



# **Bearing and Seal Technology**

**Chemical Resistance**



**Schunk Tribologie**



# Contents

	<b>Page/s</b>
<b>Preface</b>	4
<b>Experimental procedures</b>	5
<b>Inorganic compounds</b>	6 - 10
1) Acids	6, 7
2) Acid halogens	8
3) Bases	8
4) Halogens	8
5) Oxidizing agents	9
6) Water, salts, salt solutions	9, 10
<b>Organic compounds</b>	11 - 14
1) Hydrocarbons	11
2) Halogenated hydrocarbons	11
3) Alcohols and phenols	12
4) Esters	12
5) Ethers	12
6) Amines	12
7) Nitriles und isonitriles	13
8) Aldehydes	13
9) Ketones	13
10) Acids	13
11) Acid halogens	14
12) Heterocyclics	14
<b>Industrial trade products</b>	15 - 16
1) Aids for dye mills and textile industries	15
2) Detergents	15
3) Dish washing detergents	15
4) Heat transfer materials	15
5) Refrigerants	15
6) Anti-freeze	16
7) Rust inhibitors and anti-freeze	16
8) Cooling lubricants	16
9) Motor fuels	16
10) Synthetic oils	16
<b>Alphabetical chemical index</b>	18 - 30

# Preface

Carbon and graphite materials exhibit high chemical resistance and belong to the standard materials in machine and apparatus construction of the chemical industry.

Although insoluble and unmeltable, carbon and graphite materials may be attacked by several chemical substances. Nevertheless, there is multitude of possible applications for these materials.

The data of our carbon and graphite materials presented in this brochure are to help deciding the suitability for use regarding the chemical resistance. Separate other brochures available will give you information on fabrication and physical properties of our carbon and graphite materials.

The data presented in the following tables are not binding and should help to select the suitable material.

## Summary of the experimental procedure

Practical tests show whether carbon and graphites are suitable as work materials, as only we have performed corrosion tests since 1952.

The data listed in the following were determined in meticulous tests by our chemical laboratory.

Up to now, our carbon and graphite materials have been tested with more than 140 chemical reagents, and testing will be continued with further substances. Regarding the selection of chemical substances, we do appreciate suggestions of our clients.

The test conditions can be described as follows: The majority of the durability tests last 2160 hours (appr. 3 months). For all tests stationary samples with preferred dimensions of 70 x 10 x 10 mm were used. During the tests special attention was paid to the samples being fully covered by the test medium and to maintaining the composition of the medium by often exchanging it.

Changes in dimensions, weight and hardness as well as general conditions and micrographs were the basis to evaluate the durability properties of the materials.

The chemical resistance is indicated by the following symbols

+ resistant

O partially resistant

— not resistant

which to a large extent are based on the Dechema Materials Table. If for some reason or other, you should intend to use a “partially resistant” material, please contact us first.

The chemical resistance given in each case refers only to the present concentration and temperature of the medium but allows conclusions to different conditions. Metals are attacked more strongly by moving than by stationary liquids.

This is to be considered with metal impregnated carbon and graphite materials.

It may not be completely excluded that the chemical attack is stronger on a sliding surface out of carbon and graphite materials which are not impregnated, resin impregnated or resin bonded, but due to the other properties of carbon and graphite this is not probable. This has been confirmed in practical applications.

# Summary of the experimental procedure

## Additional advice

The most common terms are listed alphabetically in the Chemical Index (pp. 18 - 30) and refer to the medium which is to be found in the tables, listed below the corresponding categories. (pp. 6 - 16)

Moreover, there are materials in this index which we have not tested but which are expected to have properties similar to those listed in column 2.

The chemical formulae of the test media are indicated, if available. Technical grades are trademarks.

The test conditions (weight %, volume %, g/l), pressure (bar; no indication of pressure always means normal pressure), and temperature (°C) are indicated in the tables on pp. 6 - 16. The ratios 1 : 1 or 3 :1 are volume parts of concentrated substances.

The tables do not contain names of Schunk material grades. Instead, materials are collected in groups according to their similar chemical behaviour.

- 1 carbon graphite not impregnated
- 2 graphite not impregnated
- 3 carbon graphite resin impregnated
- 4 graphite resin impregnated
- 5 resin bonded carbon
- 6 carbon graphite and graphite antimony impregnated
- 7 carbon graphite and graphite lead impregnated
- 8 carbon graphite and graphite copper impregnated

## Examples

1	2	3	4	5	6	7	8
FH27S	FE45S	FH42Z2/Z5	FE45Z2	FF521	FE45A	FH42B	FE45C
FH42	FE45Y2	FH42ZH2/ZH5		FF541	FH42A	FH44B	FH44C
FH44Y2	FE679	FH44Z2/Z5		FF46	FH82A	FH82B	FH42C
FH82		FH82Z2/Z5					
		FH82ZH2/ZH5					

# Inorganic compounds

Test Medium	Chemical Formula	Concentration %			temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>1. Acids</b>														
Boric acid, aqueous	H <sub>3</sub> BO <sub>3</sub>	15	80	-	+	+	+	+	+	+	+	o	o	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	20	20	-	+	+	+	+	+	+	+	+	-	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	20	80	-	-	-	-	-	-	-	-	-	-	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	40	20	-	+	+	+	+	+	+	+	+	-	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	50	20	-	-	+	+	+	+	+	+	+	-	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	50	40	-	-	+	-	+	-	-	-	+	-	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	50	60	-	-	-	-	-	-	-	-	o	-	
Chromic acid, aqueous	CrO <sub>3</sub> + H <sub>2</sub> O	60	20	-	-	o	o	o	o	-	-	o	-	
Hydrofluoric acid, diluted	HF	20	20	-	+	+	+	+	+	+	-	-	o	
Hydrofluoric acid, concentrated	HF	40	20	-	+	+	+	+	+	o	-	-	o	
Aqua regia	HCl/HNO <sub>3</sub> 3:1	100	20	-	+	+	+	+	+	+	-	-	-	
Mixed acid	HNO <sub>3</sub> /H <sub>2</sub> SO <sub>4</sub> 2:3	100	20	-	-	-	-	-	-	-	-	-	-	
Perchloric acid, aqueous	HClO <sub>2</sub>	ca. 70	20	-	+	+	+	+	+	+	+	o	o	
Phosphoric acid, ortho, concentrated	H <sub>3</sub> PO <sub>4</sub>	85	130	-	+	+	+	+	+	+	+	-	-	
Nitric acid, diluted	HNO <sub>3</sub>	38	20	-	+	+	+	+	-	-	-	-	-	
Nitric acid, diluted	HNO <sub>3</sub>	7	80	-	+	+	o	o	-	-	-	-	-	
Nitric acid, concentrated	HNO <sub>3</sub>	65	20	-	+	+	+	+	-	-	-	-	-	
Nitric acid, concentrated	HNO <sub>3</sub>	65	80	-	-	+	-	-	-	-	-	-	-	
Nitric acid, red fumins	HNO <sub>3</sub> + N-Oxide	100	20	-	-	-	-	-	-	-	-	-	-	
Nitric acid, vapors	NO <sub>2</sub>	100	20	-	-	-	-	-	-	-	-	-	-	
Hydrochloric acid, diluted	HCl	20	20	-	+	+	+	+	+	+	+	-	o	
Hydrochloric acid, diluted	HCl	20	50	-	+	+	+	+	+	+	-	-	o	
Hydrochloric acid, diluted	HCl	20	80	-	+	+	+	+	+	+	-	-	-	
Hydrochloric acid, concentrated	HCl	32	20	-	+	+	+	+	+	+	+	-	o	
Hydrochloric acid, concentrated	HCl	32	50	-	+	+	+	+	+	+	-	-	-	
Hydrochloric acid, concentrated	HCl	32	80	-	+	+	+	+	+	+	-	-	-	
Hydrochloric acid, gas	HCl	100	20	-	+	+	+	+	-	+	-	-	+	

