
368.000	7.5426	7.0233
370.000	7.8479	7.0221
372.000	8.1541	7.0210
375.999	8.7690	7.0186
380.000	9.3875	7.0162
384.000	10.0079	7.0139
388.002	10.6302	7.0116
391.999	11.2548	7.0092
396.000	11.8807	7.0069
399.999	12.5078	7.0046

Table 17. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in SI Units. (continued)

T	P	ρ
K	MPa	mol·dm ⁻³
360.001	5.4741	5.9773
362.001	5.6949	5.9763
364.002	5.9167	5.9753
366.000	6.1395	5.9743
368.001	6.3631	5.9733
370.001	6.5877	5.9723
371.998	6.8122	5.9713
376.000	7.2640	5.9693
380.002	7.7179	5.9673
384.000	8.1732	5.9653
388.000	8.6302	5.9634
392.000	9.0882	5.9614
396.000	9.5472	5.9595
399.998	10.0079	5.9575
360.000	4.8317	4.1772
362.001	4.9666	4.1765
364.000	5.1014	4.1758
365.999	5.2360	4.1752
367.999	5.3703	4.1745
369.999	5.5042	4.1738
372.002	5.6386	4.1731
376.001	5.9060	4.1718
380.001	6.1729	4.1704
383.999	6.4393	4.1691
388.000	6.7051	4.1677
392.002	6.9705	4.1664
396.000	7.2353	4.1651
400.000	7.4996	4.1637
360.002	3.8467	2.2021
361.999	3.9073	2.2020
364.000	3.9676	2.2017
365.999	4.0278	2.2014
368.001	4.0875	2.2011
369.999	4.1467	2.2008
372.000	4.2059	2.2004
376.000	4.3232	2.1997
379.999	4.4398	2.1990
384.000	4.5556	2.1982
388.000	4.6706	2.1975
392.000	4.7848	2.1968
396.001	4.8984	2.1960
400.000	5.0114	2.1953
359.999	2.1310	0.8852
362.000	2.1501	0.8851
364.002	2.1691	0.8849
366.000	2.1881	0.8847
367.999	2.2070	0.8845
370.000	2.2258	0.8843
372.002	2.2443	0.8842
375.999	2.2815	0.8838
379.999	2.3185	0.8834
384.001	2.3553	0.8830
388.000	2.3919	0.8827
392.000	2.4282	0.8823
395.999	2.4644	0.8819
400.000	2.5004	0.8814

Table 18. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in PI Units.

T °F	P psia	ρ lb-ft ⁻³
-99.67	543.984	89.663
-97.87	724.246	89.642
-96.07	908.120	89.626
-94.27	1093.453	89.613
-92.47	1280.118	89.600
-90.67	1466.747	89.588
-88.87	1653.810	89.577
-87.07	1840.714	89.566
-85.27	2027.040	89.556
-83.47	2214.591	89.546
-81.67	2400.802	89.536
-78.07	2773.666	89.516
-74.47	3145.167	89.498
-70.87	3516.075	89.480
-67.27	3884.674	89.462
-63.67	4252.534	89.444
-60.07	4619.327	89.427
-56.47	4984.928	89.410
-67.27	560.395	86.411
-65.47	715.196	86.393
-63.67	872.448	86.378
-61.87	1030.082	86.366
-60.07	1189.300	86.354
-56.47	1507.200	86.332
-52.87	1825.864	86.313
-49.27	2143.846	86.294
-45.67	2461.497	86.276
-42.07	2778.996	86.258
-38.47	3095.766	86.241
-34.87	3411.417	86.224
-31.27	3726.050	86.208
-27.67	4039.587	86.191
-24.07	4352.758	86.175
-20.47	4664.817	86.159
-16.87	4975.486	86.143
-42.07	539.791	83.728
-40.27	675.931	83.711
-38.47	813.013	83.697
-36.67	951.928	83.685
-34.87	1091.265	83.674
-33.07	1231.043	83.663
-31.27	1370.677	83.653
-29.47	1510.047	83.644
-27.67	1650.404	83.634
-24.07	1929.574	83.616
-20.47	2208.826	83.599
-16.87	2487.178	83.582
-13.27	2765.435	83.566
-9.67	3043.412	83.550
-6.07	3320.616	83.534
-2.47	3597.119	83.519
1.13	3873.206	83.503
4.73	4147.909	83.488
8.33	4421.833	83.473
11.93	4695.414	83.458
15.53	4968.352	83.443

