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Orthobaric densities and molar volumes of liquids

Alcohols

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The person with overall responsibility for the work in this subject area is Mr G.H.Walter, Head of Heat Transfer, Internal Flow and Physical Data.

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ORTHOBARIC DENSITIES AND MOLAR VOLUMES OF LIQUIDS

ALCOHOLS

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TABLE 1 - COMPOUND NAME INDEX

COMPOUND TABLES in the following order

Formula	Name	Alternative Names
CH_4O	Methanol	Methyl alcohol
$\text{C}_2\text{H}_6\text{O}$	Ethanol	Ethyl alcohol
$\text{C}_3\text{H}_8\text{O}$	Propan-1-ol	Propyl alcohol
	Propan-2-ol	Isopropyl alcohol
$\text{C}_4\text{H}_{10}\text{O}$	Butan-1-ol	Butyl alcohol
	Butan-2-ol	sec-Butyl alcohol
	2-Methylpropan-1-ol	Isobutyl alcohol
	2-Methylpropan-2-ol	tert-Butyl alcohol
$\text{C}_5\text{H}_{12}\text{O}$	Pentan-1-ol	Pentyl alcohol
	Pentan-2-ol	sec-act-Pentyl alcohol
	Pentan-3-ol	sec-Pentyl alcohol
	2-Methylbutan-1-ol	pri-act-Pentyl alcohol
	3-Methylbutan-1-ol	Isopentyl alcohol
	2-Methylbutan-2-ol	tert-Pentyl alcohol
	3-Methylbutan-2-ol	
$\text{C}_6\text{H}_{14}\text{O}$	Hexan-1-ol	Hexyl alcohol
	Hexan-2-ol	
	Hexan-3-ol	
	2-Methylpentan-1-ol	
	3-Methylpentan-1-ol	
	4-Methylpentan-1-ol	
	2-Methylpentan-2-ol	
	3-Methylpentan-2-ol	
	4-Methylpentan-2-ol	
	2-Methylpentan-3-ol	
	3-Methylpentan-3-ol	
	2-Ethylbutan-1-ol	
	2,2-Dimethylbutan-1-ol	
	2,3-Dimethylbutan-1-ol	
	3,3-Dimethylbutan-1-ol	
	2,3-Dimethylbutan-2-ol	
	3,3-Dimethylbutan-2-ol	

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ORTHOBARIC DENSITIES AND MOLAR VOLUMES OF LIQUIDS ALCOHOLS

1. INTRODUCTION

This Data Item presents orthobaric liquid densities and molar volumes of alcohols arranged in the order shown on the Contents page. Table 1 is the Compound Name Index which lists alternative names of the compounds with, in bold, the first name used for each compound on the Contents page and at the head of each Table.

The values of density and molar volume for each compound have been obtained by calculation from the equation given, with the coefficients, at the top of each Table. This equation was fitted to the experimental and estimated data that had been selected and weighted in accordance with a critical assessment of all the data. The value of the critical temperature for each compound is, unless otherwise indicated, taken from the relevant Data Item giving the vapour pressure. For completeness all the critical parameters of each compound are given in the Tables which also show the density at 25 °C, where applicable, and for convenience, the approximate normal melting and boiling points.

The table of Data at Specified Temperatures gives the density, molar volume and their derivatives with respect to temperature. In addition this table also gives an assessment of the data quality indicated, in decreasing order, by one of the letters 'X', 'A', 'B' or 'C', at each temperature. Brackets enclose the letters at those temperatures which are outside the range of supporting experimental data. The estimated uncertainties in density and molar volume are shown below each letter and are given in the units of density or molar volume, rounded to 1, 2 or 5 times a power of 10.

In the main tables the uncertainties in the tabulated values of density and molar volume are shown for each value. The number of decimal places in each value is adjusted to be consistent with the uncertainty. Data quality and uncertainties are discussed at greater length in Section 4 and in Section 4 of the Introductory Item, Reference 1.

The sources of information which give liquid density or liquid molar volume data for the compound considered are listed on the reverse side of each sheet. Those sources which were used to derive the critical density and the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low, medium, high or critical) of their data. These arbitrary temperature ranges are defined more precisely in Section 2 of the Introductory Item, Reference 1.

2. NOTATION AND UNITS

All temperatures are based on the International Practical Temperature Scale (IPTS-68), which for practical purposes is interchangeable with thermodynamic temperature.

d	liquid density	kg/m ³
q	$(1-T/T_c)^{1/3}$	
T	thermodynamic temperature	K
t	Celsius temperature, $(T-273.15)$	°C
V	liquid molar volume	cm ³ /mol

Subscripts

- b denotes the normal boiling point
- c denotes the critical point
- m denotes the normal melting point

3. EVALUATION AND CORRELATION

Data over all of the liquid range are available for methanol only, but reliable data from ambient to critical temperatures are available for ethanol, the two propyl alcohols and the four butyl alcohols. Reliable data from ambient temperatures upward but terminating well below the critical temperatures are available for pentan-1-ol and over a shorter range at temperatures around ambient for hexan-1-ol. Data are also available for some higher alkanes and these were also used in deriving the correlation on which this Item is based. For other alcohols there are only data of lower quality.

Critical molar volumes of the alkan-1-ols were found to be, on average, 20 cm³/mol greater than the values for the corresponding alkanes. This value was therefore used to estimate smoothed critical molar volumes and hence the critical densities of pentan-1-ol and hexan-1-ol.

In fitting the equation to the selected data, experience has shown that four independent coefficients are necessary only when the data extends to the critical region. In cases where this is not so, the form of the equation was maintained but the number of independent coefficients was reduced to three by fixing the ratio of the fourth coefficient to the third in accordance with the value of this ratio found for methanol, propan-1-ol and butan-1-ol. This was found more satisfactory than making any one coefficient zero.

Because of the varying quality and extent of the data for each compound, the different procedures to obtain the coefficients of the density/molar volume equation for each compound were as follows.

- (a) Methanol, ethanol, propan-1-ol, propan-2-ol, butan-1-ol, butan-2-ol. The selected data were fitted by the equation and for the alkan-1-ols, the ratio of the fourth coefficient to the third was found to be approximately -0.6.
- (b) Pentan-1-ol and certain higher alcohols. The selected data were fitted by the equation with the ratio of the fourth coefficient to the third constrained to be -0.6.
- (c) The coefficients of propan-1-ol, butan-1-ol, pentan-1-ol and the higher alkan-1-ols were then used to derive a correlation for these compounds similar to that derived for the alkanes which is described in Item 87010.
- (d) The data for the remainder of the compounds were then fitted by the correlation derived in (c) above.

