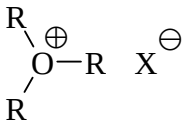
7.10

Verbindungsklassen (R = Kohlenwasserstoffrest)

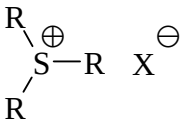
Kapitel

7 R—Hal (Hal = F, Cl, Br, I)

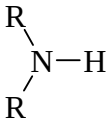
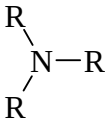
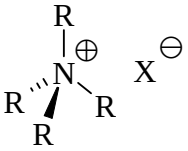
Halogenverbindungen

8 R—O—H R—O—R  R—O—O—H

Alkohole **Ether** **Oxoniumsalze** **Peroxide**

8 R—S—H R—S—R  $R—SO_3H$

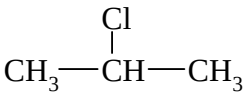
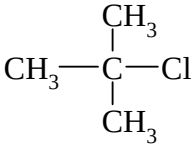
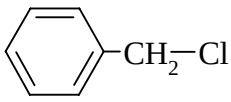
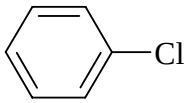
Thioalkohole **Thioether** **Sulfoniumsalze** **Sulfonsäuren**

9 $R—NH_2$   

primäre Amine **sekundäre Amine** **tertiäre Amine** **Ammoniumsalze**

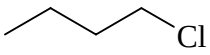
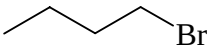
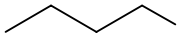
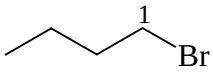
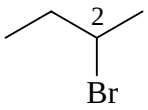
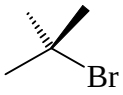
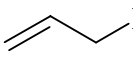
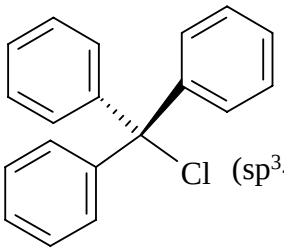
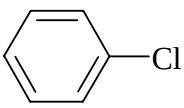
7.11

Halogenverbindungen

systematischer Name **(Trivialname)**	**Konstitution**	**Siedepunkt** **[°C]**	**Dichte** **[g/cm^3]**	**MAK** **[ppm (mg/m^3)]**
Chlor**methan** (Methylchlorid)	$CH_3—Cl$	– 24	0.9159	50 (105)
Brom**methan** (Methylbromid)	$CH_3—Br$	5	1.6755	5 (20)
Iod**methan** (Methyliodid)	$CH_3—I$	42	2.279	0.3 (2)
Chlor**ethan** (Ethylchlorid)	$CH_3—CH_2—Cl$	12	0.8978	1000 (2600)
2-Chlor**propan** (Isopropylchlorid, *i*-Propylchlorid)		36	0.8617	
2-Chlor-2-methyl**propan** (*tert*-Butylchlorid)		52	0.8420	
Chlormethyl**benzol (benzen)** (Benzylchlorid)		179	1.1002	1 (5)
Chlor**ethen** (Vinylchlorid)	$CH_2=CH—Cl$	– 13	0.9106	
Chlor**benzol (benzen)**		132	1.1058	50 (230)