Table 18. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in PI Units. (continued)

T °F	P psia	ρ lb.-ft ⁻³
-9.67	528.080	80.109
-7.87	642.650	80.093
-6.07	759.129	80.080
-4.27	874.863	80.069
-2.47	991.778	80.059
1.13	1226.256	80.039
4.73	1460.588	80.021
8.33	1694.929	80.004
11.93	1929.909	79.988
15.53	2164.083	79.972
19.13	2398.168	79.957
22.73	2632.205	79.942
26.33	2865.324	79.927
29.93	3098.030	79.912
33.53	3330.669	79.898
37.13	3563.170	79.883
40.73	3794.497	79.869
44.33	4025.431	79.855
47.93	4256.423	79.841
51.53	4486.902	79.827
55.13	4716.874	79.813
58.73	4946.044	79.799
15.53	546.870	77.141
17.33	646.945	77.127
19.13	747.498	77.116
20.93	848.512	77.105
22.73	950.055	77.095
26.33	1152.880	77.077
29.93	1356.428	77.060
33.53	1559.593	77.044
37.13	1763.461	77.029
40.73	1966.151	77.014
44.33	2169.580	76.999
51.53	2575.758	76.971
58.73	2980.896	76.943
65.93	3384.793	76.915
73.13	3787.055	76.888
80.33	4188.014	76.862
87.53	4588.047	76.835
94.73	4986.438	76.809
44.33	534.189	73.384
46.13	618.217	73.372
47.93	701.923	73.361
49.73	786.383	73.351
51.53	870.982	73.342
55.13	1040.291	73.325
58.73	1210.249	73.309
62.33	1380.114	73.294
65.93	1549.860	73.279
69.53	1719.696	73.265
73.13	1889.641	73.251
76.73	2059.142	73.238
80.33	2229.205	73.224
83.93	2398.800	73.211
87.53	2568.526	73.198
91.13	2737.688	73.185
94.73	2907.260	73.172

Table 18. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in PI Units. (continued)

T	P	ρ
$^{\circ}\text{F}$	psia	$\text{lb}\cdot\text{ft}^{-3}$
98.33	3076.382	73.160
101.93	3245.290	73.147
109.13	3582.713	73.122
116.33	3918.978	73.096
123.53	4254.610	73.071
130.73	4588.542	73.047
137.93	4922.284	73.022
73.13	484.440	68.960
74.93	551.622	68.948
76.73	619.323	68.937
78.53	686.891	68.928
80.33	754.737	68.919
83.93	891.360	68.903
87.53	1028.132	68.888
91.13	1165.649	68.874
94.73	1303.062	68.860
98.33	1440.217	68.847
101.93	1577.933	68.834
109.13	1853.254	68.809
116.33	2128.714	68.784
123.53	2403.278	68.760
130.73	2678.334	68.738
137.93	2953.052	68.715
145.13	3227.425	68.692
152.33	3502.144	68.668
159.53	3776.016	68.645
166.73	4049.316	68.622
173.93	4322.250	68.598
181.13	4593.917	68.575
188.33	4865.079	68.552
195.53	5135.730	68.529
101.93	549.961	64.229
103.73	603.763	64.220
105.53	657.791	64.211
107.33	711.693	64.203
109.13	765.785	64.196
112.73	874.472	64.182
116.33	983.432	64.168
123.53	1202.140	64.143
130.73	1421.525	64.119
137.93	1641.451	64.096
145.13	1861.782	64.073
152.33	2082.680	64.051
159.53	2303.558	64.029
166.73	2524.777	64.007
173.93	2745.773	63.985
181.13	2966.600	63.963
188.33	3187.463	63.942
195.53	3408.184	63.920
202.73	3628.592	63.899
209.93	3848.796	63.877
217.13	4068.637	63.856
224.33	4288.164	63.834
231.53	4507.004	63.812
238.73	4725.776	63.791
245.93	4943.771	63.769

