

## 2.2.2 Chloroalkanes, C<sub>3</sub> - C<sub>4</sub>

**1,1,1,3,3-Pentachloropropane** [23153-23-3] C<sub>3</sub>H<sub>3</sub>Cl<sub>5</sub> MW = 216.32 205

**Table 1.** Experimental value with uncertainty.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1583.90 ± 2.00	1946-ste

**1,1,2,2,3-Pentachloropropane** [16714-68-4] C<sub>3</sub>H<sub>3</sub>Cl<sub>5</sub> MW = 216.32 206

**Table 1.** Experimental value with uncertainty.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1632.60 ± 2.00	1946-ste

**1,1,1,2-Tetrachloropropane** [812-03-3] C<sub>3</sub>H<sub>4</sub>Cl<sub>4</sub> MW = 181.88 207

**Table 1.** Experimental values with uncertainties.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
295.15	1469.50 ± 3.00	1941-kha/ros
284.15	2015.00 ± 20.00	1948-kir/kre

**1,1,1,3-Tetrachloropropane** [1070-78-6] C<sub>3</sub>H<sub>4</sub>Cl<sub>4</sub> MW = 181.88 208

**Table 1.** Experimental values with uncertainties.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1446.30 ± 3.00	1948-joy/han
293.15	1508.50 ± 4.00	1951-bor

**1,1,2,3-Tetrachloropropane** [18495-30-2] C<sub>3</sub>H<sub>4</sub>Cl<sub>4</sub> MW = 181.88 209

**Table 1.** Experimental values with uncertainties.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
290.15	1513.00 ± 3.00	1948-kir/kre
298.15	1501.60 ± 2.00	1955-ger/har

**1,2,2,3-Tetrachloropropane** [13116-53-5] C<sub>3</sub>H<sub>4</sub>Cl<sub>4</sub> MW = 181.88 210

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
291.15	1500.00 ± 5.00	1948-kir/kre
291.15	1500.00 ± 4.00	1952-hat/dam
293.15	1497.00 ± 2.50	1953-hea/eva
298.15	1486.10 ± 2.00	1955-ger/har

**1,1,1-Trichloropropane** [7789-89-1] C<sub>3</sub>H<sub>5</sub>Cl<sub>3</sub> MW = 147.43 211

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
273.15	1402.00 ± 8.00	1872-fri/sil
298.15	1372.00 ± 8.00	1872-fri/sil
298.15	1283.60 ± 2.00	1950-har/for
293.15	1287.00 ± 1.50	1971-abr/ili

**1,1,2-Trichloropropane** [598-77-6] C<sub>3</sub>H<sub>5</sub>Cl<sub>3</sub> MW = 147.43 212

**Table .** Experimental value with uncertainty.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
289.15	1353.00 ± 6.00	1899-mou

**1,1,3-Trichloropropane** [20395-25-9] C<sub>3</sub>H<sub>5</sub>Cl<sub>3</sub> MW = 147.43 213

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
288.15	1362.00 ± 5.00	1882-rom
293.15	1355.54 ± 0.60	1952-sla

**1,2,2-Trichloropropane** [3175-23-3] C<sub>3</sub>H<sub>5</sub>Cl<sub>3</sub> MW = 147.43 214

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
273.15	1350.00 ± 5.00	1872-fri/sil
298.15	1318.00 ± 5.00	1872-fri/sil
273.15	1350.00 ± 5.00	1880-fri/sil

**1,2,3-Trichloropropane****[96-18-4]****MW = 147.43****215****Table 1.** Experimental and recommended values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
288.15	1417.00 ± 4.00	1865-lin <sup>1)</sup>	298.15	1388.80 ± 2.00	1949-kir/oth <sup>1)</sup>
273.15	1410.00 ± 20.00	1865-opp <sup>1)</sup>	293.15	1382.70 ± 4.00	1954-mar-1 <sup>1)</sup>
288.15	1417.00 ± 4.00	1893-her <sup>1)</sup>	293.15	1388.60 ± 0.60	1957-ano-10
293.15	1394.00 ± 3.00	1928-bla <sup>1)</sup>	293.15	1389.80 ± 1.00	1968-ano
293.15	1389.60 ± 1.00	1938-eft	293.15	1389.10 ± 0.70	Recommended

<sup>1)</sup> Not included in calculation of recommended value.**1,1-Dichloropropane****[78-99-9]****MW = 112.99****216****Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
293.15	1132.10 ± 3.00	1939-hen/ren
293.15	1168.70 ± 1.50	1953-nes/zak

**1,2-Dichloropropane****[78-87-5]****MW = 112.99****217****Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{\text{c,w}} = 1.4228$  (combined temperature ranges, weighted),  $\sigma_{\text{c,uw}} = 1.6960 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 278.84 \text{ to } 423.11 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
<i>A</i>	$1.44801 \cdot 10^3$
<i>B</i>	$-7.10490 \cdot 10^{-1}$
<i>C</i>	$-9.79159 \cdot 10^{-4}$

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

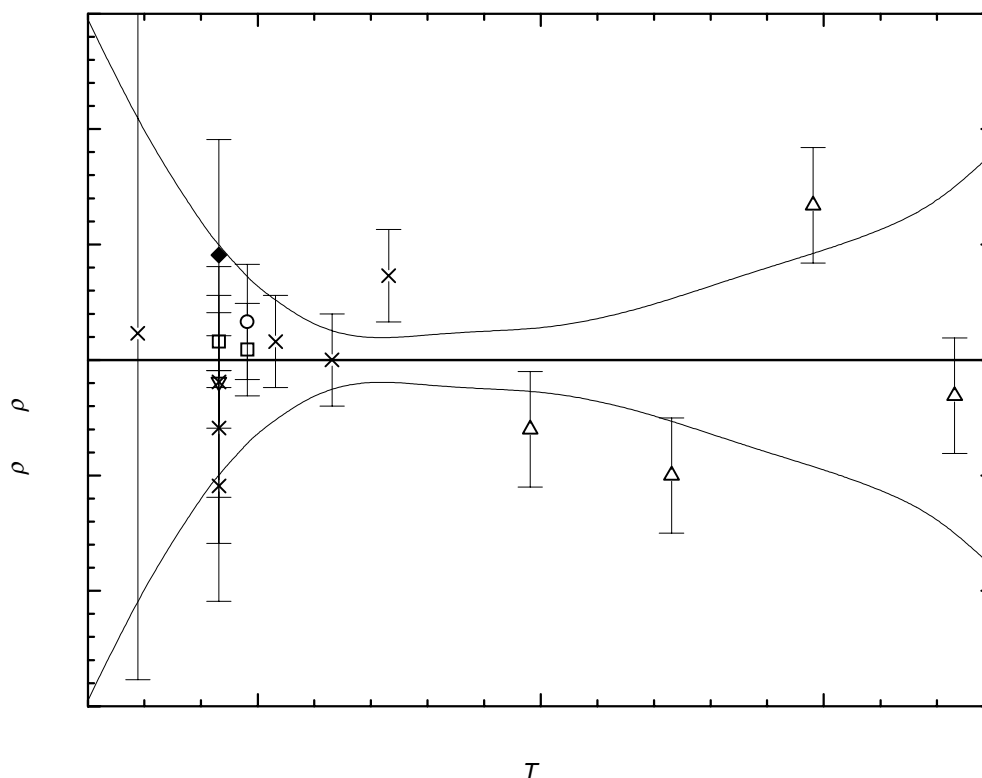
$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
293.15	1154.50 ± 1.00	-1.09	1933-nel/you(×)	298.15	1153.00 ± 3.00	3.86	1955-ste/mar <sup>1)</sup>
293.15	1155.00 ± 1.00	-0.59	1943-mcg(×)	308.15	1141.00 ± 3.00	4.90	1955-ste/mar <sup>1)</sup>
293.15	1155.40 ± 1.00	-0.19	1948-lag/eva(∇)	293.15	1156.50 ± 1.00	0.91	1968-ano(◆)
293.15	1155.75 ± 0.40	0.16	1949-dre/mar(□)	298.15	1149.47 ± 0.50	0.33	1995-com/fra-1(○)
298.15	1149.23 ± 0.40	0.09	1949-dre/mar(□)	323.14	1112.80 ± 0.50	-3.38	1997-ste/chi-1 <sup>1)</sup>
293.15	1155.40 ± 0.40	-0.19	1949-lag/mcm(×)	348.13	1081.40 ± 0.50	-0.60	1997-ste/chi-1(Δ)
303.15	1142.80 ± 0.40	0.16	1949-lag/mcm(×)	373.12	1045.60 ± 0.50	-1.00	1997-ste/chi-1(Δ)
313.15	1129.50 ± 0.40	-0.00	1949-lag/mcm(×)	398.12	1011.30 ± 0.50	1.34	1997-ste/chi-1(Δ)
323.15	1116.90 ± 0.40	0.73	1949-lag/mcm(×)	423.11	971.80 ± 0.50	-0.31	1997-ste/chi-1(Δ)
278.84	1174.00 ± 3.00	0.23	1955-ste/mar(×)				

<sup>1)</sup> Not included in Fig. 1.

cont.