+ resistant · o partially resistant · - not resistant

Test Medium	Chemical Formula	Concentration %	temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>1. Acids (continuation)</b>												
Hydrochl. acid, concentr. + chlorine	HCl + Cl <sub>2</sub>	40 g Cl <sub>2</sub> / l	20	-	+	+	+	+	+	o	-	o
Sulphur dioxide, concentr., liquid	SO <sub>2</sub>	99,7	10	ca. 3,35	+	+	+	+	+	+	+	+
Sulphurous acid, aqueous	H <sub>2</sub> SO <sub>3</sub>	50 g SO <sub>2</sub> / l	20	-	+	+	+	+	+	+	+	+
Sulphuric acid, diluted	H <sub>2</sub> SO <sub>4</sub>	25	20	-	+	+	+	+	+	+	+	+
Sulphuric acid, diluted	H <sub>2</sub> SO <sub>4</sub>	25	80	-	+	+	+	+	+	o	+	-
Sulphuric acid, diluted	H <sub>2</sub> SO <sub>4</sub>	50	20	-	+	+	+	+	+	+	+	+
Sulphuric acid, diluted	H <sub>2</sub> SO <sub>4</sub>	50	80	-	+	+	+	+	+	o	o	-
Sulphuric acid, diluted	H <sub>2</sub> SO <sub>4</sub>	62	20	-	+	+	+	+	+	+	+	+
Sulphuric acid, concentrated	H <sub>2</sub> SO <sub>4</sub>	96	20	-	+	+	+	+	+	+	+	+
Sulphuric acid, concentrated	H <sub>2</sub> SO <sub>4</sub>	96	50	-	+	+	+	+	+	+	+	+
Sulphuric acid, concentrated	H <sub>2</sub> SO <sub>4</sub>	96	80	-	+	+	+	+	-	-	o	-
Sulphuric acid, concentrated	H <sub>2</sub> SO <sub>4</sub>	96	120	-	+	+	+	+	-	-	-	-
Sulphuric acid, concentrated	H <sub>2</sub> SO <sub>4</sub>	96	160	-	+	+	-	-	-	-	-	-
Sulphuric acid, concentrated	H <sub>2</sub> SO <sub>4</sub>	96	200	-	o	o	-	-	-	-	-	-
Sulphuric acid, fumins (oleum)	H <sub>2</sub> SO <sub>4</sub> + SO <sub>3</sub>	H <sub>2</sub> SO <sub>4</sub> (100) + 60 % SO <sub>3</sub>	20	-	-	-	-	-	-	-	-	-
Hydrogen sulfide water, cold, saturated	H <sub>2</sub> S + H <sub>2</sub> O	-	20	-	+	+	+	+	+	+	+	o

+ resistant · o partially resistant · - not resistant

# Inorganic compounds

Test Medium	Chemical Formula	Concentration %			temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>2. Acid halogens</b>														
Chlorosulfonic acid	SO <sub>2</sub> · OH · Cl	100	20	-			-	o	o	o	-	-	-	o
Chlorosulfonic acid	SO <sub>2</sub> · OH · Cl	100	100	-			-	-	-	-	-	-	-	-
Phosphorus oxychloride	POCl <sub>3</sub>	100	20	-			+	+	+	+	+	-	-	+
Sulphuryl chloride	SO <sub>2</sub> Cl <sub>2</sub>	100	20	-			+	+	o	o	-	-	-	o
Thionyl chloride	SOCl <sub>2</sub>	100	20	-			+	+	+	+	+	-	-	+
<b>3. Bases</b>														
Ammonia, concentrated, liquid	NH <sub>3</sub>	100	20	ca. 9,8			+	+	+	+	-	+	+	+
Ammonia solution, aqueous	NH <sub>4</sub> OH	ca. 25	20	-			+	+	+	+	+	+	+	-
Sodium hydroxide, aqueous	NaOH	10 - 30	20	-			+	+	+	+	-	+	+	+
Sodium hydroxide, aqueous	NaOH	35 - 50	20	-			+	+	+	+	-	+	+	+
Sodium hydroxide, aqueous	NaOH	40	80	-			+	+	+	+	-	+	+	+
Sodium hydroxide, aqueous	NaOH	50	80	-			+	+	+	+	-	+	+	+
Sodium hydroxide, concentr., aqueous	NaOH	62	100	-			+	+	+	+	-	+	-	-
<b>4. Halogens</b>														
Bromine, liquid	Br <sub>2</sub>	ca. 99,6	20	-			o	-	-	-	-	-	-	-
Chlorine, liquid	Cl <sub>2</sub>	99,9	20	ca. 7,6			+	+	+	+	-	-	-	o
Chlorine water	H <sub>2</sub> O + Cl <sub>2</sub>	3,7 g Cl <sub>2</sub> / l	25	-			+	+	+	+	+	+	+	+
Chlorine water	H <sub>2</sub> O + Cl <sub>2</sub>	1,73 g Cl <sub>2</sub> / l	50	-			o	+	+	+	o	o	-	o
Chlorine water	H <sub>2</sub> O + Cl <sub>2</sub>	1,73 g Cl <sub>2</sub> / l	80	-			o	o	+	+	o	o	-	-

