



Viscosity of liquids: Halogenated aromatic hydrocarbons

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VISCOSITY OF LIQUIDS: HALOGENATED AROMATIC HYDROCARBONS

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Data Sheets for each of the liquids are given in the following order:

Formula	Name	Alternative Name(s)
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MONOHALOGENATED BENZENES

1. C_6H_5F	Fluorobenzene	Phenyl fluoride	7
2. C_6H_5Cl	Chlorobenzene	Phenyl chloride	9
3. C_6H_5Br	Bromobenzene	Phenyl bromide	11
4. C_6H_5I	Iodobenzene	Phenyl iodide	13

DIHALOGENATED BENZENES

5. $1,2-F_2C_6H_4$	1,2-Difluorobenzene	<i>o</i> -Difluorobenzene	15
6. $1,3-F_2C_6H_4$	1,3-Difluorobenzene	<i>m</i> -Difluorobenzene	16
7. $1,4-F_2C_6H_4$	1,4-Difluorobenzene	<i>p</i> -Difluorobenzene	17
8. $1,2-Cl_2C_6H_4$	1,2-Dichlorobenzene	<i>o</i> -Dichlorobenzene	18
9. $1,3-Cl_2C_6H_4$	1,3-Dichlorobenzene	<i>m</i> -Dichlorobenzene	20
10. $1,4-Cl_2C_6H_4$	1,4-Dichlorobenzene	<i>p</i> -Dichlorobenzene	22
11. $1,2-Br_2C_6H_4$	1,2-Dibromobenzene	<i>o</i> -Dibromobenzene	23
12. $1,3-Br_2C_6H_4$	1,3-Dibromobenzene	<i>m</i> -Dibromobenzene	24
13. $1,4-Br_2C_6H_4$	1,4-Dibromobenzene	<i>p</i> -Dibromobenzene	25

Formula	Name	Alternative Name(s)
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TRihalogenated Benzenes

14.	1,3,5-F ₃ C ₆ H ₃	1,3,5-Trifluorobenzene	<i>sym</i> -Trifluorobenzene	26
15.	1,2,3-Cl ₃ C ₆ H ₃	1,2,3-Trichlorobenzene		27
16.	1,2,4-Cl ₃ C ₆ H ₃	1,2,4-Trichlorobenzene		28
17.	1,3,5-Cl ₃ C ₆ H ₃	1,3,5-Trichlorobenzene	<i>sym</i> -Trichlorobenzene	29

TETRA- to Hexahalogenated Benzenes

18.	1,2,3,5-F ₄ C ₆ H ₂	1,2,3,5-Tetrafluorobenzene		30
19.	1,2,4,5-F ₄ C ₆ H ₂	1,2,4,5-Tetrafluorobenzene	<i>sym</i> -Tetrafluorobenzene	31
20.	C ₆ HF ₅	Pentafluorobenzene		32
21.	C ₆ F ₆	Hexafluorobenzene	Perfluorobenzene	33