**1,2-Dichloropropane (cont.)**

**Further references:** [1948-vog, 1950-bar/hea, 1956-bac/chu].



**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	1184.80 ± 2.95	320.00	1120.39 ± 0.17	390.00	1021.99 ± 0.80
280.00	1172.31 ± 1.95	330.00	1106.92 ± 0.22	400.00	1007.15 ± 0.95
290.00	1159.62 ± 1.19	340.00	1093.26 ± 0.25	410.00	992.12 ± 1.12
293.15	1155.59 ± 0.99	350.00	1079.39 ± 0.27	420.00	976.88 ± 1.35
298.15	1149.14 ± 0.72	360.00	1065.34 ± 0.35	430.00	961.46 ± 1.80
300.00	1146.74 ± 0.63	370.00	1051.08 ± 0.48		
310.00	1133.66 ± 0.27	380.00	1036.64 ± 0.64		

**(S)-1,2-Dichloropropane** [74282-28-3] C<sub>3</sub>H<sub>6</sub>Cl<sub>2</sub> MW = 112.99 218

**Table 1.** Experimental value with uncertainty.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1147.80 ± 1.50	1951-fic/gar

**1,3-Dichloropropane** [142-28-9] C<sub>3</sub>H<sub>6</sub>Cl<sub>2</sub> MW = 112.99 219

**Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):  $\sigma_{\text{c,w}} = 8.8276 \cdot 10^{-1}$  (combined temperature ranges, weighted),  $\sigma_{\text{c,uw}} = 3.4916 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 293.15 \text{ to } 358.15 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
A	$1.54347 \cdot 10^3$
B	-1.22345

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
298.15	1176.80 ± 1.00	-1.90	1928-ros/mar(Δ)	313.15	1160.40 ± 1.00	0.05	1960-grz/jef(□)
293.15	1185.90 ± 1.00	1.08	1950-mum/phi(○)	333.15	1136.20 ± 1.00	0.32	1960-grz/jef(□)
298.15	1180.00 ± 1.00	1.30	1950-mum/phi(○)	358.15	1105.00 ± 1.00	-0.29	1960-grz/jef(□)
293.15	1184.50 ± 1.00	-0.32	1960-grz/jef(□)	298.15	1178.45 ± 0.50	-0.25	1993-bla/ort-1(∇)

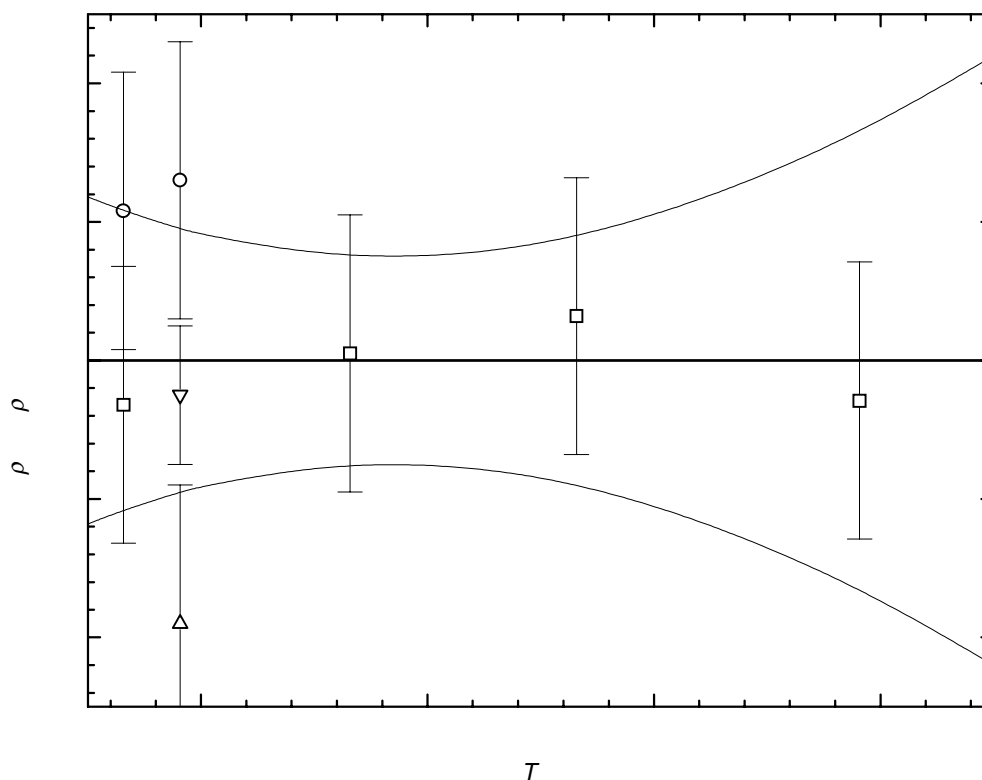
**Further references:** [1948-vog, 1958-far/spe, 1995-com/fra-1].

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
290.00	1188.67 ± 1.18	310.00	1164.20 ± 0.76	350.00	1115.26 ± 1.34
293.15	1184.82 ± 1.08	320.00	1151.97 ± 0.74	360.00	1103.03 ± 1.72
298.15	1178.70 ± 0.95	330.00	1139.73 ± 0.83	370.00	1090.79 ± 2.20
300.00	1176.44 ± 0.91	340.00	1127.50 ± 1.04		

cont.

**1,3-Dichloropropane (cont.)**

**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**1-Chloropropane****[540-54-5]****C<sub>3</sub>H<sub>7</sub>Cl****MW = 78.54****220**

**Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{c,w} = 1.4023$  (combined temperature ranges, weighted),  $\sigma_{c,uw} = 3.7391 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 273.15 \text{ to } 423.15 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
<i>A</i>	$1.09025 \cdot 10^3$
<i>B</i>	$-1.33471 \cdot 10^{-1}$
<i>C</i>	$-1.86266 \cdot 10^{-3}$

cont.

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

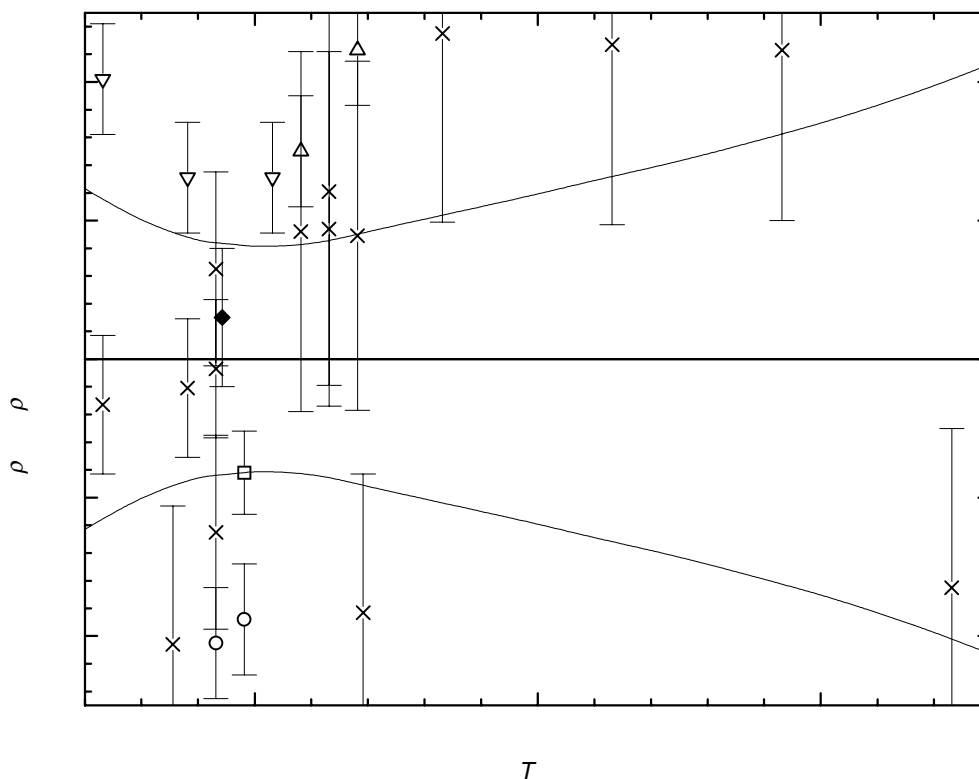
$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
293.15	889.80 ± 0.70	-1.25	1880-bru-3(×)	288.15	898.44 ± 1.37	1.31	1958-afe <sup>1)</sup>
319.15	856.10 ± 1.00	-1.83	1883-sch-3(×)	293.15	892.23 ± 1.35	1.18	1958-afe <sup>1)</sup>
273.15	914.49 ± 0.50	-0.33	1912-kar(×)	298.15	885.94 ± 1.33	1.06	1958-afe <sup>1)</sup>
288.15	896.92 ± 0.50	-0.21	1912-kar(×)	303.15	879.59 ± 1.32	0.98	1958-afe <sup>1)</sup>
293.15	890.98 ± 0.50	-0.07	1912-kar(×)	308.15	873.17 ± 1.30	0.92	1958-afe(×)
273.15	916.84 ± 0.40	2.02	1930-tim/hen(∇)	313.15	866.73 ± 1.28	0.94	1958-afe(×)
288.15	898.44 ± 0.40	1.31	1930-tim/hen(∇)	318.15	860.14 ± 1.26	0.89	1958-afe(×)
303.15	879.92 ± 0.40	1.31	1930-tim/hen(∇)	308.15	873.75 ± 0.40	1.50	1981-mal/rae(Δ)
285.55	898.20 ± 1.00	-2.06	1943-vog(×)	318.15	861.48 ± 0.40	2.23	1981-mal/rae(Δ)
293.15	889.00 ± 1.00	-2.05	1943-vog <sup>1)</sup>	293.15	891.70 ± 0.70	0.65	1983-kor/tol-1(×)
313.85	860.90 ± 1.00	-3.98	1943-vog(×)	293.15	893.40 ± 1.44	2.35	1988-rut <sup>1)</sup>
314.75	859.70 ± 1.00	-4.01	1943-vog(×)	313.15	867.00 ± 1.40	1.21	1988-rut(×)
293.15	889.00 ± 0.40	-2.05	1950-mum/phi(○)	333.15	841.40 ± 1.36	2.35	1988-rut(×)
298.15	883.00 ± 0.40	-1.88	1950-mum/phi(○)	363.15	798.40 ± 1.30	2.27	1988-rut(×)
294.25	890.00 ± 0.50	0.30	1951-bar/hea(◆)	393.15	752.10 ± 1.23	2.23	1988-rut(×)
273.15	916.88 ± 1.43	2.06	1958-afe <sup>1)</sup>	423.15	698.60 ± 1.15	-1.65	1988-rut(×)
283.15	904.67 ± 1.39	1.55	1958-afe <sup>1)</sup>	298.15	884.06 ± 0.30	-0.82	2001-kov/aim(□)