4. UNCERTAINTIES

At any temperature, the estimated uncertainties in density and molar volume are dependent upon the rates of change of these properties with temperature and the data quality. The table of Data at Specified Temperatures shows the gradients, the assessed data quality (indicated by one of the letters 'X', 'A', 'B' or 'C') and the corresponding uncertainties at various points of the liquid range. There is a tenfold increase in uncertainty with each successive data quality letter. Thus if, for example, an uncertainty is given as 10 (in the units of density or molar volume) it should be assumed that the uncertainty is greater than 1 but not necessarily as high as 10.

Comparison of the tabulated values given here with those given in Reference 2 shows good agreement for most compounds, the differences generally being comparable with the estimated uncertainties. For methanol, ethanol, the propyl and butyl alcohols, pentan-1-ol the differences in the tabulated values are somewhat larger. However, the values given here are based on more recent data.

5. REFERENCES

- 1. ESDU Orthobaric densities and molar volumes of liquids. Introduction to Data Items issued after July 1989. Item No. 89018, ESDU International, 1989.
- 2. TRC TRC Thermodynamic Tables - Non-Hydrocarbons. Thermodynamics Research Center, Texas A & M University, College Station, Texas, USA. Loose leaf data sheets extant 1989.



TABLE 1
COMPOUND NAME INDEX

The names in bold type are those by which the compounds are indexed on the Contents page

Name	
Butan-1-ol	
Butan-2-ol	
Butyl alcohol	see Butan-1-ol
sec-Butyl alcohol	see Butan-2-ol
tert-Butyl alcohol	see 2-Methylpropan-2-ol
2,2-Dimethylbutan-1-ol	
2,3-Dimethylbutan-1-ol	
3,3-Dimethylbutan-1-ol	
2,3-Dimethylbutan-2-ol	
3,3-Dimethylbutan-2-ol	
Ethanol	
Ethyl alcohol	see Ethanol
2-Ethylbutan-1-ol	
Hexan-1-ol	
Hexan-2-ol	
Hexan-3-ol	
Hexyl alcohol	see Hexan-1-ol
Isobutyl alcohol	see 2-Methylpropan-1-ol
Isopentyl alcohol	see 3-Methylbutan-1-ol
Isopropyl alcohol	see Propan-2-ol
Methanol	
Methyl alcohol	see Methanol
2-Methylbutan-1-ol	
3-Methylbutan-1-ol	
2-Methylbutan-2-ol	
3-Methylbutan-2-ol	
2-Methylpentan-1-ol	
3-Methylpentan-1-ol	
4-Methylpentan-1-ol	
2-Methylpentan-2-ol	
3-Methylpentan-2-ol	
4-Methylpentan-2-ol	
2-Methylpentan-3-ol	
3-Methylpentan-3-ol	
2-Methylpropan-1-ol	
2-Methylpropan-2-ol	
Pentan-1-ol	
Pentan-2-ol	
Pentan-3-ol	
Pentyl alcohol	see Pentan-1-ol
pri-act-Pentyl alcohol	see 2-Methylbutan-1-ol
sec-Pentyl alcohol	see Pentan-3-ol
sec-act-Pentyl alcohol	see Pentan-2-ol
tert-Pentyl alcohol	see 2-Methylbutan-2-ol
Propan-1-ol	
Propan-2-ol	
Propyl alcohol	see Propan-1-ol

CH₄O Methanol (Methyl alcohol)

Orthobaric Liquid Density and Molar Volume

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	32.04		
Critical Temperature	T _C =	512.64 K	(t _C =	239.49 °C)
Critical Pressure	p _C =	8.092 MPa	(=	79.86 atm)
Critical Density	d _C =	272.00 kg/m ³	(=	0.272 g/cm ³)
Critical Molar Volume	V _C =	117.80 cm ³ /mol		
Critical Compression Factor	Z _C =	0.224		
b ₁ = 2.01676	b ₂ □ -0.67627	b ₃ = -0.65046	b ₄ □ 0.65046	
Density at 298.15 K (25 °C)	= 786.27 kg/m ³			
Normal Melting Point	T _m □	175 K	(t _m =	-98 °C)
Normal Boiling Point	T _b =	338 K	(t _b =	65 °C)

Data at Specified Temperatures

$t/^\circ\text{C}$	-98	-50	20	30	65	170	239
$d/(\text{kg/m}^3)$	891.36	851.53	790.83	781.67	748.02	614.29	329.42
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.82	-0.84	-0.91	-0.92	-1.00	-1.76	-41.22
$V/(\text{cm}^3/\text{mol})$	35.95	37.63	40.52	40.99	42.84	52.16	97.27
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.03	0.04	0.05	0.05	0.06	0.15	12.17
Data Quality	C	B	A	A	A	A	B
Uncertainty in d (kg/m ³)	10	1	0.1	0.1	0.1	0.5	10
Uncertainty in V (cm ³ /mol)	0.5	0.05	0.005	0.005	0.005	0.05	2

Orthobaric Liquid Density of Methanol

Units: kg/m³ v. °C

$\frac{t}{^\circ\text{C}}$	$\frac{d}{\text{kg/m}^3}$	Uncert. in d kg/m ³	$\frac{t}{^\circ\text{C}}$	$\frac{d}{\text{kg/m}^3}$	Uncert. in d kg/m ³	$\frac{t}{^\circ\text{C}}$	$\frac{d}{\text{kg/m}^3}$	Uncert. in d kg/m ³	$\frac{t}{^\circ\text{C}}$	$\frac{d}{\text{kg/m}^3}$	Uncert. in d kg/m ³
-90	885.	10	100	710.8	0.2	200	552.	5	230	438.	10
-80	877.	5	105	705.1	0.2	202	546.	5	231	432.	10
-70	868.	5	110	699.2	0.2	204	541.	5	232	425.	10
-60	860.	2	115	693.3	0.2	206	535.	5	233	417.	10
			120	687.	0.5	208	530.	5	234	408.	10
-50	852.	1	125	681.	0.5	210	524.	5	235	399.	10
-40	843.	1	130	674.	0.5	212	517.	5	236	388.	10
-30	835.	0.5	135	668.	0.5	214	511.	5	237	374.	10
-20	826.	0.5	140	661.	0.5	216	504.	5	238	357.	10
-10	817.	0.5	145	654.	0.5	218	496.	5	239	329.	10
0	809.	0.5	150	647.	0.5	220	488.	5			
10	799.8	0.2	155	639.	0.5	222	480.	10			
20	790.8	0.1	160	631.	0.5	224	471.	10			
30	781.7	0.1	165	623.	0.5	226	461.	10			
40	772.3	0.1	170	614.	0.5	228	450.	10			
50	762.8	0.1	175	605.	1						
60	753.0	0.1	180	596.	2						
70	743.0	0.1	185	586.	2						
80	732.6	0.2	190	575.	2						
90	721.9	0.2	195	564.	5						