Halogenated Toluenes

22.	2-FC ₆ H ₄ CH ₃	2-Fluorotoluene	<i>o</i> -Fluorotoluene <i>o</i> -Tolyl fluoride	34
23.	3-FC ₆ H ₄ CH ₃	3-Fluorotoluene	<i>m</i> -Fluorotoluene <i>m</i> -Tolyl fluoride	35
24.	4-FC ₆ H ₄ CH ₃	4-Fluorotoluene	<i>p</i> -Fluorotoluene <i>p</i> -Tolyl fluoride	36
25.	C ₆ H ₅ CH ₂ Cl	(Chloromethyl)benzene	Benzyl chloride α -Chlorotoluene	37
26.	2-ClC ₆ H ₄ CH ₃	2-Chlorotoluene	<i>o</i> -Chlorotoluene <i>o</i> -Tolyl chloride	39
27.	3-ClC ₆ H ₄ CH ₃	3-Chlorotoluene	<i>m</i> -Chlorotoluene <i>m</i> -Tolyl chloride	40
28.	4-ClC ₆ H ₄ CH ₃	4-Chlorotoluene	<i>p</i> -Chlorotoluene <i>p</i> -Tolyl chloride	41
29.	2-BrC ₆ H ₄ CH ₃	2-Bromotoluene	<i>o</i> -Bromotoluene <i>o</i> -Tolyl bromide	42
30.	3-BrC ₆ H ₄ CH ₃	3-Bromotoluene	<i>m</i> -Bromotoluene <i>m</i> -Tolyl bromide	43
31.	4-BrC ₆ H ₄ CH ₃	4-Bromotoluene	<i>p</i> -Bromotoluene <i>p</i> -Tolyl bromide	44
32.	3,4-Cl ₂ C ₆ H ₃ CH ₃	3,4-Dichlorotoluene	1,2-Dichloro-4-methylbenzene	45
33.	C ₆ H ₅ CF ₃	(Trifluoromethyl)benzene	Benzotrifluoride Phenylfluoroform Benzenyl fluoride Benzilidyne fluoride	46
34.	C ₆ F ₅ CF ₃	Octafluorotoluene	Perfluorotoluene (Trifluoromethyl)pentafluorobenzene	47

Formula

Name

Alternative Name(s)

HALOGENATED ETHYL- AND PROPYLBENZENES

35.	$2\text{-BrC}_6\text{H}_4\text{CH}_2\text{CH}_3$	2-Bromo-1-ethylbenzene	2-Ethylbromobenzene o-Ethylbromobenzene	48
36.	$4\text{-BrC}_6\text{H}_4\text{CH}_2\text{CH}_3$	4-Bromo-1-ethylbenzene	4-Ethylbromobenzene p-Ethylbromobenzene	49
37.	$4\text{-BrC}_6\text{H}_4\text{CH}(\text{CH}_3)_2$	4-Bromo-1-isopropylbenzene	4-Isopropylbromobenzene 4-Bromo-1-(1-methylethyl)benzene 4-Bromocumene p-Bromocumene p-Isopropylbromobenzene	50

HALOGENATED NAPHTHALENES

38.	$1\text{-C}_{10}\text{H}_7\text{F}$	1-Fluoronaphthalene	α -Fluoronaphthalene 1-Naphthyl fluoride	51
39.	$1\text{-C}_{10}\text{H}_7\text{Cl}$	1-Chloronaphthalene	α -Chloronaphthalene 1-Naphthyl chloride	52
40.	$1\text{-C}_{10}\text{H}_7\text{Br}$	1-Bromonaphthalene	α -Bromonaphthalene 1-Naphthyl bromide	54

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VISCOSITY OF LIQUIDS: HALOGENATED AROMATIC HYDROCARBONS

1. INTRODUCTION

This Item presents values for the viscosity at saturation pressure, in tabular form, for liquid halogenated aromatic hydrocarbons. The range covered is from just above the melting temperature to about 0.9 times the critical temperature.

The values given are based on data which are believed to be the most reliable available and have been reviewed and suitably extended. In common with other Items, quantities are expressed in SI units and conversion factors to other units are provided in Section 3.

Section 4 gives the procedure used to obtain the values of viscosity presented and indicates the effect of pressure. Section 5 gives an explanation of the Tables and indicates the uncertainties in the values presented.

Appendix A provides a complete bibliography of data sources for this Item. Data sources for individual compounds are listed on the appropriate Data Sheet.

2. NOTATION AND UNITS

The SI unit of dynamic viscosity is the newton second per square metre (N s/m^2). The values presented in the tables are given in millinewton second per square metre (mN s/m^2), a submultiple which is convenient for the magnitudes considered and which is equal to the c.g.s. centipoise (cP).