+ resistant · o partially resistant · - not resistant

Test Medium	Chemical Formula	Concentration %											
			temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated	
<b>5. Oxidizing agents</b>													
Ammonium peroxy disulfate, solution, aqueous	$(\text{NH}_4)_2\text{S}_2\text{O}_8$	20	20	-	+	+	+	+	+	+	+	+	-
Calcium hypochloride, aqueous	$\text{Ca}(\text{OCl})_2$	20	20	-	o	o	o	o	o	o	o	-	-
Calcium hypochloride, aqueous	$\text{Ca}(\text{OCl})_2$	20	100	-	o	o	o	o	o	o	-	-	-
Chlorine containing chloride-brine	NaCl-Lösung + $\text{Cl}_2$	ca. 312g NaCl/l +ca. 0,2g $\text{Cl}_2$ /l	75	-	+	+	+	+	+	+	+	+	+
Potassium chlorate, aqueous	$\text{KClO}_3$	5	20	-	o	o	+	+	o	o	o	o	o
Potassium chlorate, aqueous	$\text{KClO}_3$	5	100	-	o	o	+	+	o	o	o	o	o
Potassium permanganate, aqueous	$\text{K Mn O}_4$	10	50	-	+	+	+	+	+	+	+	+	+
Sodium chlorite, aqueous	$\text{NaClO}_2$	2 % = 8g $\text{Cl}_2$ /l	85	-	-	+	-	+	-	+	+	+	+
Sodium chlorite, aqueous	$\text{NaClO}_2$	20 % = 80g $\text{Cl}_2$ /l	90	-	-	-	-	-	-	-	o	+	+
Sodium hypochloride, concentrated	$\text{NaOCl}$	148-160g $\text{Cl}_2$ /l 12-13% akt. $\text{Cl}_2$	20	-	-	o	-	o	-	o	-	+	+
Sodium hypochloride, concentrated	$\text{NaOCl}$	148-160g $\text{Cl}_2$ /l 12-13% akt. $\text{Cl}_2$	40	-	-	o	-	o	-	o	-	o	o
Sodium hypochloride, concentrated	$\text{NaOCl}$	148-160g $\text{Cl}_2$ /l 12-13% akt. $\text{Cl}_2$	60	-	-	o	-	o	-	o	-	o	o
Hydrogen peroxide, aqueous	$\text{H}_2\text{O}_2$	30	20	-	+	+	+	+	-	+	+	+	+
<b>6. Water, salts, salt solutions</b>													
Aluminum chloride, aqueous	$\text{AlCl}_3$	ca. 32	20	-	+	+	+	+	+	+	+	+	+
Ammonium iron (III) sulfate, aqueous	$\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	50	20	-	+	+	+	+	+	+	+	+	-
Ammonium nitrate, aqueous	$\text{NH}_4\text{NO}_3$	85	108	-	+	+	+	+	+	+	+	+	+
Ammonium sulfide solution, aqueous	$(\text{NH}_4)_2\text{S} + \text{H}_2\text{O}$	10	20	-	+	+	+	+	+	o	+	-	-
Iron (II) sulfate, aqueous	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	20	20	-	+	+	+	+	+	+	+	+	+
Hydrazine hydrate, aqueous	$\text{N}_2\text{H}_4$	0,1 - 100	100	-	+	+	+	+	+	+	+	+	+
Potassium bromide, aqueous	$\text{KBr}$	30	20	-	+	+	+	+	+	+	o	o	o
Potassium bromide, aqueous	$\text{KBr}$	30	100	-	o	o	o	o	o	-	-	-	-
Potassium iodide, aqueous	$\text{KJ}$	30	20	-	+	+	+	+	+	+	+	+	o
Potassium iodide, aqueous	$\text{KJ}$	30	100	-	+	+	+	+	+	+	+	+	-
Potassium nitrate, aqueous	$\text{KNO}_3$	20	20	-	+	+	+	+	+	+	+	+	+

+ resistant · o partially resistant · - not resistant

Test Medium	Chemical Formula	Concentration %	temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>6. Water, salts, salt solutions (continuation)</b>												
Potassium nitrate, aqueous	KNO <sub>3</sub>	20	100	-	+	+	+	+	o	o	o	o
Tap water, 348 ppm CaCO <sub>3</sub>	H <sub>2</sub> O	-	20	-	+	+	+	+	+	+	+	+
Monozinc phosphate, aqueous	Zn (H <sub>2</sub> PO <sub>4</sub> ) <sub>2</sub>	50	20	-	+	+	+	+	+	+	+	+
Monozinc phosphate, aqueous	Zn (H <sub>2</sub> PO <sub>4</sub> ) <sub>2</sub>	50	100	-	+	+	+	+	+	+	o	+
Sodium carbonate, purest, aqueous	Na <sub>2</sub> CO <sub>3</sub>	20	100	-	+	+	+	+	+	+	+	+
Sodium chloride, aqueous	NaCl	25	20	-	+	+	+	+	+	+	+	+
Sodium chloride, aqueous	NaCl	25	80	-	+	+	+	+	+	+	+	+
Sodium nitrite, aqueous	NaNO <sub>2</sub>	40	20	-	+	+	+	+	+	o	o	o
Sodium nitrite, aqueous	NaNO <sub>2</sub>	40	100	-	+	+	+	+	-	o	-	-
Tri-sodium phosphate, aqueous	Na <sub>3</sub> PO <sub>4</sub> · 12 H <sub>2</sub> O	50	100	-	+	+	+	+	+	+	+	+
Sodium sulfite solution, aqueous	Na <sub>2</sub> SO <sub>3</sub>	20	100	-	+	+	+	+	+	+	+	+
Nickel sulfate, aqueous	NiSO <sub>4</sub> · 7H <sub>2</sub> O	ca. 28	20	-	+	+	+	+	+	+	+	+
Sea water		27,3 g NaCl, 3,3 g MgCl <sub>2</sub> 2,2 g MgSO <sub>2</sub> 0,2 g KBr } /1	20	-	+	+	+	+	+	+	+	+
Silicon tetrachloride, technical	SiCl <sub>4</sub>	-	20	-	+	+	+	+	+	+	-	+
Titanium tetrachloride	TiCl <sub>4</sub>	100	20	-	+	o	+	+	+	o	-	o

+ resistant · o partially resistant · - not resistant

# Organic compounds

Test Medium	Chemical Formula	Concentration %	temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>1. Hydrocarbons</b>												
Gasoline-benzene	-	1 : 1	95	-	+	+	+	+	+	+	+	+
Cyclohexane, pure	(CH <sub>2</sub> ) <sub>6</sub>	-	80,8	-	+	+	+	+	+	+	+	+
Fuel oil (light) DIN 51603, colored, 10 % of preservation oil V-9447, Shell	-	100	20	-	+	+	+	+	+	+	+	+
Fuel oil (light) DIN 51603, colored, 10 % of preservation oil V-9447, Shell	-	100	80	-	+	+	+	+	+	+	+	+
Fuel oil (med. heavy), 20 °E/20 °C	-	100	120-125	-	+	+	+	+	+	+	+	+
Fuel oil (heavy), 78 °E/20 °C	-	100	120-125	-	+	+	+	+	+	+	+	+
Mineral oil, technical, appr. 150 cP	-	100	20	-	+	+	+	+	+	+	+	+
Terphenyl, technical	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> C <sub>6</sub> H <sub>4</sub>	95,9	300	-	+	+	-	-	-	+	-	+
Toluene-xylene	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> - C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub>	1 : 1	115	-	+	+	+	+	+	+	+	+
<b>2. Halogenated hydrocarbons</b>												
Allyl chloride, analytically pure	CH <sub>2</sub> =CH · CH <sub>2</sub> Cl	-	20	-	+	+	+	+	+	+	-	-
1,2-dibromethane	BrH <sub>2</sub> C-CH <sub>2</sub> Br	-	100	-	+	+	+	+	+	+	-	+
Methyl chloride	CH <sub>3</sub> Cl	-	10-15	4,5-5,0	+	+	+	+	+	+	+	+
Monochlorobenzene, purest	C <sub>6</sub> H <sub>5</sub> Cl	-	20	-	+	+	+	+	+	+	+	+
Carbon tetrachloride	CCl <sub>4</sub>	-	20	-	+	+	+	+	+	+	+	+
Carbon tetrachloride	CCl <sub>4</sub>	-	70	-	+	+	+	+	+	+	+	+
Carbon tetrachloride/ trichloroethylene	CCl <sub>4</sub> /ClHC=CCl <sub>2</sub>	1 : 1	83	-	+	+	+	+	+	+	-	+
1,1,1-trichloroethane	CH <sub>3</sub> -CCl <sub>3</sub>	-	20	-	+	+	+	+	+	+	+	+
Trichloroethylene, technical	ClHC=CCl <sub>2</sub>	-	20	-	+	+	+	+	+	+	+	+
Trichloroethylene	ClHC=CCl <sub>2</sub>	-	87	-	+	+	+	+	+	+	+	+