Table 18. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in PI Units. (continued)

T °F	P psia	ρ lb·ft ⁻³
130.73	538.528	57.384
132.53	576.668	57.377
134.33	614.912	57.370
136.13	653.271	57.363
137.93	691.914	57.357
141.53	769.274	57.345
145.13	846.944	57.333
152.33	1003.558	57.311
159.53	1161.090	57.289
166.73	1319.636	57.269
173.93	1478.748	57.249
181.13	1638.402	57.229
188.33	1798.611	57.209
195.53	1959.371	57.190
202.73	2120.442	57.170
209.93	2281.603	57.151
217.13	2442.960	57.132
224.33	2604.432	57.113
231.53	2766.130	57.093
238.73	2927.567	57.074
245.93	3089.225	57.055
253.13	3250.879	57.036
260.33	3412.290	57.017
159.53	662.589	49.199
161.33	688.309	49.194
163.13	714.217	49.189
164.93	740.166	49.184
166.73	766.187	49.180
170.33	818.558	49.170
173.93	871.223	49.161
181.13	977.443	49.143
188.33	1084.613	49.126
195.53	1192.721	49.109
202.73	1301.480	49.092
209.93	1410.774	49.075
217.13	1520.484	49.059
224.33	1630.634	49.042
231.53	1741.172	49.026
238.73	1851.882	49.010
245.93	1962.934	48.993
253.13	2074.148	48.977
260.33	2185.437	48.961
188.33	918.472	44.766
191.93	962.081	44.758
195.53	1005.921	44.750
199.13	1049.838	44.743
202.73	1093.956	44.735
206.33	1138.242	44.728
209.93	1182.648	44.720
217.13	1271.831	44.705
224.33	1361.541	44.690
231.53	1451.516	44.675
238.73	1541.784	44.660
245.93	1632.376	44.646
253.13	1723.145	44.631
260.33	1814.097	44.616

Table 18. Compressed Gas and Liquid-Phase PVT Data for 0.50004 HFC-143a + 0.49996 HFC-125 in PI Units. (continued)

T °F	P psia	ρ lb.-ft ⁻³
188.33	793.952	38.073
191.93	825.969	38.066
195.53	858.147	38.060
199.13	890.459	38.054
202.73	922.888	38.047
206.33	955.471	38.041
209.93	988.020	38.034
217.13	1053.556	38.022
224.33	1119.391	38.009
231.53	1185.417	37.996
238.73	1251.704	37.984
245.93	1318.131	37.971
253.13	1384.708	37.959
260.33	1451.526	37.946
188.33	700.776	26.606
191.93	720.347	26.602
195.53	739.893	26.598
199.13	759.411	26.594
202.73	778.894	26.590
206.33	798.319	26.585
209.93	817.812	26.581
217.13	856.594	26.572
224.33	895.306	26.564
231.53	933.945	26.555
238.73	972.493	26.547
245.93	1010.979	26.538
253.13	1049.391	26.530
260.33	1087.732	26.521
188.33	557.913	14.026
191.93	566.707	14.026
195.53	575.448	14.024
199.13	584.179	14.022
202.73	592.836	14.020
206.33	601.433	14.018
209.93	610.010	14.016
217.13	627.033	14.011
224.33	643.945	14.006
231.53	660.739	14.002
238.73	677.418	13.997
245.93	693.983	13.992
253.13	710.455	13.988
260.33	726.840	13.983
188.33	309.077	5.639
191.93	311.852	5.637
195.53	314.607	5.636
199.13	317.362	5.635
202.73	320.094	5.634
206.33	322.819	5.633
209.93	325.513	5.632
217.13	330.903	5.629
224.33	336.269	5.627
231.53	341.601	5.624
238.73	346.911	5.622
245.93	352.178	5.620
253.13	357.424	5.617
260.33	362.659	5.614