A, B	dimensionless constants for each liquid in Equation (4.1)	-
C	constant for each liquid in Equation (4.2)	K
D	constant for each liquid in Equation (4.1)	mN s/m^2
p	pressure	N/m^2 (Pa)
T	kelvin temperature	K
t	Celsius temperature, $T - 273.15$	$^{\circ}\text{C}$
α	constant in Equation (4.3)	m^2/N
η	dynamic viscosity	mN s/m^2 (cP)
θ	dimensionless temperature dependent variable in Equation (4.2)	-

Subscripts

c	denotes value at the critical point
p	denotes value at pressure p
r	denotes reduced quantity, <i>e.g.</i> $T_r = T/T_c$.

3. CONVERSION FACTORS

$$\begin{aligned} 1 \text{ mN s/m}^2 &= 1 \text{ centipoise} \\ &= 145.04 \times 10^{-9} \text{ lbf s/in}^2 \\ &= 101.97 \times 10^{-6} \text{ kgf s/m}^2 \\ &= 10^{-3} \text{ kg/m s} \end{aligned}$$

$$\begin{aligned} 10^5 \text{ Pa} &= 1 \text{ bar} \\ &= 14.5038 \text{ lbf/in}^2 \\ &= 1.0197 \text{ kgf/cm}^2 \\ &= 0.9869 \text{ atm} \\ &= 750.062 \text{ mmHg.} \end{aligned}$$

4. LIQUID VISCOSITY

4.1 Viscosity at Saturation Pressure

The two equations most commonly used to describe variations of viscosity with temperature at saturation pressure are:

$$\ln \eta = A' + \frac{B'}{T},$$

and
$$\ln \eta = A'' + \frac{B''}{T - C''}.$$

Both of these can provide adequate representations of viscosity over limited ranges of temperature but are unsatisfactory over the full range. The first form often produces large deviations near the melting temperature or at higher viscosities, and neither is realistic for near-critical temperatures. Several equations are available which use molar volume as an independent variable but these are limited by the need for accurate volumetric data or an equation of state.

The following equation (Reference 1), which has been used for the present work has been found to give a good representation of the data from the melting temperature to $T_r = 0.9$:

$$\ln \frac{\eta}{D} = A(\theta - 1)^{1/3} + B(\theta - 1)^{4/3}, \quad (4.1)$$

where
$$\theta = \frac{T_c - C}{T - C}. \quad (4.2)$$

Relatively few reliable data are available at reduced temperatures greater than 0.9; however, the equation form is consistent with observed trends in that region and produces reasonable estimates close to the critical temperature.

Preliminary values for the constants A , B , C and D were derived from least square percentage deviation fits to the data sets which were considered to be the most accurate. It was found that satisfactory fits could be obtained with C set to $T_c/8$ and with A taken as constant and equal to 2.4, except for 1-chloronaphthalene and 1-bromonaphthalene, for which $A = 1.8$ gave an improved correlation of the data. The constant C , which has the dimensions of temperature is much lower in value than the melting temperature. Revised values for B and D were then obtained by fitting Equation (4.1) to viscosity data

for individual compounds. The constant D is in effect a pseudo-critical viscosity, which is produced by the equation at the critical point. Values for A , B , C and D are given in Table 7.1 and the critical temperatures for these substances have been taken from ESDU 98014, 98018, 99007 (References 2, 3 and 4).

In view of the uncertainties in the experimental data, and the deviations between different data sets for certain compounds, it was found that different sets of B and D values gave equally acceptable data fits in some cases. Values for B and D were chosen so as to give a good correlation with corresponding values for other members of each chemical series, whilst maintaining an acceptable fit to the data for the compound under study. In this way a set of viscosity values was produced, which varied consistently within a given chemical series.

4.2 Effect of Pressure

No accurate general expression is available for estimating the effect of pressure on the viscosity of these liquids. However, the simple expression given for n -alkanes in ESDU 79027 (Reference 1) applies to these liquids under similar conditions and is reproduced here as an approximate guide.

The viscosity of liquids with high viscosity at saturation pressure increases more rapidly with pressure than that of liquids with a low viscosity at saturation pressure. In most cases, the viscosity increases by about 1 per cent for a pressure increase of 1 MPa (10 bar). Below the normal boiling point, the difference between values measured at atmospheric pressure and those at saturation is therefore very small.