+ resistant · o partially resistant · - not resistant

# Organic compounds

Test Medium	Chemical Formula	Concentration %			temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>3. Alcohols and phenols</b>														
Ethanol, absolute	C <sub>2</sub> H <sub>5</sub> OH	-	78	-	+	+	+	+	+	+	+	+	+	+
Glycerin, double distilled	C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	100	20	-	+	+	+	+	+	+	+	+	+	+
Glycerin, double distilled	C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	100	100	-	+	+	+	+	+	o	+	o	+	
Glycol	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	100	100	-	+	+	+	+	+	o	o	-	+	
Methanol, analytically pure	CH <sub>3</sub> OH	min. 99,5	65	-	+	+	+	+	+	o	+	+	+	
Phenol, purest	C <sub>6</sub> H <sub>5</sub> OH	-	100	-	+	+	+	+	+	+	+	+	+	
<b>4. Esters</b>														
N-butyl acetate	CH <sub>3</sub> COO · C <sub>4</sub> H <sub>9</sub>	100	20	-	+	+	+	+	+	+	+	+	+	+
N-butyl acetate	CH <sub>3</sub> COO · C <sub>4</sub> H <sub>9</sub>	100	80	-	+	+	+	+	+	o	+	o	o	
Dimethyl phthalate	C <sub>6</sub> H <sub>4</sub> (COOCH <sub>3</sub> ) <sub>2</sub>	100	20	-	+	+	+	+	+	+	+	+	+	
Dimethyl phthalate	C <sub>6</sub> H <sub>4</sub> (COOCH <sub>3</sub> ) <sub>2</sub>	100	80	-	+	+	+	+	+	+	+	+	+	
Tri-n-butyl phosphate, technical	(C <sub>4</sub> H <sub>9</sub> ) <sub>3</sub> PO <sub>4</sub>	-	20	-	+	+	+	+	+	+	+	+	+	
<b>5. Ethers</b>														
Diethyl ether	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O	100	20	-	+	+	+	+	+	+	+	+	+	
<b>6. Amines</b>														
Aniline, purest	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	100	184	-	+	+	+	+	+	+	+	+	+	
Diethanol amine	(HOC <sub>2</sub> H <sub>4</sub> ) <sub>2</sub> NH	100	20	-	+	+	+	+	+	+	+	+	+	
Ethyl amine	C <sub>2</sub> H <sub>5</sub> NH <sub>2</sub>	99	20	2,02	+	+	+	+	+	+	+	+	+	
Isopropyl amine (mono), water-free	CH <sub>3</sub> CH(NH <sub>2</sub> )CH <sub>3</sub>	98 - 100	20	-	+	+	+	+	+	+	+	+	+	

+ resistant · o partially resistant · - not resistant

Test Medium	Chemical Formula	Concentration %	temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>7. Nitriles and isonitriles</b>												
Acrylonitrile	CH <sub>2</sub> = CHCN	100	20	-	+	+	+	+	+	+	+	+
<b>8. Aldehydes</b>												
N-butyraldehyde	C <sub>3</sub> H <sub>7</sub> CHO	100	20	-	+	+	+	+	+	+	+	+
<b>9. Ketones</b>												
Acetone, purest	(CH <sub>3</sub> ) <sub>2</sub> CO	-	56	-	+	+	+	+	+	+	+	+
<b>10. Acids</b>												
Formic acid	HCOOH	98 - 100	20	-	+	+	+	+	+	+	-	+
Benzoic acid, alcoholic	C <sub>6</sub> H <sub>5</sub> COOH	40	20	-	+	+	+	+	+	+	+	+
Benzoic acid, aqueous	C <sub>6</sub> H <sub>5</sub> COOH	ca. 2	80	-	+	+	+	+	+	+	+	+
Butyric acid	C <sub>3</sub> H <sub>7</sub> COOH	98 - 100	20	-	+	+	+	+	+	+	o	+
Acetic acid	CH <sub>3</sub> COOH	98 - 100	20	-	+	+	+	+	+	+	+	+
Lauric acid	C <sub>11</sub> H <sub>23</sub> -COOH	-	160-165	-	+	+	+	+	+	+	+	+
Myristic acid	C <sub>13</sub> H <sub>27</sub> -COOH	-	160-165	-	+	+	+	+	+	+	+	+
Oxalic acid, alcoholic	(COOH) <sub>2</sub>	50	20	-	+	+	+	+	+	+	+	+
Palmitic acid	C <sub>15</sub> H <sub>31</sub> -COOH	-	160-165	-	+	+	+	+	+	+	+	+
O-phthalic acid, aqueous	C <sub>6</sub> H <sub>4</sub> (COOH) <sub>2</sub>	15	100	-	+	+	+	+	+	+	o	-
Stearic acid	C <sub>17</sub> H <sub>35</sub> -COOH	-	160-165	-	+	+	+	+	+	+	+	+
Trichloroacetic acid, aqueous	CCl <sub>3</sub> COOH	50	81	-	+	+	+	+	+	+	+	+
Undecanoic acid	C <sub>10</sub> H <sub>21</sub> -COOH	-	180-185	-	+	+	+	+	+	+	+	+
Tartaric acid, technical, aqueous	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub>	50	103	-	+	+	+	+	+	+	+	+
Citric acid, aqueous, saturated	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	62,1	100	-	+	+	+	+	+	+	-	+

+ resistant · o partially resistant · - not resistant

# Organic compounds

Test Medium	Chemical Formula	Concentration %	temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>11. Acid halogens</b>												
Acetyl chloride, pure	CH <sub>3</sub> COCl	-	20	-	+	+	+	+	+	+	-	+
<b>12. Heterocyclics</b>												
e-caprolactam, concentrated	CO(CH <sub>2</sub> ) <sub>5</sub> NH	-	90	-	+	+	+	+	+	+	+	+
Quinoline	C <sub>9</sub> H <sub>7</sub> N	-	20	-	+	+	+	+	+	+	+	+
Furan	C <sub>4</sub> H <sub>4</sub> O	-	20	-	+	+	+	+	+	+	+	+
N-methyl pyrrolidone	C <sub>5</sub> H <sub>9</sub> NO	-	20	-	+	+	+	+	+	+	+	+
N-methyl pyrrolidone	C <sub>5</sub> H <sub>9</sub> NO	-	100	-	+	+	+	+	+	+	+	+
N-methyl pyrrolidone	C <sub>5</sub> H <sub>9</sub> NO	-	206	-	+	+	+	+	-	+	+	+
Pyridine, crude	C <sub>5</sub> H <sub>5</sub> N	-	115	-	+	+	+	+	+	+	+	+