<sup>1)</sup> Not included in Fig. 1.**Further references:** [1872-lin-1, 1872-pie/puc, 1882-zan, 1884-sch-6, 1885-per, 1924-fuh, 1992-ma/fan].**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	918.42 ± 1.23	320.00	856.80 ± 0.92	390.00	754.88 ± 1.59
280.00	906.84 ± 0.99	330.00	843.36 ± 1.01	400.00	738.83 ± 1.70
290.00	894.89 ± 0.85	340.00	829.55 ± 1.10	410.00	722.41 ± 1.83
293.15	891.05 ± 0.84	350.00	815.36 ± 1.19	420.00	705.62 ± 1.97
298.15	884.88 ± 0.82	360.00	800.80 ± 1.29	430.00	688.45 ± 2.13
300.00	882.57 ± 0.81	370.00	785.87 ± 1.38		
310.00	869.87 ± 0.82	380.00	770.56 ± 1.48		

cont.

**1-Chloropropane (cont.)**

**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**2-Chloropropane**

[75-29-6]

C<sub>3</sub>H<sub>7</sub>Cl

MW = 78.54

221

 $T_c = 482.40 \text{ K}$  [1992-ma/fan]

 $\rho_c = 325.00 \text{ kg}\cdot\text{m}^{-3}$  [1992-ma/fan]

**Table 1.** Coefficients for the polynomial expansion equations. Standard deviations (see introduction):  $\sigma_t = 5.5084 \cdot 10^{-1}$  (low temperature range),  $\sigma_{c,w} = 1.2714$  (combined temperature ranges, weighted),  $\sigma_{c,uw} = 6.3555 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 273.15 \text{ to } 370.00 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$	$T = 370.00 \text{ to } 482.40 \text{ K}$ $\rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)]$ $[\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4]$
A	$1.06463 \cdot 10^3$	1.26269
B	$-9.53643 \cdot 10^{-2}$	$-3.62513 \cdot 10^{-2}$
C	$-2.03130 \cdot 10^{-3}$	$3.69083 \cdot 10^{-4}$
D		$-1.24923 \cdot 10^{-6}$

cont.

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

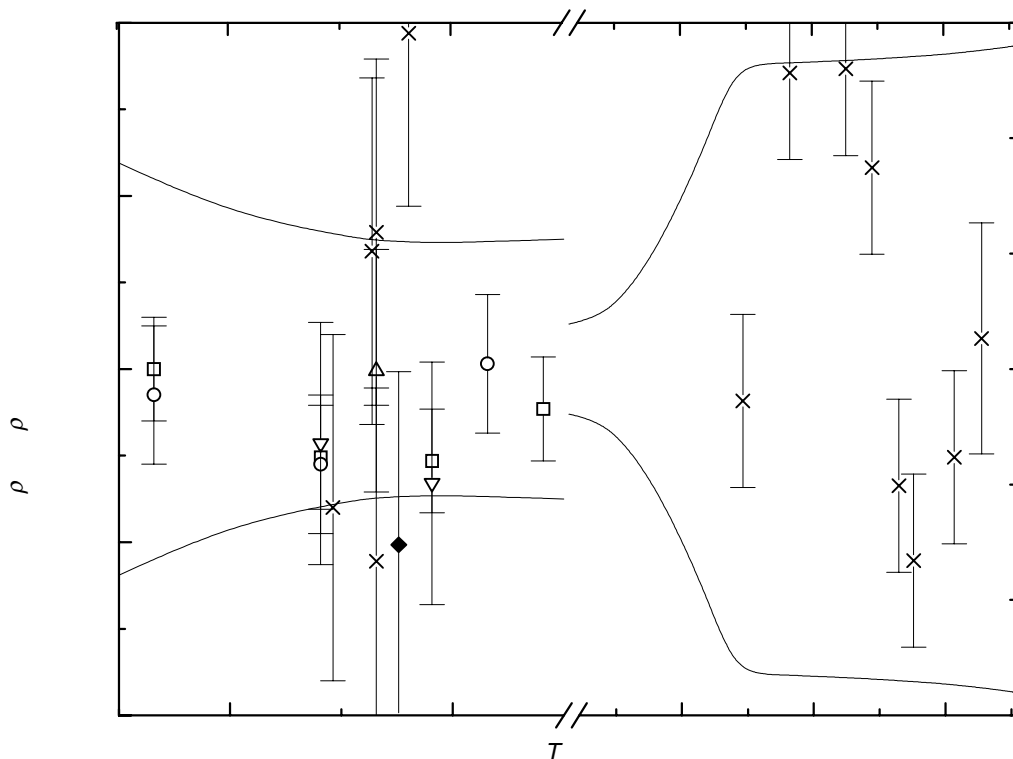
$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
288.15	868.06 ± 0.70	-0.43	1885-per-1(∇)	298.15	855.10 ± 0.30	-0.53	1958-afe(□)
298.15	854.97 ± 0.70	-0.66	1885-per-1(∇)	308.15	842.13 ± 0.30	-0.23	1958-afe(□)
273.15	886.87 ± 0.40	-0.15	1928-tim/mar(○)	373.92	744.20 ± 1.50	-0.55	1992-ma /fan(×)
288.15	867.94 ± 0.40	-0.55	1928-tim/mar(○)	391.71	717.10 ± 1.50	5.13	1992-ma /fan(×)
303.15	849.07 ± 0.40	0.03	1928-tim/mar(○)	412.95	678.40 ± 1.50	5.20	1992-ma /fan(×)
293.15	861.00 ± 1.00	-1.11	1937-gro/sug(×)	422.90	659.10 ± 1.50	3.49	1992-ma /fan(×)
289.25	866.30 ± 1.00	-0.80	1943-vog(×)	433.16	634.50 ± 1.50	-2.02	1992-ma /fan(×)
292.75	863.30 ± 1.00	0.68	1943-vog(×)	438.75	621.70 ± 1.50	-3.32	1992-ma /fan(×)
293.15	862.90 ± 1.00	0.79	1943-vog(×)	448.27	595.30 ± 1.50	-6.78	1992-ma /fan(×)
296.05	860.30 ± 1.00	1.94	1943-vog(×)	454.15	583.20 ± 1.50	-1.53	1992-ma /fan(×)
297.55	859.00 ± 1.00	2.59	1943-vog(×)	464.54	545.00 ± 2.00	0.53	1992-ma /fan(×)
298.75	858.00 ± 1.00	3.16	1943-vog <sup>1)</sup>	470.90	518.60 ± 2.00	8.48	1992-ma /fan(×)
295.15	858.50 ± 1.00	-1.03	1950-bar/hea(◆)	472.55	510.30 ± 2.00	11.04	1992-ma /fan(×)
293.15	862.10 ± 0.70	-0.01	1951-con(Δ)	476.22	495.54 ± 3.00	25.11	1992-ma /fan <sup>1)</sup>
273.15	887.02 ± 0.30	-0.00	1958-afe(□)	479.68	472.70 ± 4.00	40.92	1992-ma /fan <sup>1)</sup>
288.15	867.98 ± 0.30	-0.51	1958-afe(□)				