For liquids from the melting temperature to about $0.75 T_c$, the following relationship may be used as an approximate guide:

$$\ln \frac{\eta_p}{\eta} = \alpha p, \quad (4.3)$$

where η_p is the viscosity at pressure p , η is the viscosity at saturation pressure, and α is a pressure-viscosity coefficient. The average value for α is $1 \times 10^{-8} \text{ m}^2/\text{N}$ for pressures up to 50 MPa. For liquids in general, the higher the viscosity at saturation pressure, the higher the value of α .

5. EXPLANATION OF TABLES

The values of A , B , C and D to be used in Equations (4.1) and (4.2) are given in Table 7.1 together with the critical temperature and the range of applicability.

Values of the viscosity of individual compounds are given on separate sheets at 10 kelvin intervals with temperatures in K and °C. Extrapolated values are indicated in parenthesis. The sources of data used to derive the correlation are listed.

The highest accuracy band of the tabulated values in this Item is given as $\pm 2\%$, which is usually for temperatures close to ambient. Outside this range, it is recommended that the user allows for larger uncertainties of between $\pm 5\%$ and $\pm 20\%$ as indicated in the Tables. The uncertainties at high temperature are supported by the correlation, which was found between the liquid viscosities at $0.9 T_c$ and molecular structure.

6. REFERENCES

The references given are recommended sources of information supplementary to that in this Item.

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2. ESDU Vapour pressures and critical points of liquids: Halogenated benzenes. Data Item 98014, ESDU International plc, London, UK, 1998.
3. ESDU Thermal conductivity of liquids: Halogenated aromatic hydrocarbons. Data Item 98018, ESDU International plc, London, UK, 1998.
4. ESDU Vapour pressures and critical points of liquids: Halogenated benzenes and halogenated styrenes. Data Item 99007, ESDU International plc, London, UK, 2000.

7. TABLES

TABLE 7.1 Constants for Equations (4.1) and (4.2)