+ resistant · o partially resistant · - not resistant

# Industrial trade products

Test Medium	Chemical Formula	Concentration %	temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>1. Aids for dye mills and textile industries</b>												
Acramin®	-	-	20	-	+	+	+	+	+	+	+	+
Persistol®	-	100	20	-	+	+	+	+	+	+	+	+
<b>2. Detergents</b>												
Soaking and pre-wash detergents	-	3	60	-	+	+	+	+	+	+	+	+
Laundry detergent	-	3	20-100	-	+	+	+	+	+	+	+	+
Fine washables (silk and synthetics)	-	3	40	-	+	+	+	+	+	+	+	+
Wool detergent	-	3	20	-	+	+	+	+	+	+	+	+
<b>3. Dish washing detergents</b>												
Dish washing detergent, aqueous	-	0,4 - 0,8	20-65	-	+	+	+	+	+	+	+	+
<b>4. Heat transfer materials</b>												
Diphyl®	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> O, (C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	73 27	200	-	+	+	+	+	+	+	+	+
<b>5. Refrigerants</b>												
Freon 11®	CFCl <sub>3</sub>	-	0	1,4	+	+	+	+	+	+	+	+
Freon 12®	CF <sub>2</sub> Cl <sub>2</sub>	-	-30	-	+	+	+	+	+	+	+	+
Freon 22®	CHF <sub>2</sub> Cl	-	0	6,1	+	+	+	+	+	+	+	+
Freon 113®	C <sub>2</sub> F <sub>3</sub> Cl <sub>3</sub>	-	20	1,4	+	+	+	+	+	+	+	+
Freon 114®	C <sub>2</sub> F <sub>4</sub> Cl <sub>2</sub>	-	20	2,87	+	+	+	+	+	+	+	+

+ resistant · o partially resistant · - not resistant

# Industrial trade products

Test Medium	Chemical Formula	Concentration %										
			temperature (°C)	Pressure (bar)	carbon graphite, not impregnated	graphite, not impregnated	carbon graphite, resin impregnated	graphite, resin impregnated	resin bonded carbon	carbon graphite and graphite, antimony impregnated	carbon graphite and graphite, lead impregnated	carbon graphite and graphite, copper impregnated
<b>6. Anti-freeze</b>												
Glycolen®, aqueous	-	50 Vol.	100	-	+	+	+	+	+	+	+	+
Glysantin®, aqueous	-	50 Vol.	107	-	+	+	+	+	+	+	+	+
<b>7. Rust inhibit. and anti-freeze</b>												
Shell Donax C, aqueous	-	0,5 - 1,0	95-100	-	+	+	+	+	+	+	+	+
<b>8. Cooling lubricants</b>												
Esso-Kutwell, aqueous	-	0,5 - 1,0	95-100	-	+	+	+	+	+	+	+	+
<b>9. Motor fuels</b>												
Gasoline, leaded	-	100	75	-	+	+	+	+	+	+	+	+
Gasoline, unleaded	-	100	20	-	+	+	+	+	+	+	+	+
Gasoline, leaded, super	-	100	20	-	+	+	+	+	+	+	+	+
Diesel	-	100	20	-	+	+	+	+	+	+	+	+
Diesel	-	100	80	-	+	+	+	+	+	+	+	+
<b>10. Synthetic oils</b>												
Silicon oil DC 200/100 cSt.	-	-	200	-	+	+	+	+	+	+	+	+

+ resistant · o partially resistant · - not resistant



# Alphabetical chemical index

## A

	see	page
Acetic acid		13
Acetic acid amyl ester	N-butyl acetate	12
Acetic acid butyl ester	N-butyl acetate	12
Acetic acid chloride	Acetyl chloride	14
Acetic acid ethyl ester	N-butyl acetate	12
Acetic acid methyl ester	N-butyl acetate	12
Acetic acid pentyl ester	N-butyl acetate	12
Acetic acid propyl ester	N-butyl acetate	12
Acetic acid, glacial	Acetic acid	13
Acetone		13
Acetyl chloride		14
Acetylene tetrabromide	Trichloroethylene	11
Acetylene tetrachloride	Trichloroethylene	11
Acid halogens, inorganic		8
Acid halogens, organic		14
Acids, inorganic		6 + 7
Acids, organic		13
Acramine®		15
Acrylic acid, nitrile	Acrylonitrile	13
Acrylonitrile		13
Aids for dye mills and textile industries		15
Alcohol		12
Aldehyde ammonium	Diethanol amine	12
Aldehydes		13
Alkanals	Aldehydes	13
Allyl chloride		11
Aluminum chloride, aqueous		9
Amines		12
Amino benzene	Aniline	12
Amino butane	Ethyl amine	12
Amino ethane	Ethyl amine	12
Amino ethanol	Diethanol amine	12
1-amino glutaric acid	Tartaric acid, aqueous	13
Amino naphthalene	Aniline	12
2-amino propane	Isopropyl amine, water-free	12
1-amino propyl-1,3-dicarboxylic acid	Tartaric acid, aqueous	13
Ammonia solution, aqueous		8
Ammonia, liquid		8
Ammonium acetate	Ammonium nitrate, aqueous	9
Ammonium bicarbonate	Sodium carbonate, aqueous	10
Ammonium bromide	Potassium bromide, aqueous	9
Ammonium carbonate	Sodium carbonate, aqueous	10
Ammonium chloride	Sodium chloride, aqueous	10
Ammonium dihydrogen phosphate	Tri-sodium phosphate, aqueous	10
Ammonium hydroxide	Ammonia solution, aqueous	8

**B**

	<b>see</b>	<b>page</b>
Ammonium iron (III) sulfate, aqueous		9
Ammonium nitrate, aqueous		9
Ammonium peroxy disulfate, aqueous		9
Ammonium persulfate	Ammonium peroxy disulfate, aqueous	9
Ammonium phosphate	Tri-sodium phosphate, aqueous	10
Ammonium sulfate	Ammonium iron (III) sulfate, aqueous	9
Ammonium sulfide solution, aqueous		9
Amyl acetate	N-butyl acetate	12
Amyl alcohol	Ethanol, absolute	12
Amyl benzoate	Dimethyl phthalate	12
Amyl butyrate	N-butyl acetate	12
Amyl formate	N-butyl acetate	12
Amyl phthalate	Dimethyl phthalate	12
Amyl propionate	N-butyl acetate	12
Aniline		12
Anti-freeze		16
Aqua regia		6
N-amino propane	Isopropyl amine, water-free	12
Barium chloride	Sodium chloride, aqueous	10
Barium hydroxide	Sodium hydroxide, aqueous	8
Barium nitrate	Ammonium nitrate, aqueous	9
Bases		8
Benzene	Gasoline-benzene	11
Benzene dicarbonic acid	O-phthalic acid, aqueous	13
Benzoic acid amyl ester	Dimethyl phthalate	12
Benzoic acid ethyl ester	Dimethyl phthalate	12
Benzoic acid methyl ester	Dimethyl phthalate	12
Benzoic acid pentyl ester	Dimethyl phthalate	12
Benzoic acid propyl ester	Dimethyl phthalate	12
Benzoic acid tert-butyl ester	Dimethyl phthalate	12
Benzoic acid, alcoholic		13
Benzoic acid, aqueous		13
Biphenyl	Diphyl®	15
Bis-(2-hydroxyethyl)-amine	Diethanol amine	12
2,2-bis-(hydroxymethyl)-1,3 propanediol	Glycerin	12
Boiling detergents	Laundry detergents	15
Borax solution	Sodium carbonate, aqueous	10
Boric acid, aqueous		6
Bromine		8
Bromomethane	1,2-dibromomethane	11
Butanal	N-butyraldehyde	13
Butanoic acid	Butyric acid	13
Butanol	Ethanol, absolute	12
2-butanone	Acetone	13