<sup>1)</sup> Not included in Fig. 1.**Further references:** [1882-zan, 1924-fuh, 1926-gri/ono, 1935-has/mcb, 1946-hus/bar, 1956-goe/mcc].**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	890.80 ± 1.19	330.00	811.95 ± 1.34	410.00	678.42 ± 5.34
280.00	878.67 ± 0.90	340.00	797.39 ± 2.01	420.00	660.77 ± 5.36
290.00	866.14 ± 0.77	350.00	782.42 ± 2.89	430.00	642.61 ± 5.39
293.15	862.11 ± 0.74	360.00	767.04 ± 3.93	440.00	622.28 ± 5.42
298.15	855.63 ± 0.73	370.00	751.26 ± 5.13	450.00	597.28 ± 5.45
300.00	853.20 ± 0.73	380.00	733.91 ± 5.29	460.00	563.92 ± 5.50
310.00	839.86 ± 0.75	390.00	715.19 ± 5.30	470.00	515.64 ± 5.55
320.00	826.11 ± 0.91	400.00	696.50 ± 5.32	480.00	426.99 ± 5.62

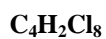
cont.

**2-Chloropropane (cont.)**

**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**1,1,1,2,2,3,3,4-Octachlorobutane**

[88982-96-1]



MW = 333.68

222

**Table 1.** Experimental value with uncertainty.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ $\text{kg} \cdot \text{m}^{-3}$	Ref.
293.15	$1861.40 \pm 2.00$	1963-ako/saa

**1,1,2,2,3,4-Hexachlorobutane**

[2431-55-2]



MW = 264.79

223

**Table 1.** Experimental value with uncertainty.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ $\text{kg} \cdot \text{m}^{-3}$	Ref.
293.15	$1658.90 \pm 2.00$	1963-ako/saa

**1,1,2,3-Tetrachloro-2-methylpropane** [18963-01-4] C<sub>4</sub>H<sub>6</sub>Cl<sub>4</sub> MW = 195.9 224

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1439.30 ± 3.00	1936-rog/nel
293.15	1446.80 ± 2.00	1959-nes/fre

**1,2,3-Trichloro-2-(chloromethyl)propane** [18963-00-3] C<sub>4</sub>H<sub>6</sub>Cl<sub>4</sub> MW = 195.9 225

**Table 1.** Experimental value with uncertainty.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1481.00 ± 3.00	1936-rog/nel

**1,1,1-Trichlorobutane** [13279-85-1] C<sub>4</sub>H<sub>7</sub>Cl<sub>3</sub> MW = 161.46 226

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	1224.20 ± 4.00	1955-bro/ash
293.15	1242.80 ± 2.00	1971-abr/ili

**1,1,3-Trichlorobutane** [13279-87-3] C<sub>4</sub>H<sub>7</sub>Cl<sub>3</sub> MW = 161.46 227

**Table 1.** Experimental value with uncertainty.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
288.15	1317.00 ± 3.00	1947-dul/bul

**1,2,3-Trichlorobutane** [18338-40-4] C<sub>4</sub>H<sub>7</sub>Cl<sub>3</sub> MW = 161.46 228

**Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
273.15	1324.10 ± 2.00	1894-lie
273.15	1324.10 ± 2.00	1899-cha
293.15	1316.40 ± 1.50	1936-tis/chu
291.15	1317.20 ± 1.50	1949-chu
293.15	1316.40 ± 1.00	1949-chu

**1,2,4-Trichlorobutane** [1790-22-3] C<sub>4</sub>H<sub>7</sub>Cl<sub>3</sub> MW = 161.46 229

**Table 1.** Experimental value with uncertainty.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	Ref.
293.15	1317.50 ± 2.00	1955-far/ust

**2,2,3-Trichlorobutane** [10403-60-8] C<sub>4</sub>H<sub>7</sub>Cl<sub>3</sub> MW = 161.46 230

**Table 1.** Experimental values with uncertainties.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	Ref.
293.15	1269.90 ± 1.50	1936-tis/chu
291.15	1263.00 ± 2.00	1938-tis

**1,1,2-Trichloro-2-methylpropane** [29559-52-2] C<sub>4</sub>H<sub>7</sub>Cl<sub>3</sub> MW = 161.46 231

**Table 1.** Fit with estimated B coefficient for 2 accepted points. Deviation  $\sigma_w = 0.000$ .

Coefficient	$\rho = A + BT$
A	1655.29
B	-1.300

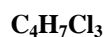
**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	$\rho_{\text{exp}} - \rho_{\text{calc}}$ kg·m <sup>-3</sup>	Ref.
289.15	1275.00 ± 4.00	-4.40	1900-mou <sup>1)</sup>
298.15	1271.20 ± 2.00	3.50	1936-rog/nel <sup>1)</sup>
303.15	1261.20 ± 0.80	0.00	1945-taf/str
298.15	1267.70 ± 0.80	0.00	1948-taf/str

<sup>1)</sup> Not included in calculation of linear coefficients.

**Table 3.** Recommended values.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>
290.00	1278.3 ± 0.6
293.15	1274.2 ± 0.5
298.15	1267.7 ± 0.4
310.00	1252.3 ± 0.6

**1,2,3-Trichloro-2-methylpropane****[1871-58-5]****MW = 161.46****232****Table 1.** Experimental and recommended values with uncertainties.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.	$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
298.15	$1302.00 \pm 1.00$	1936-rog/nel	298.15	$1301.20 \pm 0.80$	1948-taf/str
303.15	$1293.40 \pm 1.50$	1945-taf/str <sup>1)</sup>	293.15	$1291.80 \pm 2.00$	1961-fre/kos <sup>1)</sup>
298.15	$1300.20 \pm 1.00$	1947-hat/rus	298.15	$1301.30 \pm 0.80$	Recommended
298.15	$1302.00 \pm 1.00$	1947-hat/rus			

<sup>1)</sup> Not included in calculation of recommended value.**1,1-Dichlorobutane****[541-33-3]****MW = 127.01****233****Table 1.** Experimental value with uncertainty.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
293.15	$1086.30 \pm 1.00$	1937-tis/chu-1

**1,2-Dichlorobutane****[616-21-7]****MW = 127.01****234****Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{\text{c,w}} = 1.6660$  (combined temperature ranges, weighted),  $\sigma_{\text{c,uw}} = 5.4834 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

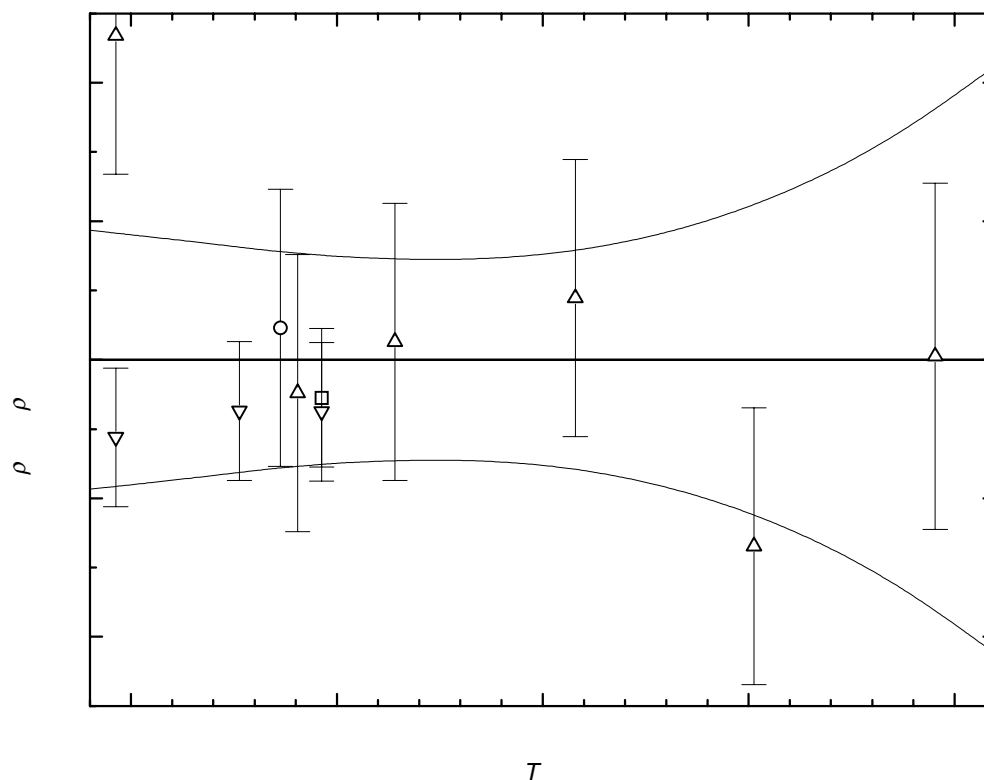
Coefficient	$T = 273.15 \text{ to } 372.65 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
A	$1.43409 \cdot 10^3$
B	-1.07912