Compound		T_c	A	B	C	D	Range of Applicability
		K			K	mN s/m ²	°C
1.	Fluorobenzene	560.12	2.4	0.347	70.02	0.0296	-40 to 240
2.	Chlorobenzene	632.35	2.4	0.290	79.04	0.0286	-50 to 300
3.	Bromobenzene	670.	2.4	0.286	83.75	0.0335	-30 to 340
4.	Iodobenzene	720.	2.4	0.292	90.00	0.0358	-30 to 380
5.	1,2-Difluorobenzene	566.	2.4	0.363	70.75	0.0310	-50 to 240
6.	1,3-Difluorobenzene	550.	2.4	0.357	68.75	0.0304	-60 to 230
7.	1,4-Difluorobenzene	558.	2.4	0.387	69.75	0.0310	0 to 240
8.	1,2-Dichlorobenzene	694.	2.4	0.307	86.75	0.0339	-20 to 360
9.	1,3-Dichlorobenzene	685.	2.4	0.244	85.63	0.0329	-30 to 350
10.	1,4-Dichlorobenzene	686.	2.4	0.270	85.75	0.0349	50 to 350
11.	1,2-Dibromobenzene	755.	2.4	0.371	94.38	0.0386	10 to 410
12.	1,3-Dibromobenzene	755.	2.4	0.416	94.38	0.0372	-10 to 410
13.	1,4-Dibromobenzene	759.	2.4	0.498	94.88	0.0370	90 to 420
14.	1,3,5-Trifluorobenzene	534.	2.4	0.394	66.75	0.0327	-10 to 220
15.	1,2,3-Trichlorobenzene	745.	2.4	0.446	93.12	0.0328	50 to 410
16.	1,2,4-Trichlorobenzene	736.	2.4	0.421	92.00	0.0280	20 to 400
17.	1,3,5-Trichlorobenzene	730.	2.4	0.263	91.25	0.0330	60 to 390
18.	1,2,3,5-Tetrafluorobenzene	535.21	2.4	0.491	66.90	0.0378	-50 to 220
19.	1,2,4,5-Tetrafluorobenzene	543.31	2.4	0.499	66.64	0.0397	-50 to 220
20.	Pentafluorobenzene	530.93	2.4	0.609	66.37	0.0391	10 to 210
21.	Hexafluorobenzene	516.69	2.4	0.824	64.59	0.0393	0 to 200
22.	2-Fluorotoluene	590.	2.4	0.362	73.75	0.0278	-80 to 270
23.	3-Fluorotoluene	593.	2.4	0.327	74.12	0.0256	-70 to 270
24.	4-Fluorotoluene	594.	2.4	0.320	74.25	0.0264	-60 to 270
25.	(Chloromethyl)benzene	681.	2.4	0.441	85.12	0.0266	-40 to 350
26.	2-Chlorotoluene	658.	2.4	0.332	82.25	0.0289	-40 to 330
27.	3-Chlorotoluene	662.	2.4	0.294	82.75	0.0261	-50 to 330
28.	4-Chlorotoluene	664.	2.4	0.287	83.00	0.0267	10 to 330
29.	2-Bromotoluene	692.	2.4	0.332	86.50	0.0333	-30 to 360
30.	3-Bromotoluene	696.	2.4	0.298	87.00	0.0301	-40 to 360
31.	4-Bromotoluene	697.	2.4	0.284	87.12	0.0309	30 to 360
32.	3,4-Dichlorotoluene	723.	2.4	0.330	90.38	0.0293	0 to 370
33.	(Trifluoromethyl)benzene	551.	2.4	0.309	68.88	0.0321	-40 to 230
34.	Octafluorotoluene	534.43	2.4	0.701	66.80	0.0417	-20 to 220
35.	2-Bromo-1-ethylbenzene	704.	2.4	0.348	88.00	0.0319	10 to 360
36.	4-Bromo-1-ethylbenzene	711.	2.4	0.290	88.88	0.0317	10 to 370
37.	4-Bromo-1-isopropylbenzene	719.	2.4	0.366	89.88	0.0293	10 to 380
38.	1-Fluoronaphthalene	734.	2.4	0.439	91.75	0.0292	-10 to 400
39.	1-Chloronaphthalene	800.	1.8	0.526	100.00	0.0410	0 to 450
40.	1-Bromonaphthalene	833.	1.8	0.551	104.13	0.0434	20 to 480

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C_6H_5F FLUOROBENZENE (PHENYL FLUORIDE)

$$\ln(\eta/D) = A(\theta - 1)^{1/3} + B(\theta - 1)^{4/3}$$

$$\text{where } \theta = (T_c - C)/(T - C)$$

η = viscosity at saturation pressure (mN s/m²)

$$T_c = 560.12 \text{ K}$$

$$A = 2.4, \quad B = 0.347, \quad C = 70.02, \quad D = 0.0296$$

T K	η mN s/m ²	Uncert. in η %	T K	η mN s/m ²	Uncert. in η %	t °C	η mN s/m ²	Uncert. in η %	t °C	η mN s/m ²	Uncert. in η %
230	(1.56)	10	380	0.259	5	-40	(1.47)	10	110	0.253	5
240	(1.29)	10	390	0.240	5	-30	(1.21)	10	120	0.235	5
250	(1.08)	5	400	0.223	5	-20	(1.02)	5	130	0.218	5
260	(0.917)	5	410	0.207	5	-10	(0.875)	5	140	0.202	5
270	(0.792)	2	420	0.192	5	0	(0.758)	2	150	0.188	5
280	0.692	2	430	0.179	5	10	0.664	2	160	0.175	5
290	0.610	2	440	0.166	10	20	0.588	2	170	0.163	10
300	0.543	2	450	0.155	10	30	0.524	2	180	0.151	10
310	0.487	2	460	(0.144)	10	40	0.471	2	190	(0.141)	10
320	0.439	5	470	(0.134)	10	50	0.426	5	200	(0.131)	10
330	0.398	5	480	(0.124)	10	60	0.387	5	210	(0.121)	10
340	0.363	5	490	(0.115)	10	70	0.353	5	220	(0.112)	10
350	0.332	5	500	(0.105)	10	80	0.323	5	230	(0.103)	10
360	0.305	5	510	(0.097)	10	90	0.297	5	240	(0.094)	10
370	0.281	5				100	0.274	5			