# Alphabetical chemical index

	see	page
Butyl alcohol	Ethanol, absolute	12
Butyl amine	Ethyl amine	12
Butyl benzoate	Dimethyl phthalate	12
Butyl butyrate	N-butyl acetate	12
Butyl formate	N-butyl acetate	12
Butyl phosphate	Tri-n-butyl phosphate	12
Butyl phthalate	Dimethyl phthalate	12
Butyl propionate	N-butyl acetate	12
Butyric acid		13
Butyric acid amyl ester	N-butyl acetate	12
Butyric acid ethyl ester	N-butyl acetate	12
Butyric acid isoamyl ester	N-butyl acetate	12
Butyric acid methyl ester	N-butyl acetate	12
Butyric acid n-butyl ester	N-butyl acetate	12
Butyric acid pentyl ester	N-butyl acetate	12
Butyric acid propyl ester	N-butyl acetate	12
Cis-butene-1,4-diolic acid	Oxalic acid, alcoholic	13
N-butyl acetate		12
N-butyraldehyde		13
Trans-butene-1,4-diolic acid	Oxalic acid, alcoholic	13
<b>e</b> -caprolactam		14
Calcium bisulfite	Sodium sulfite, aqueous	10
Calcium carbonate	Sodium carbonate, aqueous	10
Calcium chloride	Sodium chloride, aqueous	10
Calcium hydroxide	Sodium hydroxide, aqueous	8
Calcium hypochloride, aqueous		9
Calcium nitrate	Ammonium nitrate, aqueous	9
Calcium phosphate	Tri-sodium phosphate, aqueous	10
Carbamide	Isopropyl amine, water-free	12
Carbinol	Methanol	12
Carbon disulfide	Ammonium sulfide solution, aqueous	9
Carbon disulfide	Ammonium sulfide solution, aqueous	9
Carbon tetrachloride		11
Carbon tetrachloride-trichloroethylene (1: 1)		11
Chlorine		8
Chlorine + concentrated hydrochloric acid		7
Chlorine containing sodium chloride-brine		9
Chlorine water		8
Chlorobenzene	Monochlorobenzene	11
Chlorodinitrobenzene	Monochlorobenzene	11
Chloroethane	1,1,1-trichloroethane	11

## C

	<b>see</b>	<b>page</b>
Chloroform	Carbon tetrachloride	11
Chlorohydrogen	Hydrochloric acid, gas	6
Chloromethane	Methyl chloride	11
3 -chloropropene-(l)	Allyl chloride	11
Chlorosulfonic acid		8
Chlorothene nu®	1,1,1-trichloroethane	11
Chromic acid		6
Cis-9-octadecenoic acid	Stearic acid	13
Cis-butene-1,4-diolic acid	Oxalic acid, alcoholic	13
Citric acid	Citric acid, aqueous, saturated	13
Citric acid, aqueous, saturated		13
Colamin	Diethanol amine	12
Cooling lubricants		16
Copper nitrate	Ammonium nitrate, aqueous	9
Copper sulfate	Iron (II) sulfate, aqueous	9
Cresol	Phenol	12
Crude oil	Fuel oil	11
Cumol Phenol		12
Cyclohexane		11
P-cymol	Toluene-xylene	11
Detergents		15
Diacetone	Acetone	13
Diacetone alcohol	Acetone	13
Diamide	Hydrazine hydrate, aqueous	9
Di-ammonium hydrogen phosphate	Tri-sodium phosphate, aqueous	10
Dibromomethane	1,2 -dibromoethane	11
Dibutyl phthalate	Dimethyl phthalate	12
Dichloroacetic acid	Trichloroacetic acid, aqueous	13
Dichlorobenzene	Monochlorobenzene	11
1,2 -dibromoethane		11
1,2 -dichloroethane	1,1,1-trichloroethane	11
1,1-dichloroethene	Trichloroethylene	11
1,1-dichloroethylene	Trichloroethylene	11
Dichloromethane	Methyl chloride	11
2,2-diethyl dihexyl amine	Ethyl amine	12
Di-(2-ethyl hexyl)-amine	Ethyl amine	12
Di-(2-ethyl hexyl)-phthalate	Dimethyl phthalate	12
Diesel fuel		16
Diethanol amine		12
Diethyl ether		12
Diethyl phthalate	Dimethyl phthalate	12
Diethylene glycol	Glycol	12

## D

# Alphabetical chemical index

	see	page
Diglycol	Glycol	12
Dihydroxy succinic acid	Tartaric acid, aqueous	13
Dimethyl benzene	Toluene-xylene	11
Dimethyl ketone	Acetone	13
Dimethyl phthalate		12
Dinitro chlorobenzene	Monochlorobenzene	11
Diocetyl amine	Ethyl amine	12
Diocetyl phthalate	Dimethyl phthalate	12
Diphenyl	Diphyl®	15
Diphenyl benzene	Terphenyl	11
Diphyl®		15
Dish washing detergents		15
Dodecanoic acid	Lauric acid	13
Dowtherm A®	Diphyl®	15
Dye bath	Acramine®	15
<b>E</b>		
Esso Kutwell, aqueous		16
Ester		12
Ethane	Cyclohexane	11
Ethane dicarbonic acid	Oxalic acid, alcoholic	13
Ethane diol	Glycol	12
Ethanedioic acid	Oxalic acid, alcoholic	13
Ethanoic acid	Acetic acid	13
Ethanol amine	Diethanol amine	12
Ethanol, absolute		12
Ether		12
Ethyl acetate	N-butyl acetate	12
Ethyl alcohol	Ethanol, absolute	12
Ethyl amine		12
Ethyl benzoate	Dimethyl phthalate	12
Ethyl butyrate	N-butyl acetate	12
Ethyl chloride	1,1,1 -trichloroethane	11
Ethyl formate	N-butyl acetate	12
Ethyl phthalate	Dimethyl phthalate	12
Ethyl propionate	N-butyl acetate	12
Ethylalcohol, absolute	Ethanol, absolute	12
Ethylene bromide	1,2 -dibromoethane	11
Ethylene chloride	1,1,1 -trichloroethane	11
Ethylene dichloride	1,1,1 -trichloroethane	11
Ethylene glycol	Glycol	12
<b>F</b>		
Fatty acid	Lauric acid	13
Fine washables (silk and synthetics)	Detergents	15
Fluorochlorohydrocarbon	Freon®	15
Formic acid		13

	<b>see</b>	<b>page</b>
Formic acid, amyl ester	N-butyl acetate	12
Formic acid, ethyl ester	N-butyl acetate	12
Formic acid, methyl ester	N-butyl acetate	12
Formic acid, n-butyl ester	N-butyl acetate	12
Formic acid, pentyl ester	N-butyl acetate	12
Formic acid, propyl ester	N-butyl acetate	12
Freon®		15
Fuel oil		11
Fumaric acid	Oxalic acid, alcoholic	13
Furan		14
Furfuran	Furan	14
Furfural	Ethanol, absolute	12
Furfuryl alcohol	Ethanol, absolute	12
Furfuryl aldehyde	N-butyraldehyde	13