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
273.15	$1144.00 \pm 2.00$	4.68	1924-bri/hau( $\Delta$ )	273.15	$1138.20 \pm 1.00$	-1.12	1930-nav( $\nabla$ )
295.25	$1115.00 \pm 2.00$	-0.48	1924-bri/hau( $\Delta$ )	288.15	$1122.40 \pm 1.00$	-0.74	1930-nav( $\nabla$ )
307.05	$1103.00 \pm 2.00$	0.26	1924-bri/hau( $\Delta$ )	298.15	$1111.60 \pm 1.00$	-0.75	1930-nav( $\nabla$ )
328.95	$1080.00 \pm 2.00$	0.89	1924-bri/hau( $\Delta$ )	293.15	$1118.20 \pm 2.00$	0.46	1937-tis/chu( $\circ$ )
350.65	$1053.00 \pm 2.00$	-2.69	1924-bri/hau( $\Delta$ )	293.15	$1114.70 \pm 0.00$	-3.04	1937-tis/chu-1 <sup>1)</sup>
372.65	$1032.00 \pm 2.50$	0.05	1924-bri/hau( $\Delta$ )	298.15	$1111.80 \pm 1.00$	-0.55	1955-bro/ash( $\square$ )

<sup>1)</sup> Not included in Fig. 1.**Further references:** [1954-ali].

cont.

**1,2-Dichlorobutane** (cont.)

**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	1142.72 ± 1.87	300.00	1110.35 ± 1.49	350.00	1056.39 ± 2.19
280.00	1131.93 ± 1.74	310.00	1099.56 ± 1.44	360.00	1045.60 ± 2.70
290.00	1121.14 ± 1.60	320.00	1088.77 ± 1.46	370.00	1034.81 ± 3.38
293.15	1117.74 ± 1.56	330.00	1077.98 ± 1.58	380.00	1024.02 ± 4.25
298.15	1112.35 ± 1.51	340.00	1067.19 ± 1.82		

**1,3-Dichlorobutane****[1190-22-3]****MW = 127.01****235****Table 1.** Experimental values with uncertainties.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
293.15	$1115.80 \pm 2.00$	1937-tis/chu-1
293.15	$1084.90 \pm 5.00$	1953-ter/ger
298.15	$1108.30 \pm 2.00$	1955-bro/ash
293.15	$1111.72 \pm 0.60$	1958-far/spe
298.15	$1120.00 \pm 3.00$	1990-an/he

**1,4-Dichlorobutane****[110-56-5]****MW = 127.01****236****Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{\text{c,w}} = 1.7516$  (combined temperature ranges, weighted),  $\sigma_{\text{c,uw}} = 4.1339 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 285.15 \text{ to } 358.15 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
<i>A</i>	$1.43385 \cdot 10^3$
<i>B</i>	-1.00531

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
293.15	$1140.80 \pm 1.00$	1.66	1950-mum/phi(∇)	333.15	$1099.30 \pm 1.00$	0.37	1960-grz/jef(×)
298.15	$1135.30 \pm 1.00$	1.19	1950-mum/phi(∇)	358.15	$1072.20 \pm 1.50$	-1.60	1960-grz/jef(×)
285.15	$1149.80 \pm 2.00$	2.62	1953-wil-1(×)	298.15	$1132.90 \pm 0.50$	-1.21	1985-lai/wil(□)
293.15	$1138.40 \pm 1.00$	-0.74	1955-tan(◆)	298.15	$1133.06 \pm 0.50$	-1.05	1993-bla/ort-1(Δ)
293.15	$1139.50 \pm 1.00$	0.36	1960-grz/jef(×)	298.15	$1133.86 \pm 0.50$	-0.25	1995-com/fra-1(○)
313.15	$1117.70 \pm 1.00$	-1.33	1960-grz/jef(×)				

**Further references:** [1937-tis/chu-1, 1951-oka, 1953-ter/ger, 1955-bro/ash, 1955-lut/kut, 1956-shu/bel-3, 1958-sha, 1959-lut/kut, 1959-lut/kut-1, 1960-tsu/kad, 1990-an/he].

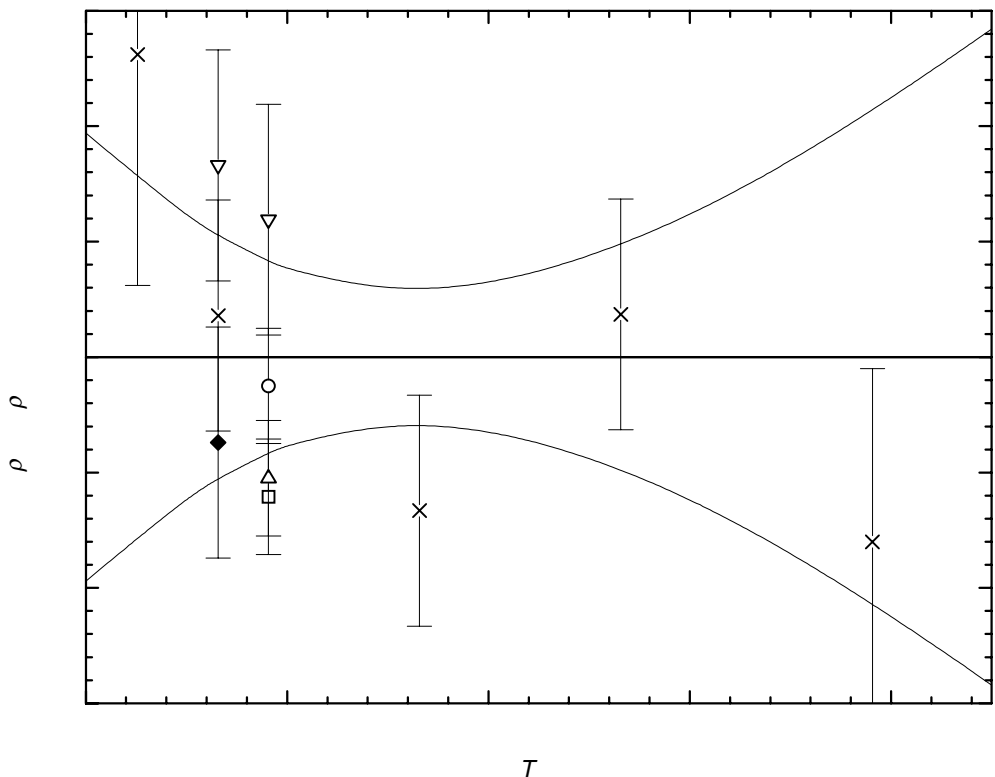
**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4]$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
280.00	$1152.36 \pm 1.94$	300.00	$1132.25 \pm 0.76$	340.00	$1092.04 \pm 1.22$
290.00	$1142.31 \pm 1.22$	310.00	$1122.20 \pm 0.56$	350.00	$1081.99 \pm 1.69$
293.15	$1139.14 \pm 1.05$	320.00	$1112.15 \pm 0.62$	360.00	$1071.94 \pm 2.24$
298.15	$1134.11 \pm 0.83$	330.00	$1102.09 \pm 0.86$	370.00	$1061.88 \pm 2.84$

cont.

**1,4-Dichlorobutane (cont.)**



**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**2,2-Dichlorobutane** [4279-22-5] C<sub>4</sub>H<sub>8</sub>Cl<sub>2</sub> MW = 127.01 237

**Table 1.** Experimental values with uncertainties.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	Ref.
293.15	1066.50 ± 2.00	1937-tis/chu
294.95	1069.00 ± 2.50	1938-sto/rou

**2,3-Dichlorobutane** [7581-97-7] C<sub>4</sub>H<sub>8</sub>Cl<sub>2</sub> MW = 127.01 238

**Table 1.** Fit with estimated B coefficient for 4 accepted points. Deviation  $\sigma_w = 0.490$ .

Coefficient	$\rho = A + BT$
A	1463.92
B	-1.200

cont.