Orthobaric Liquid Molar Volume of Methanol

Units: cm³/mol v. K

T	V	Uncert.	T	V	Uncert.	T	V	Uncert.	T	V	Uncert.
K	cm ³ /mol	in V	K	cm ³ /mol	in V	K	cm ³ /mol	in V	K	cm ³ /mol	in V
			400	47.23	0.01	472	58.	0.5	501	71.	1
			405	47.68	0.01	474	58.	0.5	502	72.	1
			410	48.17	0.01	476	59.	0.5	503	73.	1
180	36.	0.5	415	48.67	0.01	478	59.	0.5	504	74.	2
190	36.4	0.2	420	49.21	0.01	480	60.	0.5	505	75.	2
200	36.8	0.2	425	49.77	0.01	482	61.	0.5	506	77.	2
210	37.1	0.1	430	50.37	0.01	484	62.	0.5	507	78.	2
220	37.5	0.05	435	51.02	0.01	486	62.	1	508	80.	2
230	37.9	0.05	440	51.70	0.02	488	63.	1	509	82.	2
240	38.3	0.05	445	52.4	0.05	490	64.	1	510	85.	2
250	38.66	0.02	450	53.2	0.1	492	65.	1	511	89.	2
260	39.07	0.02	455	54.1	0.2	494	66.	1	512	96.	2
270	39.49	0.02	460	55.1	0.2	496	67.	1			
280	39.92	0.01	465	56.1	0.2	498	69.	1			
290	40.37	0.005	470	57.	0.5	500	70.	1			
300	40.84	0.005									
310	41.33	0.005									
320	41.84	0.005									
330	42.38	0.005									
340	42.94	0.005									
350	43.54	0.005									
360	44.18	0.005									
370	44.85	0.01									
380	45.58	0.01									
390	46.37	0.01									

The following Sources give liquid density or liquid molar volume data for this compound. Those Sources used to derive the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low 'L', medium 'M', high 'H' or critical 'C') of the data.

YOUNG, S.,	Sci.Proc.Roy.Dublin Soc., Vol.12, p.374, 1910.	
KORBER, F.,	Ann.Phys., Vol.37, p.1014, 1912.	
RAKOWSKI, A., FROST, A.B.,	Trans.Pure.Reagents (Moscow), No.334, Vol.9, p.95, 1930.	
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KAY, W.B., DONHAM, W.E.,	Chem.Eng.Sci., Vol.4, p.1, 1955.	H,C
COSTELLO, J.M., BOWDEN, S.T.,	Rec.Trav.Chim., Vol.77, p.803, 1958.	
MIKHAIL, S.Z., KIMEL, W.R.,	J.Chem.Eng.Data, Vol.6, p.4, 1961.	
BHATTACHARYYA, D., THODOS, G.,	J.Chem.Eng.Data, Vol.9, p.530, 1964.	
EFREMOV, Y.V.,	Russ.J.Phys.Chem., Vol.40, p.667, 1966.	
KOMARENKO, V.G., MANZHELII, V.G.,	RADTSIG, A.V., Ukr.Fiz.Zh., Vol.12, p.4, 1967.	
ZUBAREV, V.N., BAGDONAS, A.,	Teploenergetika, Vol.16, p.88, 1969.	C
WILHOIT, R.C., ZWOLINSKI, B.J.,	J.Phys.Chem.Ref.Data, Vol.2, Supplement No.1, 1973.	
ZUBAREV, V.N., PRUSAKOV, P.G., et al.,	J.Appl.Chem.USSR, Vol.47, p.1478, 1974.	
HALES, J.L., ELLENDER, J.H.,	J.Chem.Thermodynamics, Vol.8, p.1177, 1976.	M,H

C₂H₆O Ethanol (Ethyl alcohol)

Orthobaric Liquid Density and Molar Volume

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	46.07	
Critical Temperature	$T_c =$	513.92 K	($t_c = 240.77$ °C)
Critical Pressure	$p_c =$	6.132 MPa	($\square = 60.52$ atm)
Critical Density	$d_c =$	276.00 kg/m ³	($\square = 0.276$ g/cm ³)
Critical Molar Volume	$V_c =$	166.92 cm ³ /mol	
Critical Compression Factor	$Z_c =$	0.240	

$$b_1 = 1.56755 \quad b_2 = 1.03298 \quad b_3 = -2.83746 \quad b_4 = 1.53790$$

Density at 298.15 K (25 °C)	=	784.90 kg/m ³	
Normal Melting Point	$T_m =$	159 K	($t_m = -114$ °C)
Normal Boiling Point	$T_b =$	351 K	($t_b = 78$ °C)

Data at Specified Temperatures

$t/^\circ\text{C}$	-114	-55	20	30	78	185	240
$d/(\text{kg/m}^3)$	890.83	847.43	789.07	780.67	736.73	586.86	333.39
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.73	-0.74	-0.83	-0.85	-1.00	-2.15	-28.10
$V/(\text{cm}^3/\text{mol})$	51.71	54.36	58.38	59.01	62.53	78.50	138.18
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.04	0.05	0.06	0.06	0.08	0.29	11.65
Data Quality	(C)	(B)	A	A	A	A	B
Uncertainty in d (kg/m ³)	10	1	0.1	0.1	0.1	0.5	10
Uncertainty in V (cm ³ /mol)	0.5	0.05	0.005	0.01	0.01	0.1	5

Orthobaric Liquid Density of Ethanol

Units: kg/m³ v. °C

t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d
°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³
			100	713.7	0.2	200	551.	2	230	437.	10
			105	708.1	0.2	202	546.	5	231	431.	10
			110	702.4	0.2	204	540.	5	232	424.	10
			115	696.5	0.2	206	534.	5	233	417.	10
-110	(888.)	10	120	690.4	0.2	208	528.	5	234	410.	10
-100	(881.)	10	125	684.	0.5	210	522.	5	235	402.	10
-90	(873.)	5	130	678.	0.5	212	516.	5	236	392.	10
-80	(866.)	5	135	671.	0.5	214	509.	5	237	382.	10
-70	(859.)	2	140	664.	0.5	216	502.	5	238	370.	10
-60	(851.)	2	145	657.	0.5	218	494.	5	239	355.	10
-50	(844.)	1	150	650.	0.5	220	486.	5	240	333.	10
-40	(836.)	1	155	642.	0.5	222	478.	5			
-30	(829.)	0.5	160	634.	0.5	224	469.	5			
-20	(821.)	0.5	165	625.	0.5	226	459.	10			
-10	(813.)	0.5	170	616.	0.5	228	449.	10			
0	805.3	0.2	175	607.	0.5						
10	797.3	0.2	180	597.	0.5						
20	789.1	0.1	185	587.	0.5						
30	780.7	0.1	190	576.	2						
40	772.1	0.1	195	564.	2						
50	763.2	0.1									
60	754.0	0.1									
70	744.6	0.1									
80	734.7	0.1									
90	724.5	0.2									