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C_6H_5Cl CHLOROBENZENE (PHENYL CHLORIDE)

$$\ln(\eta/D) = A(\theta - 1)^{1/3} + B(\theta - 1)^{4/3}$$

$$\text{where } \theta = (T_c - C)/(T - C)$$

η = viscosity at saturation pressure (mN s/m²)

$$T_c = 632.35 \text{ K}$$

$$A = 2.4, \quad B = 0.290, \quad C = 79.04, \quad D = 0.0286$$

T K	η mN s/m ²	Uncert. in η %	T K	η mN s/m ²	Uncert. in η %	t °C	η mN s/m ²	Uncert. in η %	t °C	η mN s/m ²	Uncert. in η %
220	(2.98)	5	400	0.298	10	-50	(2.75)	5	130	0.291	10
230	(2.33)	5	410	0.278	10	-40	(2.17)	5	140	0.272	10
240	(1.87)	5	420	0.259	10	-30	(1.76)	5	150	0.254	10
250	(1.54)	2	430	0.242	10	-20	(1.46)	2	160	0.237	10
260	(1.29)	2	440	0.227	10	-10	(1.23)	2	170	0.222	10
270	(1.10)	2	450	0.213	10	0	1.05	2	180	0.208	10
280	0.954	2	460	0.200	10	10	0.913	2	190	0.196	10
290	0.834	2	470	0.188	10	20	0.802	2	200	0.184	10
300	0.737	2	480	0.176	10	30	0.710	2	210	0.173	10
310	0.657	2	490	0.166	10	40	0.635	2	220	0.162	10
320	0.590	2	500	0.156	10	50	0.571	2	230	0.153	10
330	0.533	2	510	0.146	10	60	0.517	2	240	0.143	10
340	0.485	2	520	(0.137)	10	70	0.471	2	250	(0.135)	10
350	0.443	5	530	(0.129)	10	80	0.431	5	260	(0.126)	10
360	0.406	5	540	(0.121)	10	90	0.396	5	270	(0.118)	10
370	0.374	5	550	(0.113)	10	100	0.365	5	280	(0.110)	10
380	0.346	5	560	(0.105)	10	110	0.338	5	290	(0.103)	10
390	0.321	10	570	(0.097)	10	120	0.313	10	300	(0.095)	10

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C_6H_5Br BROMOBENZENE (PHENYL BROMIDE)

$$\ln(\eta/D) = A(\theta - 1)^{1/3} + B(\theta - 1)^{4/3}$$

$$\text{where } \theta = (T_c - C)/(T - C)$$

η = viscosity at saturation pressure (mN s/m²)