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
273.15	$1136.60 \pm 1.00$	0.46	1930-nav	293.15	$1106.70 \pm 2.00$	-5.44	1937-tis/chu <sup>1)</sup>
288.15	$1118.30 \pm 1.00$	0.16	1930-nav	298.15	$1106.30 \pm 0.60$	0.16	1941-luc/gou
298.15	$1105.10 \pm 1.00$	-1.04	1930-nav	293.15	$1107.00 \pm 2.00$	-5.14	1954-ali <sup>1)</sup>

<sup>1)</sup> Not included in calculation of linear coefficients.**Table 3.** Recommended values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	$1139.9 \pm 1.0$
280.00	$1127.9 \pm 0.8$
290.00	$1115.9 \pm 0.7$
293.15	$1112.1 \pm 0.7$
298.15	$1106.1 \pm 0.7$

**Meso-2,3-Dichlorobutane**

[500005-85-6]

C<sub>4</sub>H<sub>8</sub>Cl<sub>2</sub>

MW = 127.01

239

**Table 1.** Fit with estimated B coefficient for 4 accepted points. Deviation  $\sigma_w = 0.179$ .

Coefficient	$\rho = A + BT$
A	1466.27
B	-1.220

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref.
273.15	$1133.30 \pm 1.00$	0.27	1930-nav
288.15	$1114.70 \pm 1.00$	-0.03	1930-nav
298.15	$1102.50 \pm 1.00$	-0.03	1930-nav
298.15	$1102.30 \pm 1.00$	-0.23	1941-luc/gou

**Table 3.** Recommended values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	$1136.9 \pm 1.3$
280.00	$1124.7 \pm 1.0$
290.00	$1112.5 \pm 0.9$
293.15	$1108.6 \pm 0.9$
298.15	$1102.5 \pm 1.0$

**(R\*,S\*)-2,3-Dichlorobutane****[4028-56-2]****C<sub>4</sub>H<sub>8</sub>Cl<sub>2</sub>****MW = 127.01****240****Table 1.** Experimental value with uncertainty.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	Ref.
298.15	1104.80 ± 1.50	1941-luc/gou

**1-Chlorobutane****[109-69-3]****C<sub>4</sub>H<sub>9</sub>Cl****MW = 92.57****241****Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{\text{c,w}} = 1.0605$  (combined temperature ranges, weighted),  $\sigma_{\text{c,uw}} = 2.3107 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 183.15 \text{ to } 423.15 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
<i>A</i>	$1.13642 \cdot 10^3$
<i>B</i>	$-5.91083 \cdot 10^{-1}$
<i>C</i>	$-8.95978 \cdot 10^{-4}$

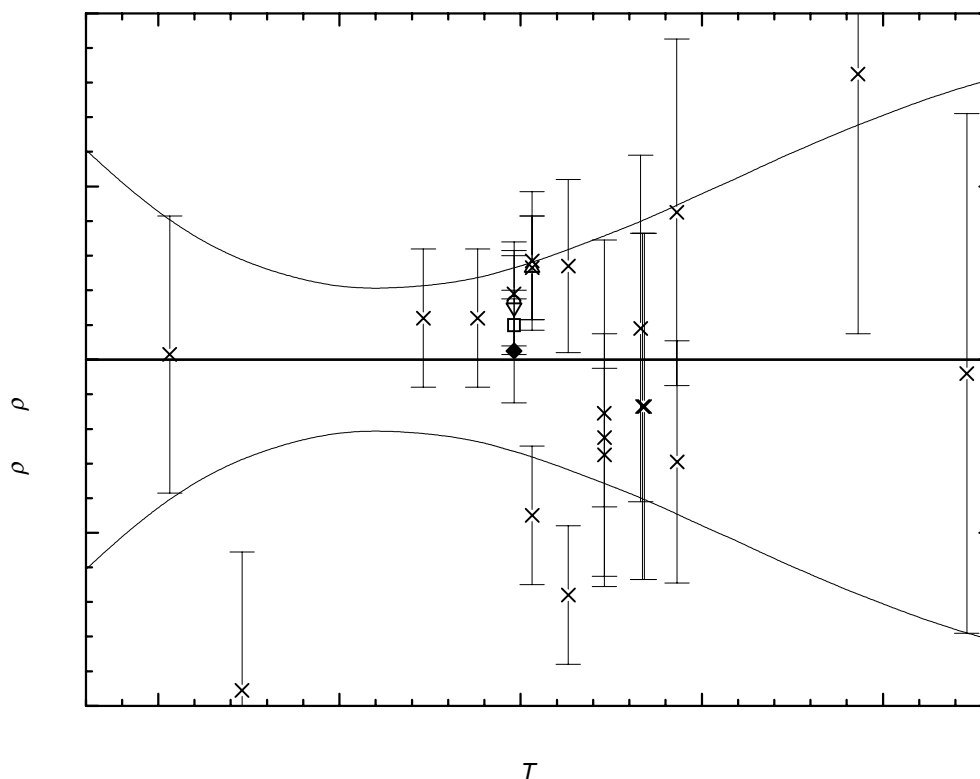
**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	$\rho_{\text{exp}} - \rho_{\text{calc}}$ kg·m <sup>-3</sup>	Ref. (Symbol in Fig. 1)	$T$ K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ kg·m <sup>-3</sup>	$\rho_{\text{exp}} - \rho_{\text{calc}}$ kg·m <sup>-3</sup>	Ref. (Symbol in Fig. 1)
273.15	905.34 ± 0.80	-2.78	1912-kar(×)	323.15	851.40 ± 0.40	-0.45	1949-lag/mcm(×)
288.15	889.21 ± 0.80	-2.50	1912-kar <sup>1)</sup>	293.10	885.50 ± 1.00	-0.71	1955-kus <sup>1)</sup>
293.15	883.85 ± 0.80	-2.30	1912-kar <sup>1)</sup>	298.10	879.70 ± 1.00	-0.90	1955-kus <sup>1)</sup>
183.15	1000.48 ± 0.80	2.37	1930-smy/rog-1(×)	303.10	874.10 ± 1.00	-0.85	1955-kus <sup>1)</sup>
203.15	979.40 ± 0.80	0.03	1930-smy/rog-1(×)	313.10	862.90 ± 1.00	-0.62	1955-kus <sup>1)</sup>
223.15	958.00 ± 0.80	-1.91	1930-smy/rog-1(×)	323.10	851.60 ± 1.00	-0.31	1955-kus(×)
243.15	937.50 ± 0.80	-2.23	1930-smy/rog-1(×)	333.10	840.30 ± 1.00	0.18	1955-kus(×)
263.15	915.70 ± 0.70	-3.14	1930-smy/rog-1 <sup>1)</sup>	343.10	829.00 ± 1.00	0.85	1955-kus(×)
283.15	895.00 ± 0.70	-2.23	1930-smy/rog-1(×)	298.15	880.93 ± 0.30	0.38	1969-cou/her(×)
303.15	873.60 ± 0.70	-1.30	1930-smy/rog-1 <sup>1)</sup>	303.15	875.43 ± 0.30	0.53	1980-kri/rao(×)
323.15	851.30 ± 0.70	-0.55	1930-smy/rog-1(×)	303.15	875.43 ± 0.30	0.53	1986-mou/nai(Δ)
343.15	827.50 ± 0.70	-0.59	1930-smy/rog-1(×)	298.15	880.60 ± 0.30	0.05	1988-jun/tar(◆)
273.15	908.36 ± 0.40	0.24	1930-tim/hen(×)	293.15	888.50 ± 1.50	2.35	1988-rut <sup>1)</sup>
288.15	891.95 ± 0.40	0.24	1930-tim/hen(×)	313.15	865.40 ± 1.50	1.94	1988-rut <sup>1)</sup>
303.15	875.47 ± 0.40	0.57	1930-tim/hen(×)	333.15	842.40 ± 1.50	2.34	1988-rut(×)
293.15	885.90 ± 1.00	-0.25	1943-vog <sup>1)</sup>	363.15	806.20 ± 1.50	2.59	1988-rut(×)
296.45	882.10 ± 1.00	-0.36	1943-vog <sup>1)</sup>	393.15	767.20 ± 1.50	1.65	1988-rut(×)
315.15	860.50 ± 1.00	-0.66	1943-vog <sup>1)</sup>	423.15	725.80 ± 1.50	-0.08	1988-rut(×)
333.65	839.20 ± 1.00	-0.27	1943-vog(×)	298.15	880.88 ± 0.30	0.33	1990-mun/ber(○)
334.15	838.60 ± 1.00	-0.27	1943-vog(×)	298.15	880.85 ± 0.30	0.30	1996-dom/rod(V)
293.15	885.10 ± 0.40	-1.05	1949-lag/mcm <sup>1)</sup>	298.15	880.80 ± 0.50	0.25	2000-dom/laf <sup>1)</sup>
303.15	874.00 ± 0.40	-0.90	1949-lag/mcm(×)	313.15	864.00 ± 0.50	0.54	2000-dom/laf(×)
313.15	862.10 ± 0.40	-1.36	1949-lag/mcm(×)	298.15	880.75 ± 0.20	0.20	2001-kov/aim(□)

<sup>1)</sup> Not included in Fig. 1.

cont.

**Further references:** [1871-lie/ros, 1872-lin, 1879-ram, 1924-fuh, 1933-bri, 1937-gro/sug, 1937-tis, 1942-aud/gos-1, 1948-lag/eva, 1949-dre/mar, 1950-mum/phi, 1951-bar/hea, 1952-kla/ste, 1968-ano, 1970-her/cou-1, 1971-her/cou, 1972-her/cou, 1975-str/sun, 1981-kri/rao, 1981-mal/rae, 1982-dig/jad, 1985-lai/wil, 1986-auc/par, 1999-san/bal].