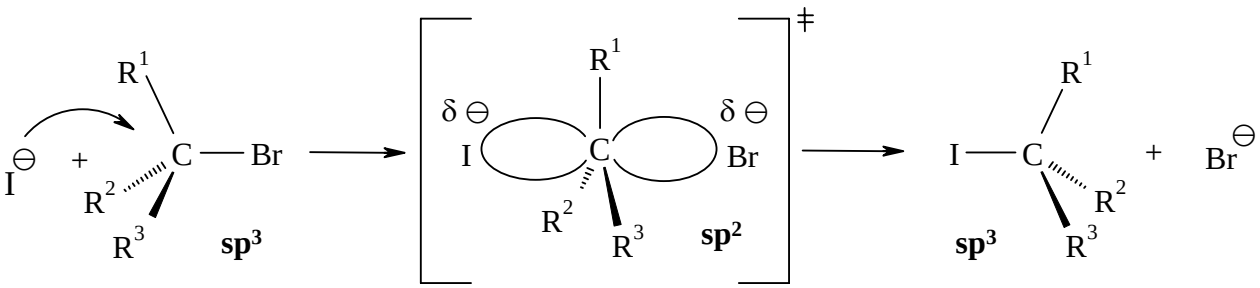
7.12

Geschwindigkeit nucleophiler Substitutionen

	Substrat	**Reagenz**	
		$AgNO_3$ in Wasser	NaI in Aceton
Einfluß der **Art** des Halogens	  		
Einfluß der **Stellung** des Halogens	 (primär)  (sekundär)  (tertiär)  (allylisch)		
Einfluß der **Hybridisierung** des C-Atoms	 (sp^3-C)  (sp^2-C)		

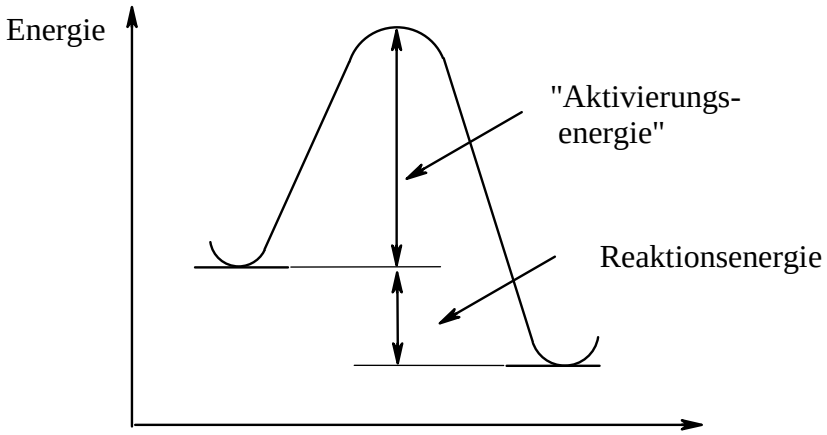
7.13

Bimolekulare nucleophile Substitution (S_N2-Reaktion)



Edukte (Energieminimum) — Übergangszustand (Energiemaximum) — Produkte (Energieminimum)

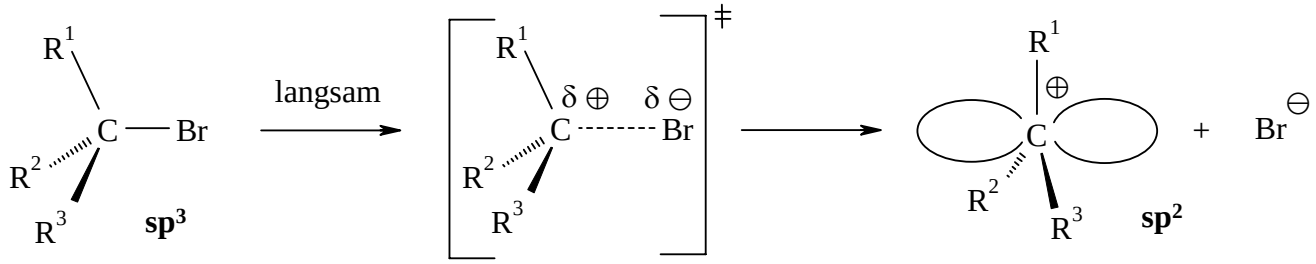
"Energieprofil" der Reaktion (vereinfacht)



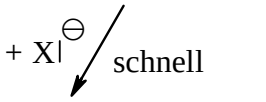
7.14

Monomolekulare nucleophile Substitution (S_N1-Reaktion)

