

3.1.5 Haloalkenes of General Formula $C_nH_{2n-(k+1)}A_kB_l$ (A,B - elements of halogen series)

1,4-Dibromo-2,3-dichloro-2-butene [1773-64-4] $C_4H_4Br_2Cl_2$ MW = 282.79 767

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	2069.50 ± 2.00	1965-bab/pet

3,4-Dibromo-1,2-dichloro-1-butene [1573-53-1] $C_4H_4Br_2Cl_2$ MW = 282.79 768

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	2050.00 ± 2.00	1965-bab/pet

1-Bromo-2,3-dichloro-2-butene [1573-76-8] $C_4H_5BrCl_2$ MW = 203.89 769

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1649.10 ± 2.00	1965-bab/pet

3-Bromo-1,2-dichloro-1-butene [1573-54-2] $C_4H_5BrCl_2$ MW = 203.89 770

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1673.00 ± 2.00	1965-bab/pet

3-Bromo-1,1-dichloro-2-methylpropene [118725-59-0] $C_4H_5BrCl_2$ MW = 203.89 771

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1654.80 ± 2.00	1959-nes/fre

1-Bromo-2,2-difluoroethene [500043-66-3] C_2HBrF_2 MW = 142.93 772

Table 1. Experimental value with uncertainty.

T K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ $\text{kg} \cdot \text{m}^{-3}$	Ref.
273.65	1817.50 ± 1.00	1948-hen/ruh

(E)-1,2-Dichloro-1,2-difluoroethene [381-71-5] $C_2Cl_2F_2$ MW = 132.92 773

Table 1. Experimental value with uncertainty.

T K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ $\text{kg} \cdot \text{m}^{-3}$	Ref.
273.15	1493.60 ± 1.00	1934-loc/bro

(Z)-1,2-Dichloro-1,2-difluoroethene [311-81-9] $C_2Cl_2F_2$ MW = 132.92 774

Table 1. Experimental value with uncertainty.

T K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ $\text{kg} \cdot \text{m}^{-3}$	Ref.
273.15	1495.00 ± 1.00	1934-loc/bro

Trichlorofluoroethene [359-29-5] C_2Cl_3F MW = 149.38 775

Table 1. Experimental values with uncertainties.

T K	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$ $\text{kg} \cdot \text{m}^{-3}$	Ref.
293.15	1554.10 ± 1.00	1934-loc/bro
293.15	1546.00 ± 1.00	1948-hen/ruh

1-Chloro-2,2-difluoroethene [359-10-4] C_2HClF_2 MW = 98.48 776

$T_c = 400.55 \text{ K}$ [1996-amb/tso]

$\rho_c = 499.00 \text{ kg} \cdot \text{m}^{-3}$ [1996-amb/tso]

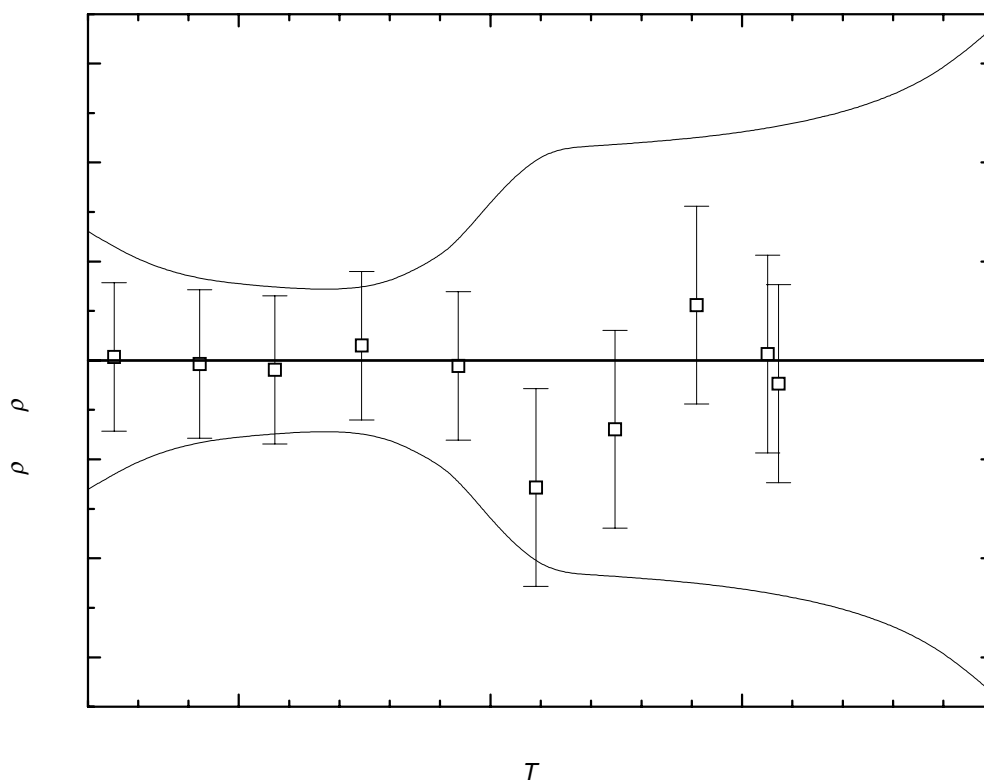
Table 1. Coefficients for the polynomial expansion equations. Standard deviations (see introduction): $\sigma_t = 1.7095 \cdot 10^{-1}$ (low temperature range), $\sigma_{c,w} = 8.6138 \cdot 10^{-1}$ (combined temperature ranges, weighted), $\sigma_{c,uw} = 3.5692 \cdot 10^{-1}$ (combined temperature ranges, unweighted).