## G

Gasoline®	Mineral oil	11
Gasoline, leaded		16
Gasoline, leaded, super		16
Gasoline, unleaded		16
Gasoline-benzene (1 : 1)		11
Genklene®	1,1,1-trichloroethane	11
Glutamic acid	Tartaric acid, aqueous	13
Glutaric acid	Tartaric acid, aqueous	13
Glycerin		12
Glycol		12
Glycolen®, aqueous		16
Glysantin®, aqueous		16

## H

Halogenated hydrocarbons		11
Halogens		8
Heat transfer materials		15
Heptane	Cyclohexane	11
Heterocyclics		14
Hexachloroacetone	Acetone	13
Hexadecanoic acid	Palmitic acid	13
Hexahydrobenzene	Cyclohexane	11
Hexamethylene	Cyclohexane	11
Hexane	Cyclohexane	11
Hexone	Acetone	13
Hydrazine	Hydrazine hydrate, aqueous	9
Hydrazine hydrate, aqueous		9
Hydrobromic acid	Bromine, liquid	8
Hydrocarbons		11

# Alphabetical chemical index

	see	page
Hydrochloric acid		6
Hydrochloric acid, concentrated + chlorine		7
Hydrochloric acid, gas		6
Hydrofluoric acid		6
Hydrogen peroxide		9
Hydrogen sulfide water, cold, saturated		7
4 -hydroxy-4-methyl-2 -pentanone	Acetone	
2-hydroxypropionic acid	Tartaric acid, aqueous	13
Hydroxysuccinic acid	Tartaric acid, aqueous	13
Hydroxytoluene	Phenol	13
Hydroxyxylene	Phenol	12
		12
Iron (III) ammonium sulfate		
2,2-iminodiethanol	Ammonium iron (III) sulfate, aqueous	9
Iodoform	Diethanol amine	12
Iron (II) sulfate, aqueous	Carbon tetrachloride	11
Iron chloride		9
Iron sulfide	Sodium chloride, aqueous	10
Isoamyl butyrate	Ammonium sulfide solution, aqueous	9
Isobutane	N-butyl acetate	12
Isobutene	Cyclohexane	11
Isobutyl methyl ketone	Cyclohexane	11
Isonitrile	Acetone	13
Isopentane		13
Isophthalic acid methyl ester	Cyclohexane	11
Isopropanol	Dimethyl phthalate	12
Isopropyl acetate	Ethanol, absolute	12
Isopropyl alcohol	N-butyl acetate	12
Isopropyl amine (mono)	Ethanol, absolute	12
Isopropyl benzene		12
Isopropyl methyl benzene	Toluene-xylene	11
	Toluene-xylene	11
Kerosene		
Ketone	Gasoline	11
		13
Lactic acid		
Laundry detergents	Tartaric acid, aqueous	13
Lauric acid	Detergents	15
Lindol®		13
Lithium bromide	Tri-n-butyl phosphate	12
Lithium chloride	Potassium bromide	9
Magnesium chloride	Sodium chloride, aqueous	10

I

K

L

# M

	see	page
Magnesium hydroxide	Sodium chloride, aqueous	10
Magnesium sulfate	Sodium hydroxide, aqueous	8
Maleic acid	Ammonium iron (III) sulfate, aqueous	9
Malic acid	Oxalic acid, alcoholic	13
Malonic acid	Tartaric acid, aqueous	13
Manganese chloride	Oxalic acid, alcoholic	13
Mecloran®	Sodium chloride, aqueous	10
Mercury chloride	1,1,1-trichloroethane	11
Mercury nitrate	Sodium chloride, aqueous	10
Mesityl oxide	Ammonium nitrate, aqueous	9
Methane	Acetone	13
Methanoic acid	Cyclohexane	11
Methanol	Formic acid	13
Methyl acetate		12
Methyl acrylic acid ester	N-butyl acetate	12
Methyl alcohol	N-butyl acetate	12
Methyl benzoate	Methanol	12
Methyl bromide	Diemethyl phthalate	12
Methyl butane	1,2 -dibromoethane	11
Methyl butyrate	Cyclohexane	11
Methyl chloride	N-butyl acetate	12
Methyl chloroform		11
Methyl ethyl ketone	1,1,1-trichloroethane	11
Methyl formate	Acetone	13
Methyl hydroxyl benzene	N-butyl acetate	12
Methyl isobutyl ketone	Phenol	12
1-methyl-4-isopropyl benzene	Acetone	13
Methyl methacrylate	Toluene-xylene	11
4-methyl-2-pentanone	N-butyl acetate	12
4-methyl-3 -penten-(2)-one	Acetone	13
Methyl phenol	Acetone	13
Methyl phthalate	Phenol	12
2-methyl propane	Dimethyl phthalate	12
2-methyl propene	Cyclohexane	11
Methyl propionate	Cyclohexane	11
1-methyl-2-pyrrolidone	N-butyl acetate	12
Methylene bromide	N-methyl pyrrolidone	14
Methylene chloride	1,2 -dibromoethane	11
Mineral oil, technical	Methyl chloride	11
Mixed acid		11
Monoammonium		6
dihydrogen phosphate		10
Monochloroacetic acid	Tri-sodium phosphate, aqueous	
Monochlorobenzene	Trichloroacetic acid, aqueous	13
Monoethanol amine		11

# Alphabetical chemical index

	see	page
Monoethyl amine	Diethanol amine	12
Monozinc phosphate, aqueous	Ethyl amine	12
Motor fuels		10
Myristic acid		16
N-methyl-pyrrolidone		13
		14
Naphtha		
Naphthalene	Mineral oil	11
Naphthene	Diphyl®	15
Naphthyl amine	Cyclohexane	11
N-butyl acetate	Aniline	12
Nickel chloride		12
Nickel sulfate, aqueous	Sodium chloride, aqueous	10
Nitric acid		10
Nitric acid, vapors		6
Nitrile		6
Nitrobenzene		13
Nitromethane	Gasoline-benzene	11
Nonyl Phenol	Methyl chloride	11
	Phenol	12
Octadecanoic acid		
Cis-9-octadecenoid acid	Stearic acid	13
Octyl phenol	Stearic acid	13
Oleic acid	Phenol	12
Oleum	Stearic acid	13
Oxalic acid, alcoholic	Sulphuric acid, fumins	7
Oxidizing agents		13
Oxyethane dicarbonic acid		9
2-oxypropane tricarbonic acid	Tartaric acid, aqueous	13
	Citric acid, aqueous, saturated	13
Palmitic acid		
Pentachlorophenol		13
Pentaerythrite	Phenol	12
Pentane	Glycerin	12
Pentanedioic acid	Cyclohexane	11
Pentanol-(l)	Tartaric acid, aqueous	13
Pentyl butyrate	Ethanol, absolute	12
Per	N-butyl acetate	12
Perchloric acid	Trichloroethylene	11
Perchloroethylene		6
Persistol®	Trichloroethylene	11
Phenol		15
Phenyl acetic acid		12
Phenyl amine	Acetic acid	13