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Orthobaric Liquid Molar Volume of Ethanol

Units: cm^3/mol v. K

$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$	$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$	$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$	$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$
160	(52.)	0.5	400	67.6	0.05	472	83.	0.5	501	102.	2
170	(52.)	0.5	405	68.2	0.05	474	84.	0.5	502	104.	2
180	(53.)	0.5	410	68.9	0.05	476	85.	0.5	503	105.	2
190	(53.1)	0.2	415	69.6	0.05	478	86.	0.5	504	107.	2
			420	70.4	0.05	480	87.	0.5	505	108.	2
200	(53.5)	0.2	425	71.2	0.05	482	88.	1	506	110.	2
210	(54.0)	0.1	430	72.1	0.05	484	89.	1	507	112.	2
220	(54.5)	0.05	435	73.0	0.05	486	90.	1	508	114.	2
230	(54.9)	0.05	440	74.1	0.05	488	91.	1	509	117.	2
240	(55.4)	0.05	445	75.1	0.05	490	92.	1	510	120.	2
250	(56.0)	0.05	450	76.3	0.1	492	94.	1	511	124.	2
260	(56.48)	0.02	455	77.6	0.1	494	95.	1	512	129.	5
270	(57.03)	0.02	460	79.0	0.1	496	97.	1	513	137.	5
280	57.60	0.02	465	80.6	0.2	498	99.	2			
290	58.19	0.01	470	82.	0.5	500	101.	2			
300	58.81	0.01									
310	59.46	0.01									
320	60.14	0.01									
330	60.86	0.01									
340	61.62	0.01									
350	62.43	0.01									
360	63.30	0.01									
370	64.24	0.02									
380	65.25	0.02									
390	66.35	0.02									

The following Sources give liquid density or liquid molar volume data for this compound. Those Sources used to derive the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low 'L', medium 'M', high 'H' or critical 'C') of the data.

YOUNG, S.,	Sci.Proc.Roy.Dublin Soc., Vol.12, p.374, 1910.	
FROST, A.B.,	Trans.Pure.Reagents (Moscow), No.334, Vol.9, p.105, 1930.	
KRETSCHMER, C.B., NOWAKOWSKA, J., WIEBE, R.,	J.Am.Chem.Soc., Vol.70, p.1785, 1948.	
KRETSCHMER, C.B., WIEBE, R.,	J.Am.Chem.Soc., Vol.71, p.1793, 1949.	
BROWN, I., EWALD, A.H.,	Australian J.Sci.Res., Vol.A4, p.198, 1951.	
GRIFFITHS, V.S.,	J.Chem.Soc., p.1326, 1952.	
COSTELLO, J.M., BOWDEN, S.T.,	Rec.Trav.Chim., Vol.77, p.803, 1958.	
SKAATES, J.M., KAY, W.B.,	Chem.Eng.Sci., Vol.19, p.431, 1964.	H,C
EFREMOV, Y.V.,	Russ.J.Phys.Chem., Vol.40, p.667, 1966.	
WILHOIT, R.C., ZWOLINSKI, B.J., J.Phys.Chem.Ref.Data, Vol.2, Supplement No.1, 1973.		
HALES, J.L., ELLENDER, J.H.,	J.Chem.Thermodynamics, Vol.8, p.1177, 1976.	M,H

C₃H₈O Propan-1-ol (Propyl alcohol)

Orthobaric Liquid Density and Molar Volume

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	60.10	
Critical Temperature	$T_c =$	536.78 K	($t_c = 263.63$ °C)
Critical Pressure	$p_c =$	5.168 MPa	($= 51.00$ atm)
Critical Density	$d_c =$	275.00 kg/m ³	($= 0.275$ g/cm ³)
Critical Molar Volume	$V_c =$	218.53 cm ³ /mol	
Critical Compression Factor	$Z_c =$	0.253	
$b_1 = 1.98079$	$b_2 = -1.32674$	$b_3 = 1.36202$	$b_4 = -0.81721$
Density at 298.15 K (25 °C)	=	799.47 kg/m ³	
Normal Melting Point	$T_m =$	147 K	($t_m = -126$ °C)
Normal Boiling Point	$T_b =$	370 K	($t_b = 97$ °C)

Data at Specified Temperatures

$t/^\circ\text{C}$	-126	-50	20	30	97	210	263
$d/(\text{kg/m}^3)$	880.85	847.33	803.19	795.66	735.64	571.59	334.44
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.35	-0.53	-0.74	-0.77	-1.04	-2.15	-32.52
$V/(\text{cm}^3/\text{mol})$	68.22	70.92	74.82	75.53	81.69	105.14	179.69
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.03	0.04	0.07	0.07	0.12	0.40	17.48
Data Quality	(C)	(B)	A	A	A	A	B
Uncertainty in d (kg/m ³)	10	1	0.1	0.1	0.1	0.5	10
Uncertainty in V (cm ³ /mol)	1	0.1	0.01	0.01	0.01	0.1	5

Orthobaric Liquid Density of Propan-1-ol

Units: kg/m³ v. °C

t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d
°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³
			100	732.5	0.1	222	544.	2	251	447.	10
			105	727.2	0.1	224	539.	2	252	442.	10
			110	721.7	0.2	226	534.	2	253	436.	10
-120	(879.)	10	115	716.1	0.2	228	528.	5	254	431.	10
-110	(875.)	10	120	710.4	0.2	230	523.	5	255	424.	10
-100	(871.)	5	125	704.5	0.2	232	517.	5	256	418.	10
-90	(867.)	5	130	698.5	0.2	234	511.	5	257	411.	10
-80	(862.)	5	135	692.3	0.2	236	505.	5	258	403.	10
-70	(857.)	2	140	685.9	0.2	238	499.	5	259	394.	10
-60	(853.)	2	145	679.	0.5	240	492.	5	260	385.	10
-50	(847.)	1	150	673.	0.5	242	485.	5	261	373.	10
-40	(842.)	1	155	666.	0.5	244	477.	5	262	358.	10
-30	(836.)	0.5	160	659.	0.5	246	469.	5	263	334.	10
-20	(830.)	0.5	165	651.	0.5	248	461.	5			
-10	(824.)	0.5	170	644.	0.5	250	452.	10			
0	817.	0.5	175	636.	0.5						
10	810.4	0.2	180	628.	0.5						
20	803.2	0.1	185	619.	0.5						
30	795.7	0.1	190	611.	0.5						
40	787.8	0.1	195	602.	0.5						
50	779.6	0.1	200	592.	0.5						
60	771.0	0.1	205	582.	0.5						
70	762.0	0.1	210	572.	0.5						
80	752.6	0.1	215	561.	2						
90	742.8	0.1	220	549.	2						