Coefficient	$T = 225.21 \text{ to } 305.00 \text{ K}$ $\rho = A + BT + CT^2 + DT^3 + \dots$	$T = 305.00 \text{ to } 400.55 \text{ K}$ $\rho = [1 + 1.75(1 - T/T_c)^{1/3} + 0.75(1 - T/T_c)]$ $[\rho_c + A(T_c - T) + B(T_c - T)^2 + C(T_c - T)^3 + D(T_c - T)^4]$
A	$1.85760 \cdot 10^3$	1.77124
B	-1.38258	$-4.63435 \cdot 10^{-2}$
C	$-2.56903 \cdot 10^{-3}$	$5.25864 \cdot 10^{-4}$
D		$-2.10250 \cdot 10^{-6}$

cont.

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)
225.21	1416.00 ± 1.50	0.07	1955-mea/sta(□)	309.03	1182.00 ± 2.00	-2.57	1955-mea/sta(□)
242.19	1372.00 ± 1.50	-0.07	1955-mea/sta(□)	324.76	1129.00 ± 2.00	-1.39	1955-mea/sta(□)
257.15	1332.00 ± 1.50	-0.19	1955-mea/sta(□)	340.96	1071.00 ± 2.00	1.12	1955-mea/sta(□)
274.43	1285.00 ± 1.50	0.30	1955-mea/sta(□)	355.10	1013.00 ± 2.00	0.13	1955-mea/sta(□)
293.64	1230.00 ± 1.50	-0.11	1955-mea/sta(□)	357.26	1003.00 ± 2.00	-0.47	1955-mea/sta(□)

**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.

1-Chloro-2,2-difluoroethene (cont.)**Table 3.** Recommended values (fit to the reliable experimental values according to the equations

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

$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$	$\frac{T}{K}$	$\frac{\rho \pm \sigma_{\text{fit}}}{\text{kg} \cdot \text{m}^{-3}}$
220.00	1429.09 \pm 2.61	290.00	1240.60 \pm 2.11	340.00	1073.57 \pm 4.49
230.00	1403.71 \pm 2.01	293.15	1231.52 \pm 2.39	350.00	1034.18 \pm 4.61
240.00	1377.81 \pm 1.68	298.15	1217.02 \pm 2.96	360.00	991.16 \pm 4.78
250.00	1351.39 \pm 1.54	300.00	1211.62 \pm 3.20	370.00	941.10 \pm 5.01
260.00	1324.46 \pm 1.46	310.00	1181.47 \pm 4.27	380.00	878.17 \pm 5.35
270.00	1297.02 \pm 1.42	320.00	1147.47 \pm 4.33	390.00	790.43 \pm 5.87
280.00	1269.07 \pm 1.55	330.00	1111.18 \pm 4.40	400.00	597.72 \pm 6.74

1,1,2-Trichloro-3,3,3-trifluoro-1-propene

[431-52-7]

 $C_3Cl_3F_3$

MW = 199.39

777

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	1617.00 \pm 2.00	1954-pro

1,1,2,3-Tetrachloro-3,3-difluoro-1-propene

[431-50-5]

 $C_3Cl_4F_2$

MW = 215.84

778

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	1659.00 \pm 2.00	1954-pro

1,1,2,2,3-Pentachloro-3-fluoro-1-propene

[815-14-5]

 C_3Cl_5F

MW = 232.29

779

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	1702.00 \pm 2.00	1954-pro

1,1-Dichloro-1,1,1-trifluoro-2-trifluoromethyl-1-propene

[359-66-0]

 $C_4Cl_2F_6$

MW = 232.94

780

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1642.90 ± 2.50	1950-hen/she

1,3,4,4-Tetrachloro-1,2,3,4-tetrafluoro-1-butene

[357-20-0]

 $C_4Cl_4F_4$

MW = 265.85

781

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1425.30 ± 0.80	1957-ruh/dav

1,1-Dichloro-3,3,3-trifluoro-2-methyl-1-propene

[381-94-2]

 $C_4H_3Cl_2F_3$

MW = 178.97

782

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1424.80 ± 2.00	1950-hen/she

2-(Chloromethyl)-3,3,3-trifluoro-1-propene

[381-82-8]

 $C_4H_4ClF_3$

MW = 144.52

783

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1282.40 ± 2.00	1950-hen/she

1-Chloro-3,3,3-trifluoro-2-methyl-1-propene

[381-83-9]

 $C_4H_4ClF_3$

MW = 144.52

784

Table 1. Experimental value with uncertainty.

T	$\rho_{\text{exp}} \pm 2\sigma_{\text{est}}$	Ref.
K	$\text{kg} \cdot \text{m}^{-3}$	
293.15	1239.50 ± 1.50	1950-hen/she

1,3-Dichloro-3,3-difluoro-2-methyl-1-propene [500060-29-7] $C_4H_4Cl_2F_2$ MW = 160.98 785

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	1340.60 ± 2.00	1950-hen/she

3-Chloro-1-iodo-2-butene [54201-06-8] C_4H_6ClI MW = 216.45 786

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	1820.00 ± 2.00	1960-kle/vos