$$T_c = 670. \text{ K}$$

$$A = 2.4, \quad B = 0.286, \quad C = 83.75, \quad D = 0.0335$$

T	η	Uncert. in η	T	η	Uncert. in η	t	η	Uncert. in η	t	η	Uncert. in η
K	mN s/m ²	%	K	mN s/m ²	%	°C	mN s/m ²	%	°C	mN s/m ²	%
240	(2.92)	10	430	(0.334)	10	-30	(2.72)	10	160	(0.327)	10
250	(2.35)	5	440	(0.313)	10	-20	(2.21)	5	170	(0.306)	10
260	(1.95)	5	450	(0.293)	10	-10	(1.84)	5	180	(0.288)	10
270	(1.64)	2	460	(0.276)	10	0	(1.56)	2	190	(0.270)	10
280	1.40	2	470	(0.259)	10	10	1.34	2	200	(0.254)	10
290	1.21	2	480	(0.244)	10	20	1.16	2	210	(0.239)	10
300	1.06	2	490	(0.230)	10	30	1.02	2	220	(0.226)	10
310	0.939	2	500	(0.217)	10	40	0.905	2	230	(0.213)	10
320	0.838	5	510	(0.204)	10	50	0.809	5	240	(0.201)	10
330	0.753	5	520	(0.193)	10	60	0.729	5	250	(0.189)	10
340	0.681	5	530	(0.182)	15	70	0.660	5	260	(0.179)	15
350	0.619	5	540	(0.171)	15	80	0.602	5	270	(0.168)	15
360	0.566	5	550	(0.162)	15	90	0.551	5	280	(0.159)	15
370	0.520	5	560	(0.152)	15	100	0.507	5	290	(0.149)	15
380	0.479	5	570	(0.143)	15	110	0.468	5	300	(0.140)	15
390	0.444	5	580	(0.134)	15	120	0.433	5	310	(0.131)	15
400	0.412	5	590	(0.126)	15	130	0.402	5	320	(0.123)	15
410	0.383	5	600	(0.117)	15	140	0.375	5	330	(0.115)	15
420	(0.357)	5	610	(0.109)	15	150	(0.350)	5	340	(0.106)	15

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C_6H_5I IODOBENZENE (PHENYL IODIDE)

$$\ln(\eta/D) = A(\theta - 1)^{1/3} + B(\theta - 1)^{4/3}$$

$$\text{where } \theta = (T_c - C)/(T - C)$$

η = viscosity at saturation pressure (mN s/m²)

$$T_c = 720. \text{ K}$$

$$A = 2.4, \quad B = 0.292, \quad C = 90.00, \quad D = 0.0358$$

T K	η mN s/m ²	Uncert. in η %	T K	η mN s/m ²	Uncert. in η %	t °C	η mN s/m ²	Uncert. in η %	t °C	η mN s/m ²	Uncert. in η %
240	(4.87)	5	450	(0.387)	10	-30	(4.49)	5	180	(0.379)	10
250	(3.80)	5	460	(0.363)	10	-20	(3.54)	5	190	(0.356)	10
260	(3.05)	5	470	(0.341)	10	-10	(2.86)	5	200	(0.335)	10
270	(2.50)	2	480	(0.321)	10	0	(2.36)	2	210	(0.315)	10
280	2.10	2	490	(0.303)	10	10	1.99	2	220	(0.297)	10
290	1.78	2	500	(0.286)	10	20	1.70	2	230	(0.281)	10
300	1.54	2	510	(0.270)	10	30	1.47	2	240	(0.265)	10
310	1.34	2	520	(0.255)	10	40	1.29	2	250	(0.251)	10
320	1.18	5	530	(0.242)	10	50	1.14	5	260	(0.237)	10
330	1.05	5	540	(0.229)	10	60	1.01	5	270	(0.225)	10
340	0.942	5	550	(0.217)	10	70	0.911	5	280	(0.213)	10
350	0.850	5	560	(0.205)	10	80	0.824	5	290	(0.202)	10
360	0.771	5	570	(0.194)	10	90	0.749	5	300	(0.191)	10
370	0.704	5	580	(0.184)	10	100	0.684	5	310	(0.181)	10
380	0.645	5	590	(0.174)	10	110	0.628	5	320	(0.171)	10
390	0.594	5	600	(0.164)	15	120	0.579	5	330	(0.161)	15
400	0.549	5	610	(0.155)	15	130	0.536	5	340	(0.152)	15
410	0.509	5	620	(0.146)	15	140	0.497	5	350	(0.144)	15
420	0.473	5	630	(0.138)	15	150	0.463	5	360	(0.135)	15
430	(0.442)	10	640	(0.129)	15	160	(0.432)	10	370	(0.127)	15
440	(0.413)	10	650	(0.121)	15	170	(0.404)	10	380	(0.118)	15

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