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Orthobaric Liquid Molar Volume of Propan-1-ol

Units: cm³/mol v. K

Uncert. in V			Uncert. in V			Uncert. in V			Uncert. in V		
T	V		T	V		T	V		T	V	
K	cm ³ /mol	cm ³ /mol	K	cm ³ /mol	cm ³ /mol	K	cm ³ /mol	cm ³ /mol	K	cm ³ /mol	cm ³ /mol
150	(68.)	1	400	85.57	0.02	500	113.	1	530	146.	2
160	(69.)	0.5	405	86.3	0.05	502	114.	1	531	149.	2
170	(69.)	0.5	410	87.1	0.05	504	115.	1	532	152.	5
180	(69.)	0.5	415	87.9	0.05	506	117.	1	533	156.	5
190	(70.)	0.5	420	88.8	0.05	508	118.	1	534	160.	5
200	(70.0)	0.2	425	89.7	0.05	510	120.	1	535	167.	5
210	(70.4)	0.2	430	90.6	0.05	512	121.	1	536	177.	5
220	(70.8)	0.1	435	91.6	0.05	514	123.	2			
230	(71.2)	0.1	440	92.7	0.05	516	125.	2			
240	(71.7)	0.05	445	93.8	0.05	518	127.	2			
250	(72.2)	0.05	450	95.0	0.1	520	129.	2			
260	(72.8)	0.05	455	96.2	0.1	522	132.	2			
270	(73.3)	0.05	460	97.5	0.1	524	134.	2			
280	73.96	0.02	465	99.0	0.1	526	138.	2			
290	74.61	0.01	470	100.5	0.1	528	141.	2			
300	75.30	0.01	475	102.1	0.1						
310	76.04	0.01	480	103.9	0.1						
320	76.83	0.01	485	105.9	0.2						
330	77.67	0.01	490	108.	0.5						
340	78.57	0.01	495	110.	0.5						
350	79.53	0.01									
360	80.56	0.01									
370	81.67	0.01									
380	82.87	0.02									
390	84.17	0.02									

The following Sources give liquid density or liquid molar volume data for this compound. Those Sources used to derive the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low 'L', medium 'M', high 'H' or critical 'C') of the data.

YOUNG, S.,	Sci. Proc. Roy. Dublin Soc., Vol. 12, p. 374, 1910.	
COSTELLO, J. M., BOWDEN, S. T.,	Rec. Trav. Chim., Vol. 77, p. 803, 1958.	
AMBROSE, D., TOWNSEND, R.,	J. Chem. Soc., p. 3614, 1963.	H, C
MARTIN, J. J., CAMPBELL, J. A., SEIDEL, E. M.,	J. Chem. Eng. Data, Vol. 8, p. 560, 1963.	
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EFREMOV, Y. V.,	Russ. J. Phys. Chem., Vol. 40, p. 667, 1966.	
KUBICEK, A. J., EUBANK, P. T.,	J. Chem. Eng. Data, Vol. 17, p. 232, 1972.	
WILHOIT, R. C., ZWOLINSKI, B. J.,	J. Phys. Chem. Ref. Data, Vol. 2, Supplement No. 1, 1973.	
HALES, J. L., ELLENDER, J. H.,	J. Chem. Thermodynamics, Vol. 8, p. 1177, 1976.	M, H

C₃H₈O Propan-2-ol (Isopropyl alcohol)**Orthobaric Liquid Density and Molar Volume**

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	60.10		
Critical Temperature	T_c =	508.30 K	(t_c =	235.15 °C)
Critical Pressure	p_c =	4.763 MPa	(=	47.01 atm)
Critical Density	d_c =	273.20 kg/m ³	(=	0.273 g/cm ³)
Critical Molar Volume	V_c =	219.97 cm ³ /mol		
Critical Compression Factor	Z_c =	0.248		
b_1 =	1.80821	b_2 =	-0.69176	b_3 = 0.63646 b_4 = -0.57154
Density at 298.15 K (25 °C)	=	780.91 kg/m ³		
Normal Melting Point	T_m =	185 K	(t_m =	-88 °C)
Normal Boiling Point	T_b =	355 K	(t_b =	82 °C)

Data at Specified Temperatures

$t/^\circ\text{C}$	-88	-50	20	30	82	160	235
$d/(\text{kg/m}^3)$	850.43	831.80	784.97	776.74	726.21	615.44	307.26
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.44	-0.55	-0.80	-0.84	-1.11	-1.84	-78.37
$V/(\text{cm}^3/\text{mol})$	70.66	72.25	76.56	77.37	82.75	97.65	195.58
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.04	0.05	0.08	0.08	0.13	0.29	49.88
Data Quality	(C)	B	A	A	A	A	B
Uncertainty in d (kg/m ³)	10	1	0.1	0.1	0.1	0.5	10
Uncertainty in V (cm ³ /mol)	1	0.1	0.01	0.01	0.01	0.1	5

Orthobaric Liquid Density of Propan-2-olUnits: kg/m³ v. °C

t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d
°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³
			100	705.2	0.2	200	525.	5	230	393.	10
			105	698.9	0.2	202	519.	5	231	384.	10
-80 (847.)	10		110	692.5	0.2	204	513.	5	232	373.	10
-70 (842.)	5		115	685.9	0.2	206	507.	5	233	360.	10
-60 837.	2		120	679.0	0.2	208	500.	5	234	343.	10
-50 832.	1		125	672.	0.5	210	494.	5	235	307.	10
-40 826.	1		130	665.	0.5	212	487.	5			
-30 820.	0.5		135	657.	0.5	214	479.	5			
-20 814.	0.5		140	649.	0.5	216	471.	10			
-10 807.	0.5		145	641.	0.5	218	463.	10			
0 800.	0.5		150	633.	0.5	220	454.	10			
10 792.8	0.2		155	624.	0.5	222	444.	10			
20 785.0	0.1		160	615.	0.5	224	434.	10			
30 776.7	0.1		165	606.	1	226	422.	10			
40 768.1	0.1		170	596.	2	228	409.	10			
50 758.9	0.1		175	586.	2						
60 749.3	0.1		180	575.	2						
70 739.1	0.1		185	564.	5						
80 728.4	0.1		190	552.	5						
90 717.1	0.1		195	539.	5						