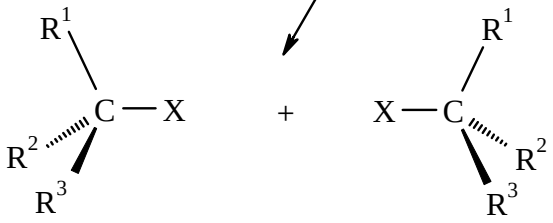
Dissoziation



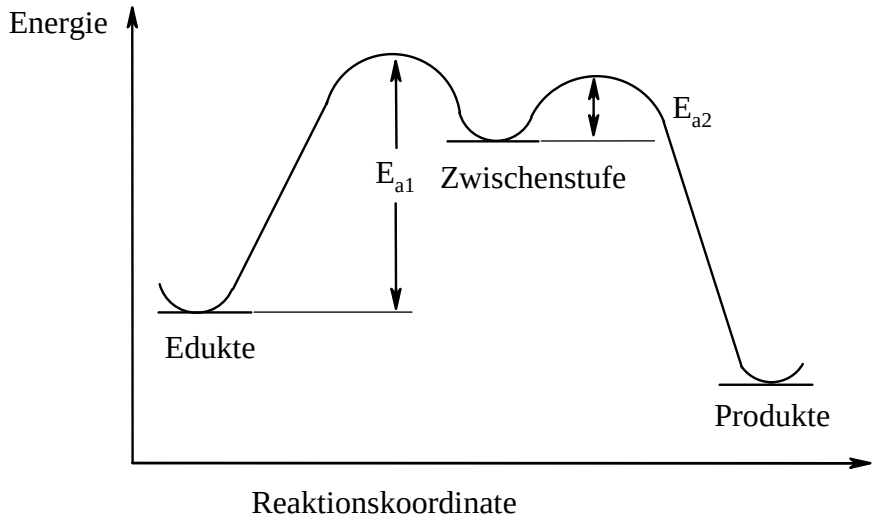
Edukt | Übergangszustand 1 (Energiemaximum) | Zwischenstufe Carbenium-Ion



Addition [Übergangszustände 2]‡



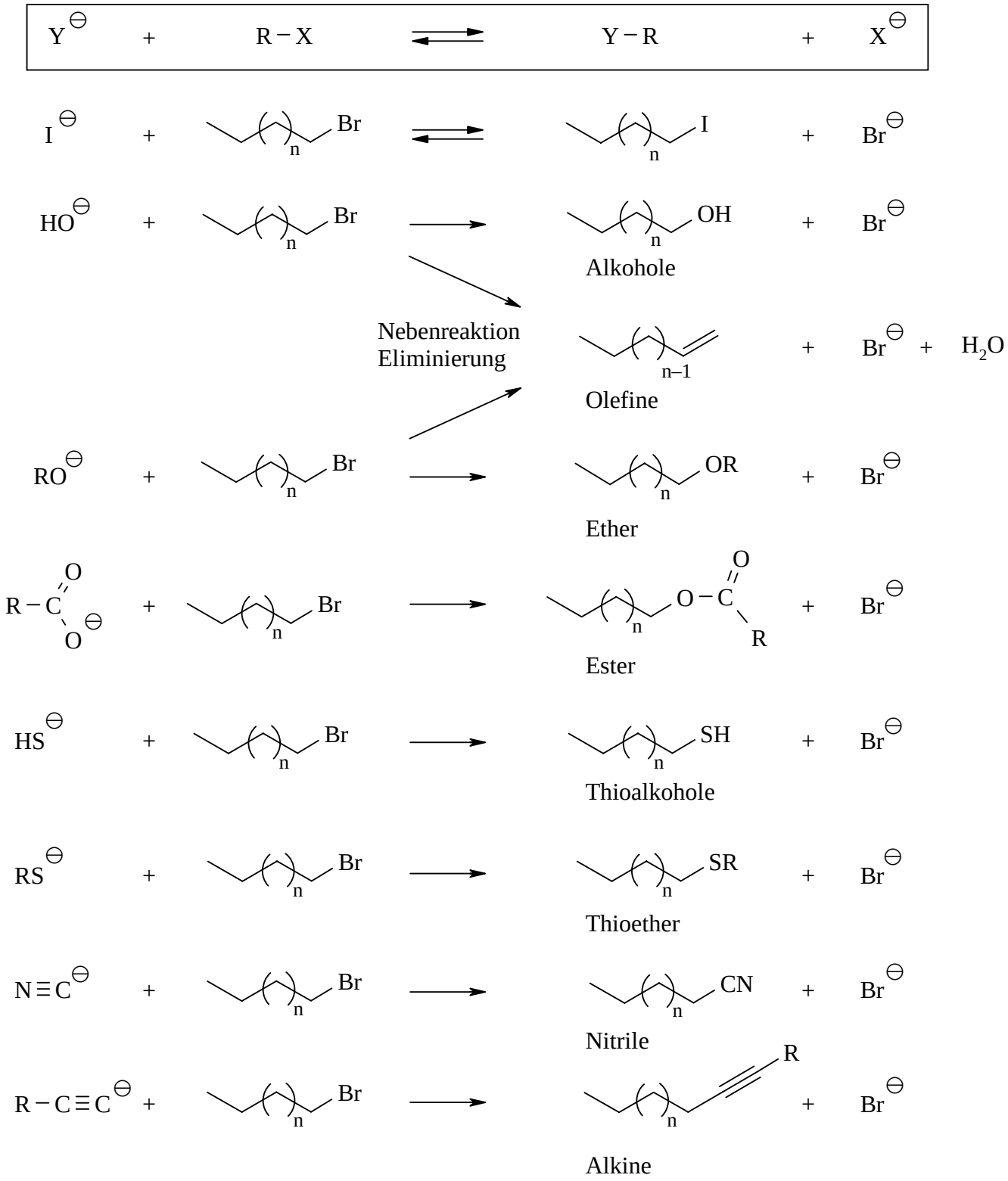
"Energieprofil"