	<b>see</b>	<b>page</b>
Phenyl chloride	Aniline	12
Phenyl ethylene	Monochlorobenzene	11
Phenylbenzene	Gasoline-benzene	11
2-phenyl propane	Diphyl®	15
Phosphoric acid	Phenol	12
Phosphorus oxychloride		6
Phthalic acid amyl ester		8
Phthalic acid dibutyl ester	Dimethyl phthalate	12
Phthalic acid diethyl ester	Dimethyl phthalate	12
Phthalic acid dimethyl ester	Dimethyl phthalate	12
Phthalic acid ethyl ester	Dimethyl phthalate	12
Phthalic acid methyl ester	Dimethyl phthalate	12
Phthalic acid propyl ester	Dimethyl phthalate	12
Phthalic acid, aqueous	Dimethyl phthalate	12
Potash lye		12
Potassium bicarbonate	Sodium hydroxide, aqueous	8
Potassium bromide	Sodium carbonate, aqueous	10
Potassium carbonate		9
Potassium chlorate, aqueous	Sodium carbonate, aqueous	10
Potassium chloride		9
Potassium hydroxide	Sodium chloride, aqueous	10
Potassium iodide	Sodium hydroxide, aqueous	8
Potassium nitrate, aqueous		9
Potassium permanganate, aqueous		9 + 10
Potassium phosphate		9
Potassium silicate	Tri-sodium phosphate, aqueous	10
Potassium sulfate	Sodium carbonate, aqueous	10
Pre-wash detergents	Ammonium iron (III) sulfate, aqueous	9
Propane	Detergents	15
Propane carbonic acid	Cyclohexane	11
Propane dicarbonic acid	Butyric acid	13
Propanediocid acid	Tartaric acid, aqueous	13
1,2,3-propanetriol	Oxalic acid, alcoholic	13
Propanoic acid	Glycerin	12
Propanol	Acetic acid	13
Propanone	Ethanol, absolute	12
Propen	Acetone	13
Propionic acid	Cyclohexane	11
Propionic acid amyl ester	Acetic acid	13
Propionic acid butyl ester	N-butyl acetate	12
Propionic acid ethyl ester	N-butyl acetate	12
Propionic acid methyl ester	N-butyl acetate	12
Propionic acid pentyl ester	N-butyl acetate	12
Propionic acid propyl ester	N-butyl acetate	12
Propyl acetate	N-butyl acetate	12

# Alphabetical chemical index

	see	page
Propyl alcohol	N-butyl acetate	12
1-propyl amine	Ethanol, absolute	12
2-propyl amine	Isopropyl amine, water-free	12
Propyl benzoate	Isopropyl amine, water-free	12
Propyl butyrate	Dimethyl phthalate	12
Propyl formate	N-butyl acetate	12
Propyl phthalate	N-butyl acetate	12
Propyl propionate	Dimethyl phthalate	12
Propylene	N-butyl acetate	12
Pyridine	Cyclohexane	11
Pyrogallol		14
	Phenol	12
Quinoline		14
Refrigerants		
Rinsing agents	Acetone	15
Rust inhibitors and anti-freeze	Dish washing detergents	15
		16
Salt solutions		
Salts		9 + 10
Sea water		9 + 10
Shell Donax C, aqueous		10
Silicon oil		16
Silicon tetrachloride		16
Soaking and pre-wash detergents		10
Sodium acetate	Detergents	15
Sodium bicarbonate	Sodium carbonate, aqueous	10
Sodium borate	Sodium carbonate, aqueous	10
Sodium carbonate, aqueous	Sodium carbonate, aqueous	10
Sodium chloride, aqueous		10
Sodium chlorite, aqueous		10
Sodium hexamethaphosphate		9
Sodium hydrogen carbonate	Tri-sodium phosphate, aqueous	10
Sodium hydroxide	Sodium carbonate, aqueous	10
Sodium hypochloride	Sodium hydroxide, aqueous	8
Sodium nitrate		9
Sodium nitrite, aqueous	Potassium nitrate, aqueous	9 + 10
Sodium peroxide solution		10
Sodium silicate	Sodium hydroxide, concentrated, aqueous	8
Sodium sulfate	Sodium carbonate, aqueous	10
Sodium sulfide	Ammonium iron (III) sulfate, aqueous	9
Sodium sulfite, aqueous	Ammonium sulfide solution, aqueous	9

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S

# T

	see	page
Sodium tetraborate		10
Solvethane®	Sodium carbonate, aqueous	10
Stearic acid	1,1,1-trichloroethane	11
Strontium nitrate		13
Styrene	Ammonium nitrate, aqueous	9
Succinic acid	Gasoline-benzene	11
Sulphuric acid	Oxalic acid, alcoholic	13
Sulphuric acid, fumins		7
Sulphuric dioxide		7
Sulphurous acid		7
Sulphuryl chloride		7
Synthetic oil		8
Tri-sodium phosphate, aqueous		16
		10
Tannic acid		
	Benzoic acid, alcoholic and	13
Tap water, 348 ppm CaCO <sub>3</sub>	Tartaric acid, aqueous	
Tartaric acid, aqueous		10
Terphenyl		13
Tetra		11
Tetrabromoethane	Carbon tetrachloride	11
Tetrachloroethane	1,1,1-trichloroethane	11
Tetrachloroethylene	1,1,1-trichloroethane	11
Tetrachloromethane	Trichloroethylene	11
Tetradecanoic acid	Carbon tetrachloride	11
Textile industry aids	Myristic acid	13
	Aids for dye mills and textile	15
Thionyl chloride	industries	
Titanium chloride		8
Titanium tetrachloride	Titanium tetrachloride	10
Toluene		10
Toluene-xylene (1 : 1)	Toluene-xylene	11
Tolyl acid		11
Tolyl phosphate	Benzoic acid	13
Trans-butene 1,4-diolic acid	Tri-n-butyl phosphate	12
Tri	Oxalic acid, alcoholic	13
Tri-n-butyl phosphate	Trichloroethylene	11
1,1,1-trichloroethane		12
Tri-sodium phosphate, aqueous		11
Trichloroacetic acid, aqueous		10
Trichloroethylene		13
Trichloromethane		11
Tricresyl phosphate	Carbon tetrachloride	11
Triethanol amine	Tri-n-butyl phosphate	12
Triethyl amine	Diethanol amine	12

# Alphabetical chemical index

	see	page
Trihydroxybenzene	Ethyl amine	12
Triiodomethane	Phenol	12
Trinitrophenol	Carbon tetrachloride	11
Trixylenyl phosphate	Phenol	12
	Tri-n-butyl phosphate	12
Urea		
U	Undecanoic acid	Isopropyl amine, water-free
		13
Vinyl acetate		
V	Vinyl benzene	N-butyl acetate
	Vinyl chloride	Gasoline-benzene
	Vinyl cyanide	Methyl chloride
	Vinylidene chloride	Acrylonitrile
	Vitrolic acid	Trichloroethylene
		Sulphuric acid, fumins, oleum
	7	
Water-repellent		
W	White spirit	Persistol®
	Water	Gasoline
	Water glass	Tap water
	Wine vinegar	Sodium carbonate, aqueous
	Wool detergents	Acetic acid
	Detergents	
	15	
Xylene (o-, m-, p-)		
X	Xylenol	Toluene-xylene
		Toluene-xylene
	11	
	11	
Zinc chloride		
Z	Zinc nitrate	Sodium chloride, aqueous
	Zinc phosphate	Ammonium nitrate, aqueous
	Zinc stearate	Monozinc phosphate, aqueous
	Zinc sulfate	Stearic acid
		Iron (II) sulfate, aqueous
	9	
	10	
	9	
	10	
	13	
	9	

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