Orthobaric Liquid Molar Volume of Propan-2-ol

Units: cm³/mol v. K

T	V	Uncert. in V	T	V	Uncert. in V	T	V	Uncert. in V	T	V	Uncert. in V
K	cm ³ /mol	cm ³ /mol	K	cm ³ /mol	cm ³ /mol	K	cm ³ /mol	cm ³ /mol	K	cm ³ /mol	cm ³ /mol
			350	82.11	0.01	450	103.	0.5	490	128.	2
			355	82.73	0.01	452	104.	0.5	491	130.	2
			360	83.38	0.01	454	105.	0.5	492	131.	2
			365	84.06	0.02	456	106.	0.5	493	132.	2
190	(71.)	0.5	370	84.76	0.02	458	107.	0.5	494	134.	2
200	(71.)	0.5	375	85.50	0.02	460	107.	1	495	135.	2
210	(72.)	0.5	380	86.28	0.02	462	108.	1	496	137.	2
220	72.1	0.2	385	87.09	0.02	464	109.	1	497	138.	2
230	72.6	0.1	390	87.9	0.05	466	110.	1	498	140.	2
240	73.1	0.05	395	88.8	0.05	468	111.	1	499	142.	2
250	73.7	0.05	400	89.8	0.05	470	113.	1	500	144.	2
260	74.3	0.05	405	90.8	0.05	472	114.	1	501	147.	2
270	74.9	0.05	410	91.8	0.05	474	115.	1	502	149.	2
280	75.58	0.02	415	93.0	0.05	476	116.	1	503	152.	5
290	76.31	0.01	420	94.1	0.05	478	118.	1	504	156.	5
300	77.11	0.01	425	95.4	0.1	480	119.	2	505	160.	5
310	77.96	0.01	430	96.7	0.1	482	121.	2	506	166.	5
320	78.88	0.01	435	98.2	0.1	484	122.	2	507	174.	5
330	79.87	0.01	440	99.7	0.2	486	124.	2	508	190.	5
340	80.95	0.01	445	101.	0.5	488	126.	2			

The following Sources give liquid density or liquid molar volume data for this compound. Those Sources used to derive the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low 'L', medium 'M', high 'H' or critical 'C') of the data.

KRETSCHMER, C.B., WIEBE, R.,	J. Am. Chem. Soc., Vol. 76, p. 2579, 1954.	
STAROBINETZ, G.L., STAROBINETZ, K.C.,	Zh. Fiz. Khim., Vol. 25, p. 759, 1954.	
TOROPOV, A.P.,	J. Gen. Chem. USSR, Vol. 26, p. 1453, 1956.	
COSTELLO, J.M., BOWDEN, S.T.,	Rec. Trav. Chim., Vol. 77, p. 803, 1958.	
AMBROSE, D., TOWNSEND, R.,	J. Chem. Soc., p. 3614, 1963.	
DANNHAUSER, W., BAHE, L.W.,	J. Chem. Phys., Vol. 4, p. 3058, 1964.	
WILHOIT, R.C., ZWOLINSKI, B.J., J. Phys. Chem. Ref. Data, Vol. 2, Supplement No. 1, 1973.		
HALES, J.L., ELLENDER, J.H.,	J. Chem. Thermodynamics, Vol. 8, p. 1177, 1976.	M, H
AMBROSE, D., COUNSELL, J.F., et al.,	J. Chem. Thermodynamics, Vol. 10, p. 1033, 1978.	M, H, C

C₄H₁₀O Butan-1-ol (Butyl alcohol)**Orthobaric Liquid Density and Molar Volume**

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	74.12	
Critical Temperature	$T_c =$	563.05 K	($t_c = 289.90$ °C)
Critical Pressure	$p_c =$	4.424 MPa	($= 43.66$ atm)
Critical Density	$d_c =$	270.00 kg/m ³	($= 0.270$ g/cm ³)
Critical Molar Volume	$V_c =$	274.53 cm ³ /mol	
Critical Compression Factor	$Z_c =$	0.259	

$$b_1 = 1.93521 \quad b_2 = -1.20353 \quad b_3 = 1.25997 \quad b_4 = -0.75598$$

$$\text{Density at } 298.15 \text{ K (25 °C)} = 805.68 \text{ kg/m}^3$$

$$\text{Normal Melting Point } T_m = 184 \text{ K} \quad (t_m = -89 \text{ °C})$$

$$\text{Normal Boiling Point } T_b = 391 \text{ K} \quad (t_b = 118 \text{ °C})$$

Data at Specified Temperatures

$t/^\circ\text{C}$	-89	-50	20	30	118	200	289
$d/(\text{kg/m}^3)$	873.17	853.40	809.30	801.99	724.21	620.03	333.66
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.47	-0.55	-0.72	-0.74	-1.04	-1.57	-24.57
$V/(\text{cm}^3/\text{mol})$	84.89	86.86	91.59	92.42	102.35	119.55	222.15
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.05	0.06	0.08	0.09	0.15	0.30	16.36
Data Quality	(C)	B	A	A	A	A	B
Uncertainty in d (kg/m ³)	10	1	0.1	0.1	0.1	0.5	10
Uncertainty in V (cm ³ /mol)	1	0.1	0.01	0.01	0.01	0.1	5

Orthobaric Liquid Density of Butan-1-olUnits: kg/m³ v. °C

t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d
°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³
			150	688.4	0.2	250	523.	5	280	419.	10
			155	682.3	0.2	252	518.	5	281	414.	10
-80	(869.)	10	160	676.1	0.2	254	513.	5	282	408.	10
-70	(864.)	5	165	669.7	0.2	256	508.	5	283	401.	10
-60	859.	2	170	663.	0.5	258	502.	5	284	394.	10
-50	853.	1	175	656.	0.5	260	497.	5	285	386.	10
-40	848.	1	180	650.	0.5	262	491.	5	286	377.	10
-30	842.	0.5	185	643.	0.5	264	484.	5	287	366.	10
-20	836.	0.5	190	635.	0.5	266	478.	10	288	353.	10
-10	830.	0.5	195	628.	0.5	268	471.	10	289	334.	10
0	823.	0.5	200	620.	0.5	270	464.	10			
10	816.3	0.2	205	612.	1	272	456.	10			
20	809.3	0.1	210	604.	2	274	448.	10			
30	802.0	0.1	215	595.	2	276	439.	10			
40	794.4	0.1	220	586.	2	278	430.	10			
50	786.5	0.1	225	577.	2						
60	778.3	0.1	230	567.	5						
70	769.9	0.1	235	557.	5						
80	761.0	0.1	240	547.	5						
90	751.9	0.1	245	535.	5						
100	742.3	0.1									
110	732.4	0.1									
120	722.1	0.1									
130	711.3	0.2									
140	700.1	0.2									