**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations  $\rho = A + BT + CT^2 + DT^3 + \dots$  or  $\rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4]$ ).

$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
180.00	1001.00 ± 1.21	230.00	953.08 ± 0.52	280.00	900.68 ± 0.44
190.00	991.77 ± 1.02	240.00	942.96 ± 0.46	290.00	889.66 ± 0.48
200.00	982.37 ± 0.85	250.00	932.66 ± 0.42	293.15	886.15 ± 0.50
210.00	972.78 ± 0.71	260.00	922.17 ± 0.41	298.15	880.55 ± 0.53
220.00	963.02 ± 0.60	270.00	911.52 ± 0.42	300.00	878.46 ± 0.54

cont.

**1-Chlorobutane** (cont.)**Table 3.** (cont.)

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
310.00	867.09 ± 0.61	360.00	807.52 ± 1.05	410.00	743.47 ± 1.49
320.00	855.53 ± 0.69	370.00	795.06 ± 1.15	420.00	730.12 ± 1.56
330.00	843.79 ± 0.77	380.00	782.43 ± 1.24	430.00	716.59 ± 1.62
340.00	831.88 ± 0.86	390.00	769.62 ± 1.33		
350.00	819.79 ± 0.96	400.00	756.63 ± 1.41		

**2-Chlorobutane**

[78-86-4]

C<sub>4</sub>H<sub>9</sub>Cl

MW = 92.57

242

**Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{\text{c,w}} = 4.8080 \cdot 10^{-1}$  (combined temperature ranges, weighted),  $\sigma_{\text{c,uw}} = 1.0718 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

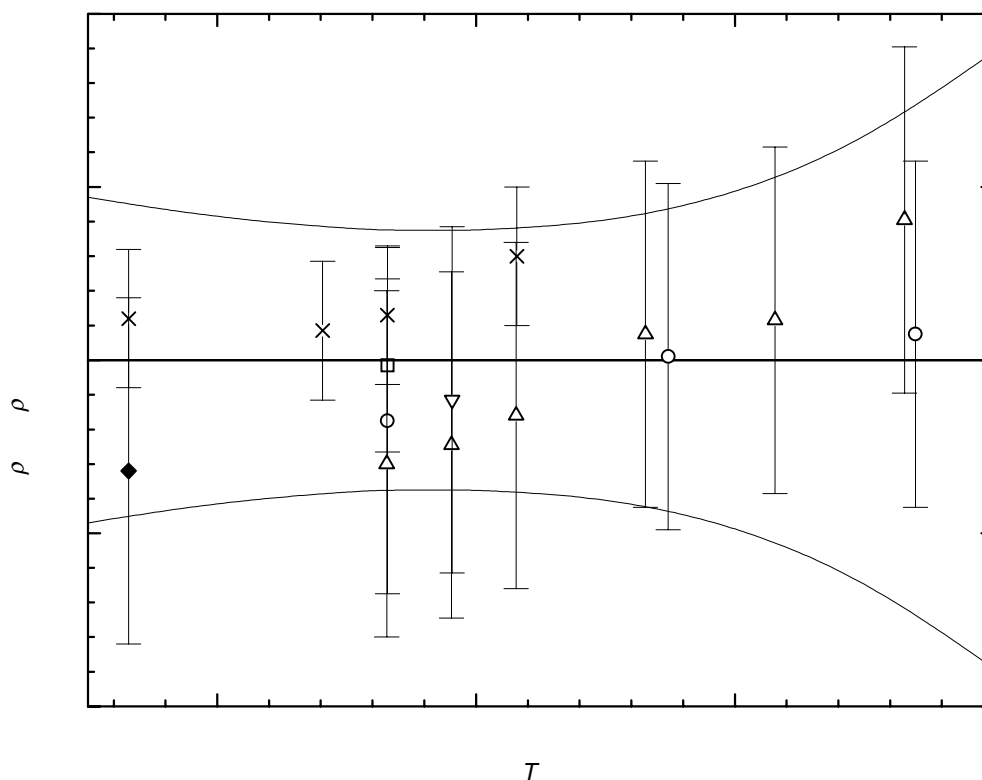
Coefficient	$T = 273.15 \text{ to } 333.95 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
<i>A</i>	$1.11992 \cdot 10^3$
<i>B</i>	$-5.47220 \cdot 10^{-1}$
<i>C</i>	$-1.00719 \cdot 10^{-3}$

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
273.15	894.66 ± 1.00	-0.64	1900-est(◆)	298.15	867.00 ± 1.00	-0.23	1955-fre/lwo(∇)
273.15	895.54 ± 0.40	0.24	1928-tim/mar(×)	293.10	872.40 ± 1.00	-0.60	1955-kus(Δ)
288.15	878.78 ± 0.40	0.17	1928-tim/mar(×)	298.10	866.80 ± 1.00	-0.49	1955-kus(Δ)
293.15	873.21 ± 0.40	0.26	1928-tim/mar(×)	303.10	861.20 ± 1.00	-0.32	1955-kus(Δ)
303.15	862.07 ± 0.40	0.60	1928-tim/mar(×)	313.10	850.00 ± 1.00	0.15	1955-kus(Δ)
293.15	872.60 ± 1.00	-0.35	1943-vog(○)	323.10	838.20 ± 1.00	0.23	1955-kus(Δ)
314.85	847.80 ± 1.00	0.02	1943-vog(○)	333.10	826.70 ± 1.00	0.81	1955-kus(Δ)
333.95	825.00 ± 1.00	0.15	1943-vog(○)	293.15	872.92 ± 0.50	-0.03	1982-dig/jad(□)

**Further references:** [1901-nor/gre, 1937-tis/chu].

cont.



**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations  $\rho = A + BT + CT^2 + DT^3 + \dots$  or  $\rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4]$ ).

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	$898.74 \pm 0.94$	298.15	$867.23 \pm 0.75$	330.00	$829.65 \pm 1.26$
280.00	$887.73 \pm 0.82$	300.00	$865.10 \pm 0.75$	340.00	$817.43 \pm 1.78$
290.00	$876.52 \pm 0.76$	310.00	$853.49 \pm 0.79$		
293.15	$872.95 \pm 0.75$	320.00	$841.67 \pm 0.95$		

**1-Chloro-2-methylpropane****[513-36-0]****C<sub>4</sub>H<sub>9</sub>Cl****MW = 92.57****243****Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

$\sigma_{c,w} = 1.0707$  (combined temperature ranges, weighted),  $\sigma_{c,uw} = 2.5939 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 273.15 \text{ to } 333.15 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
<i>A</i>	$1.21458 \cdot 10^3$
<i>B</i>	-1.15251

**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{K}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
288.15	$882.77 \pm 1.00$	0.28	1885-per-1(◆)	293.15	$876.80 \pm 1.00$	0.07	1955-kus(Δ)
298.15	$871.35 \pm 1.00$	0.39	1885-per-1(◆)	298.15	$871.11 \pm 1.00$	0.15	1955-kus(Δ)
273.15	$899.48 \pm 0.40$	-0.30	1926-tim/mar-1(□)	303.15	$865.30 \pm 1.00$	0.10	1955-kus(Δ)
288.15	$882.11 \pm 0.40$	-0.38	1926-tim/mar-1(□)	313.15	$853.60 \pm 1.00$	-0.07	1955-kus(Δ)
303.15	$862.43 \pm 0.40$	-2.77	1926-tim/mar-1(□)	323.15	$842.00 \pm 1.00$	-0.15	1955-kus(Δ)
293.15	$878.00 \pm 1.00$	1.27	1950-mum/phi(∇)	333.15	$830.40 \pm 1.00$	-0.22	1955-kus(Δ)
298.15	$872.50 \pm 1.00$	1.54	1950-mum/phi(∇)	298.15	$871.05 \pm 0.80$	0.09	2001-inf/art(○)