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Orthobaric Liquid Molar Volume of Butan-1-ol

Units: cm³/mol v. K

T	V	Uncert.	T	V	Uncert.	T	V	Uncert.	T	V	Uncert.
K	cm ³ /mol	in V cm ³ /mol	K	cm ³ /mol	in V cm ³ /mol	K	cm ³ /mol	in V cm ³ /mol	K	cm ³ /mol	in V cm ³ /mol
			400	103.70	0.02	522	141.	2	550	170.	2
			405	104.50	0.02	524	142.	2	551	172.	5
			410	105.33	0.02	526	144.	2	552	174.	5
			415	106.19	0.02	528	145.	2	553	176.	5
190	(85.)	1	420	107.1	0.05	530	147.	2	554	179.	5
200	(86.)	0.5	425	108.0	0.05	532	148.	2	555	181.	5
210	(86.)	0.5	430	109.0	0.05	534	150.	2	556	184.	5
220	86.7	0.2	435	110.0	0.05	536	152.	2	557	188.	5
230	87.2	0.1	440	111.1	0.05	538	154.	2	558	192.	5
240	87.8	0.1	445	112.2	0.05	540	156.	2	559	196.	5
250	88.5	0.05	450	113.3	0.05	542	158.	2	560	202.	5
260	89.1	0.05	455	114.6	0.1	544	161.	2	561	209.	5
270	89.8	0.05	460	115.8	0.1	546	164.	2	562	220.	5
280	90.56	0.02	465	117.2	0.1	548	167.	2			
290	91.34	0.02	470	118.6	0.1						
300	92.16	0.01	475	120.1	0.1						
310	93.02	0.01	480	121.7	0.2						
320	93.94	0.01	485	123.	0.5						
330	94.91	0.01	490	125.	0.5						
340	95.94	0.01	495	127.	0.5						
350	97.04	0.01	500	129.	1						
360	98.20	0.01	505	131.	1						
370	99.44	0.01	510	134.	1						
380	100.77	0.01	515	137.	1						
390	102.18	0.01	520	140.	1						

The following Sources give liquid density or liquid molar volume data for this compound. Those Sources used to derive the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low 'L', medium 'M', high 'H' or critical 'C') of the data.

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SINGH, R., SHEMILT, L.W.,	J.Chem.Phys., Vol.23, p.1370, 1955.	
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McKINNEY, W.P., SKINNER, G.F., STAVELEY, L.A.K.,	J.Chem.Soc., p.2415, 1959.	
SHEMILT, L.W., ESPLIN, R.W., SINGH MANN, R.,	Can.J.Chem.Eng., Vol.37, p.142, 1959.	
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DANNHAUSER, W., BAHE, L.W.,	J.Chem.Phys., Vol.4, p.3058, 1964.	
SKAATES, J.M., KAY, W.B.,	Chem.Eng.Sci., Vol.19, p.431, 1964.	H,C
EFREMOV, Y.V.,	Russ.J.Phys.Chem., Vol.40, p.667, 1966.	
WILHOIT, R.C., ZWOLINSKI, B.J.,	J.Phys.Chem.Ref.Data, Vol.2, Supplement No.1, 1973.	
HALES, J.L., ELLENDER, J.H.,	J.Chem.Thermodynamics, Vol.8, p.1177, 1976.	M,H

C₄H₁₀O Butan-2-ol (sec-Butyl alcohol)**Orthobaric Liquid Density and Molar Volume**

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	74.12	
Critical Temperature	$T_c =$	536.01 K	($t_c = 262.86$ °C)
Critical Pressure	$p_c =$	4.198 MPa	($= 41.43$ atm)
Critical Density	$d_c =$	272.00 kg/m ³	($= 0.272$ g/cm ³)
Critical Molar Volume	$V_c =$	272.51 cm ³ /mol	
Critical Compression Factor	$Z_c =$	0.257	
$b_1 = 1.78169$	$b_2 = -0.67814$	$b_3 = 0.67638$	$b_4 = -0.53989$
Density at 298.15 K (25 °C)	=	802.44 kg/m ³	
Normal Melting Point	$T_m =$	158 K	($t_m = -115$ °C)
Normal Boiling Point	$T_b =$	373 K	($t_b = 100$ °C)

Data at Specified Temperatures

$t/^\circ\text{C}$	-115	-50	20	30	100	200	262
$d/(\text{kg/m}^3)$	891.08	856.28	806.56	798.25	729.48	580.42	332.31
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.46	-0.61	-0.82	-0.85	-1.14	-2.03	-24.84
$V/(\text{cm}^3/\text{mol})$	83.18	86.56	91.90	92.86	101.61	127.70	223.05
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.04	0.06	0.09	0.10	0.16	0.45	16.67
Data Quality	(C)	B	A	A	A	A	B
Uncertainty in d (kg/m ³)	10	1	0.1	0.1	0.1	0.5	10
Uncertainty in V (cm ³ /mol)	1	0.1	0.01	0.01	0.01	0.1	5

Orthobaric Liquid Density of Butan-2-olUnits: kg/m³ v. °C

t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d
°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³
			100	729.5	0.1	222	530.	5	251	430.	10
			105	723.7	0.1	224	525.	5	252	425.	10
			110	717.9	0.2	226	520.	5	253	419.	10
			115	711.9	0.2	228	514.	5	254	413.	10
-110	(889.)	10	120	705.7	0.2	230	508.	5	255	407.	10
-100	(884.)	10	125	699.4	0.2	232	503.	5	256	400.	10
-90	(879.)	5	130	693.0	0.2	234	496.	5	257	393.	10
-80	(874.)	5	135	686.4	0.2	236	490.	5	258	385.	10
-70	(868.)	5	140	679.6	0.2	238	483.	5	259	376.	10
-60	862.	2	145	672.6	0.2	240	476.	5	260	365.	10
-50	856.	1	150	665.	0.5	242	469.	5	261	351.	10
-40	850.	1	155	658.	0.5	244	461.	5	262	332.	10
-30	843.	0.5	160	651.	0.5	246	453.	10			
-20	837.	0.5	165	643.	0.5	248	445.	10			
-10	830.	0.5	170	635.	0.5	250	435.	10			
0	822.	0.5	175	627.	0.5						
10	814.5	0.2	180	618.	0.5						
20	806.6	0.1	185	609.	0.5						
30	798.2	0.1	190	600.	0.5						
40	789.6	0.1	195	590.	0.5						
50	780.6	0.1	200	580.	0.5						
60	771.2	0.1	205	570.	1						
70	761.4	0.1	210	559.	2						
80	751.2	0.1	215	548.	2						
90	740.6	0.1	220	535.	5						