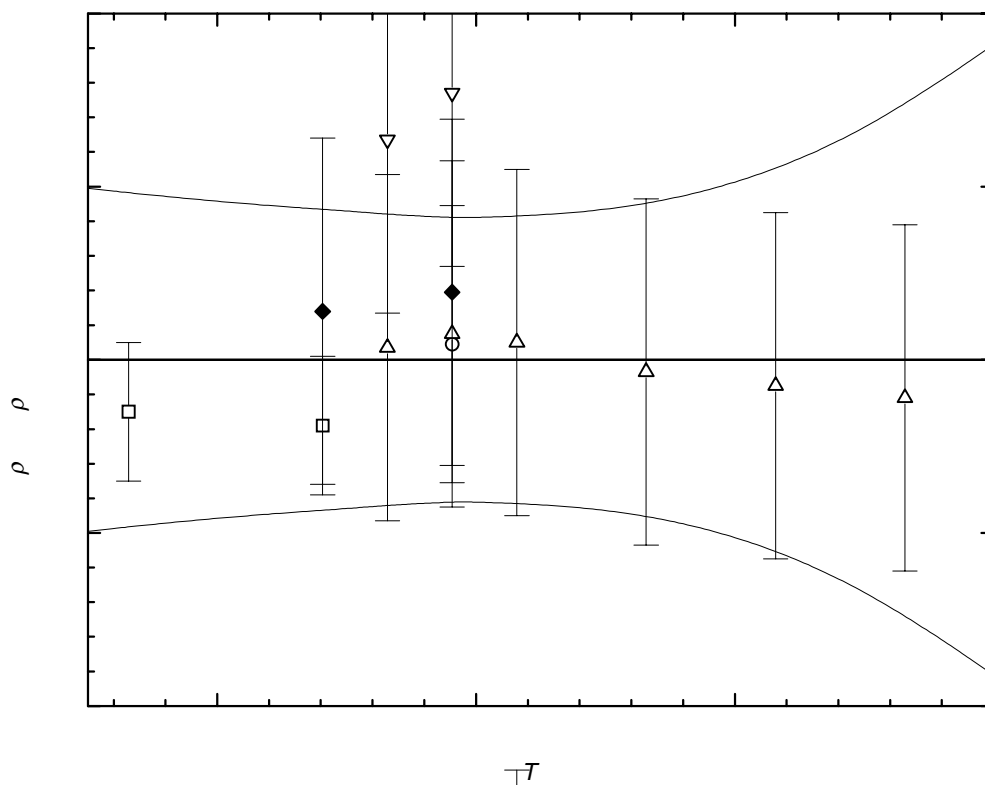
**Further references:** [1872-lin-2, 1872-pie/puc, 1884-gla, 1886-sch, 1924-fuh, 1943-vog, 1948-taf/str].

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
270.00	$903.41 \pm 0.99$	298.15	$870.96 \pm 0.82$	330.00	$834.26 \pm 1.31$
280.00	$891.88 \pm 0.91$	300.00	$868.83 \pm 0.82$	340.00	$822.73 \pm 1.82$
290.00	$880.36 \pm 0.86$	310.00	$857.31 \pm 0.85$		
293.15	$876.73 \pm 0.84$	320.00	$845.78 \pm 1.00$		

cont.



**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

## 2-Chloro-2-methylpropane

[507-20-0]

C<sub>4</sub>H<sub>9</sub>Cl

MW = 92.57

244

**Table 1.** Coefficients of the polynomial expansion equation. Standard deviations (see introduction):

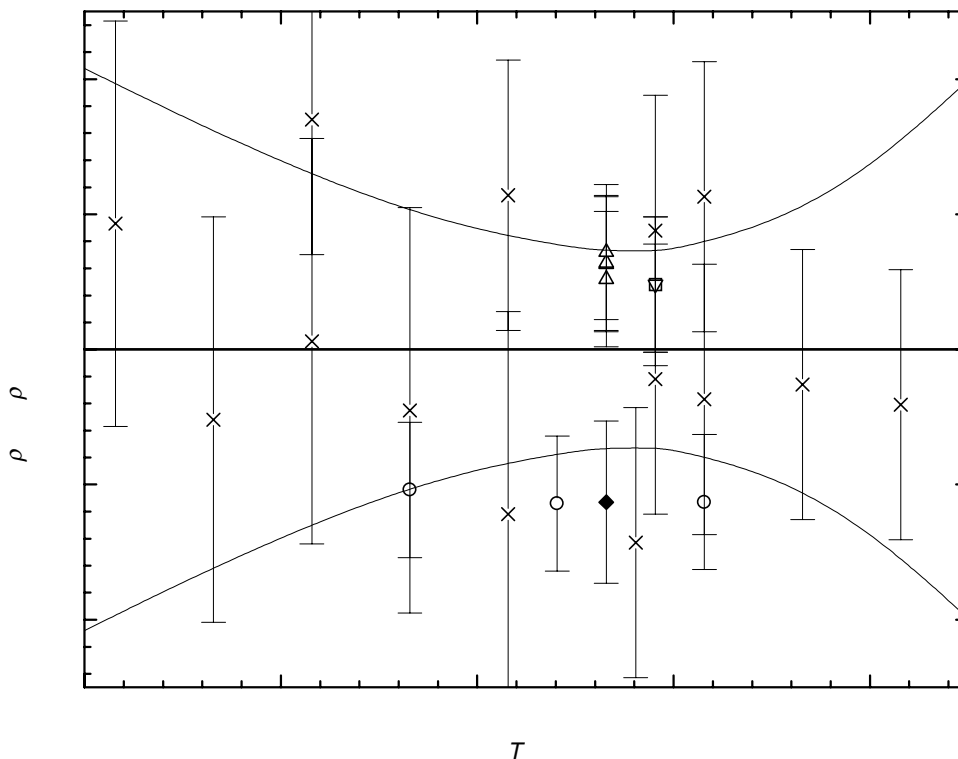
$\sigma_{c,w} = 1.3055$  (combined temperature ranges, weighted),  $\sigma_{c,uw} = 1.8738 \cdot 10^{-1}$  (combined temperature ranges, unweighted).

Coefficient	$T = 243.15 \text{ to } 323.15 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$
$A$	$1.13428 \cdot 10^3$
$B$	$-7.90676 \cdot 10^{-1}$
$C$	$-6.97752 \cdot 10^{-4}$

cont.

**2-Chloro-2-methylpropane** (cont.)**Table 2.** Experimental values with uncertainties and deviation from calculated values.

$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)	$\frac{T}{\text{K}}$	$\frac{\rho_{\text{exp}} \pm 2\sigma_{\text{est}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{\rho_{\text{exp}} - \rho_{\text{calc}}}{\text{kg} \cdot \text{m}^{-3}}$	Ref. (Symbol in Fig. 1)
263.15	879.60 ± 1.00	1.70	1931-smy/dor-1(×)	313.15	818.00 ± 1.00	-0.26	1955-kus(×)
283.15	855.60 ± 1.00	1.14	1931-smy/dor-1(×)	323.15	805.50 ± 1.00	-0.41	1955-kus(×)
303.15	831.60 ± 1.00	1.13	1931-smy/dor-1(×)	298.15	837.00 ± 0.50	0.48	1956-fai/win(∇)
298.15	837.00 ± 0.50	0.48	1932-nor/rig(□)	243.15	901.71 ± 1.50	0.93	1965-mal/hil(×)
273.15	865.21 ± 0.50	-1.04	1934-tim/del(○)	253.15	888.89 ± 1.50	-0.52	1965-mal/hil(×)
288.15	847.37 ± 0.50	-1.14	1934-tim/del(○)	263.15	877.96 ± 1.50	0.06	1965-mal/hil(×)
303.15	829.34 ± 0.50	-1.13	1934-tim/del(○)	273.15	865.80 ± 1.50	-0.45	1965-mal/hil(×)
298.15	837.40 ± 1.00	0.88	1948-taf/str(×)	283.15	853.24 ± 1.50	-1.22	1965-mal/hil(×)
296.15	837.50 ± 1.00	-1.43	1949-bar/ony(×)	293.15	841.75 ± 1.50	-0.78	1965-mal/hil <sup>1)</sup>
293.15	841.40 ± 0.60	-1.13	1954-ano-2(◆)	293.15	843.16 ± 0.50	0.63	1982-dig/jad(Δ)
293.15	842.30 ± 1.00	-0.23	1955-kus <sup>1)</sup>	293.15	843.17 ± 0.50	0.64	1982-dig/jad(Δ)
298.15	836.30 ± 1.00	-0.22	1955-kus(×)	293.15	843.25 ± 0.50	0.72	1982-dig/jad(Δ)
303.15	830.10 ± 1.00	-0.37	1955-kus(×)	293.15	843.05 ± 0.50	0.52	1982-dig/jad(Δ)

<sup>1)</sup> Not included in Fig. 1.**Further references:** [1885-per-1, 1935-has/mcb, 1939-qua/owe, 1941-sut/mal, 1943-vog, 1951-ger/lap-1, 1951-lev/skv-3].**Fig. 1.** The symbols show the deviation of the calculated from the experimental values from Table 2. The curves above and below the zero line indicate the calculated error region of the recommended values given in Table 3. The error bars represent the experimental errors. (Error bars smaller than the symbols are omitted for clarity of the figure.)

cont.

**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

$$\rho = A + BT + CT^2 + DT^3 + \dots \text{ or } \rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)][\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4].$$

$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{\text{K}}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
240.00	904.33 ± 2.08	280.00	858.19 ± 0.88	300.00	834.28 ± 0.74
250.00	893.00 ± 1.72	290.00	846.31 ± 0.75	310.00	822.12 ± 0.92
260.00	881.54 ± 1.39	293.15	842.53 ± 0.73	320.00	809.82 ± 1.33
270.00	869.93 ± 1.10	298.15	836.52 ± 0.73	330.00	797.37 ± 1.99