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Orthobaric Liquid Molar Volume of Butan-2-ol

Units: cm^3/mol v. K

$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$	$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$	$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$	$\frac{T}{K}$	$\frac{V}{\text{cm}^3/\text{mol}}$	Uncert. in $\frac{V}{\text{cm}^3/\text{mol}}$
160	(83.)	1	400	106.3	0.05	500	143.	1	530	188.	5
170	(84.)	1	405	107.3	0.05	502	145.	1	531	192.	5
180	(84.)	0.5	410	108.4	0.05	504	147.	2	532	197.	5
190	(85.)	0.5	415	109.5	0.05	506	148.	2	533	202.	5
			420	110.6	0.05	508	150.	2	534	210.	5
200	(85.)	0.5	425	111.8	0.05	510	152.	2	535	221.	5
210	(85.8)	0.2	430	113.1	0.05	512	154.	2			
220	86.4	0.1	435	114.4	0.1	514	157.	2			
230	87.0	0.1	440	115.8	0.1	516	159.	2			
240	87.7	0.1	445	117.3	0.1	518	162.	2			
250	88.4	0.05	450	118.9	0.1	520	165.	2			
260	89.1	0.05	455	120.6	0.1	522	168.	2			
270	89.9	0.05	460	122.4	0.1	524	172.	2			
280	90.72	0.02	465	124.3	0.1	526	176.	5			
290	91.61	0.02	470	126.3	0.1	528	182.	5			
300	92.55	0.01	475	128.5	0.2						
310	93.55	0.01	480	131.	0.5						
320	94.61	0.01	485	134.	0.5						
330	95.74	0.01	490	136.	1						
340	96.95	0.01	495	140.	1						
350	98.24	0.01									
360	99.63	0.01									
370	101.12	0.01									
380	102.72	0.02									
390	104.46	0.02									

The following Sources give liquid density or liquid molar volume data for this compound. Those Sources used to derive the coefficients of the liquid density/molar volume equation are shown in bold type together with the temperature range (low 'L', medium 'M', high 'H' or critical 'C') of the data.

COSTELLO, J.M., BOWDEN, S.T.,	Rec. Trav. Chim., Vol. 77, p. 803, 1958.	
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HALES, J.L., ELLENDER, J.H.,	J. Chem. Thermodynamics, Vol. 8, p. 1177, 1976.	M, H

C₄H₁₀O 2-Methylpropan-1-ol (Isobutyl alcohol)**Orthobaric Liquid Density and Molar Volume**

$$\ln(d/d_c) = -\ln(V/V_c) = b_1q + b_2q^2 + b_3q^3 + b_4q^4$$

where d is the density, d_c the critical density, V the molar volume, V_c the critical molar volume and $q = (1-T/T_c)^{1/3}$, T being the temperature and T_c the critical temperature in kelvins.

Molecular Weight	MW =	74.12		
Critical Temperature	$T_c =$	547.78 K	($t_c =$	274.63 °C)
Critical Pressure	$P_c =$	4.304 MPa	($=$	42.48 atm)
Critical Density	$d_c =$	270.00 kg/m ³	($=$	0.270 g/cm ³)
Critical Molar Volume	$V_c =$	274.53 cm ³ /mol		
Critical Compression Factor	$Z_c =$	0.259		
$b_1 =$	1.93814	$b_2 =$	-1.21166	$b_3 =$ 1.25786 $b_4 =$ -0.75471
Density at 298.15 K (25 °C)	=	797.05 kg/m ³		
Normal Melting Point	$T_m =$	-	($t_m =$	-)
Normal Boiling Point	$T_b =$	381 K	($t_b =$	108 °C)

Data at Specified Temperatures

$t/^\circ\text{C}$	-100	-50	20	30	108	150	274
$d/(\text{kg/m}^3)$	872.16	846.64	800.83	793.19	722.04	672.77	326.86
$(d(d)/dT)/(\text{kg/m}^3 \text{ K})$	-0.46	-0.57	-0.75	-0.78	-1.07	-1.29	-31.21
$V/(\text{cm}^3/\text{mol})$	84.99	87.55	92.56	93.45	102.66	110.17	226.77
$(dV/dT)/(\text{cm}^3/\text{mol K})$	0.04	0.06	0.09	0.09	0.15	0.21	21.65
Data Quality	(C)	B	B	B	B	B	B
Uncertainty in d (kg/m ³)	10	1	1	1	1	2	10
Uncertainty in V (cm ³ /mol)	1	0.1	0.1	0.1	0.1	0.5	5

Orthobaric Liquid Density of 2-Methylpropan-1-olUnits: kg/m³ v. °C

t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d	t	d	Uncert. in d
°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³	°C	kg/m ³	kg/m ³
-100	(872.)	10	150	673.	2	230	537.	10	260	445.	10
-90	(867.)	10	155	666.	2	232	533.	10	261	440.	10
-80	(863.)	5	160	659.	5	234	528.	10	262	435.	10
-70	(858.)	5	165	653.	5	236	523.	10	263	430.	10
-60	852.	2	170	645.	5	238	518.	10	264	425.	10
-50	847.	1	175	638.	5	240	512.	10	265	420.	10
-40	841.	1	180	631.	5	242	507.	10	266	414.	10
-30	835.	1	185	623.	5	244	501.	10	267	407.	10
-20	829.	1	190	615.	5	246	495.	10	268	400.	10
-10	822.	1	195	606.	5	248	489.	10	269	393.	10
0	815.	1	200	598.	5	250	482.	10	270	385.	10
10	808.	1	205	589.	5	252	476.	10	271	375.	10
20	801.	1	210	580.	5	254	469.	10	272	364.	10
30	793.	1	215	570.	5	256	461.	10	273	349.	10
40	785.	1	220	560.	5	258	453.	10	274	327.	10
50	777.	1	225	549.	5						
60	768.	1									
70	759.	1									
80	750.	1									
90	741.	1									
100	730.	1									
110	720.	1									
120	709.	2									
130	697.	2									
140	685.	2									

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