7.15

Präparative Anwendungen der nucleophilen Substitution I

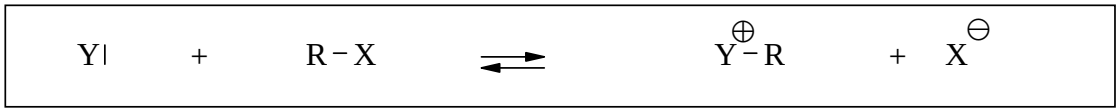
Anionische Nucleophile:

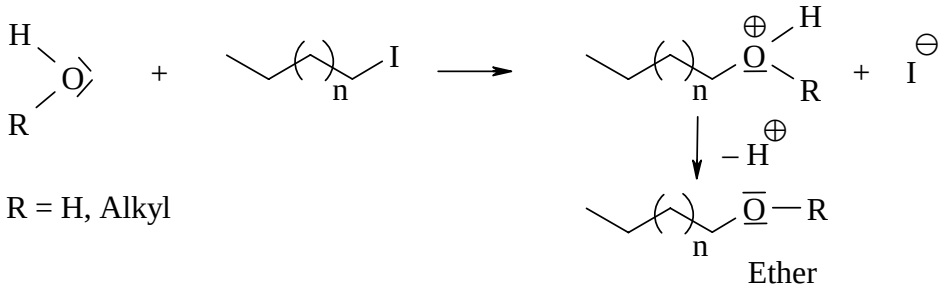


7.16

Präparative Anwendungen II

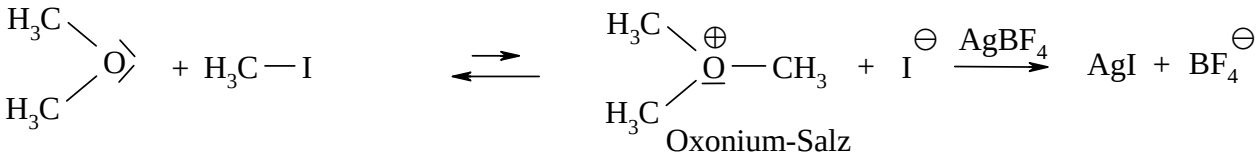
Ungeladene Nucleophile:



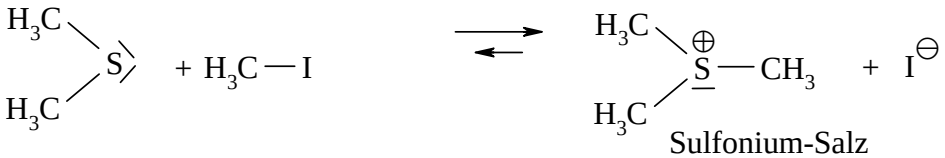


R = H, Alkyl

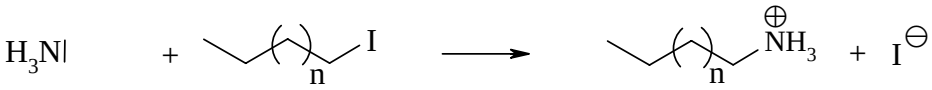
Ether



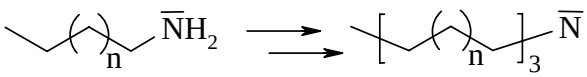
Oxonium-Salz



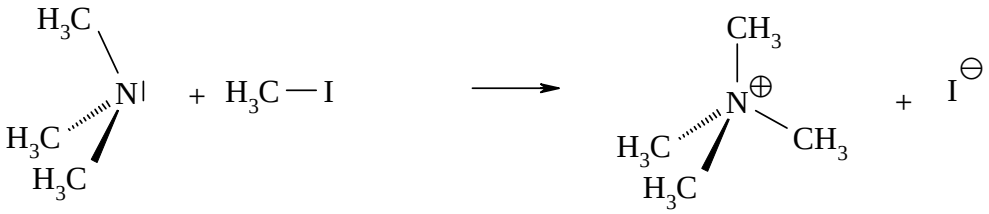
Sulfonium-Salz



Ammonium-Salz



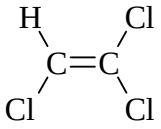
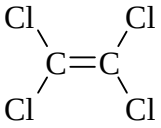
primäres Amin tertiäres Amin



quartäres Ammonium-Salz

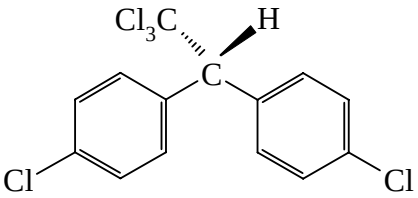
7.17

Polychlorverbindungen

systematischer Name (Trivialname)	**Konstitution**	**Siedepunkt [°C]**	**Dichte [g/cm^3]**	**MAK [ppm (mg/m^3)]**
Dichlor**methan** (Methylenchlorid)	CH_2Cl_2	40	1.327	100 (360)
Trichlor**methan** (Chloroform)	$CHCl_3$	61	1.483	10 (50)
Tetrachlor**methan** (Tetrachlorkohlenstoff)	CCl_4	77	1.594	10 (65)
1,2-Dichlor**ethan** (Ethylenchlorid)	$Cl—CH_2—CH_2—Cl$	84	1.253	20 (80)
Trichlor**ethen** (Trichlorethylen, „Tri“)		87	1.464	50 (270)
Tetrachlor**ethen** (Tetrachlorethylen, Perchlorethylen, „Per“)		121	1.623	50 (345)

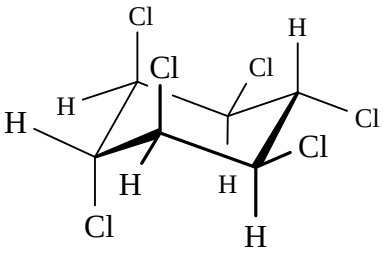
7.18

Insektizide Polyhalogenverbindungen



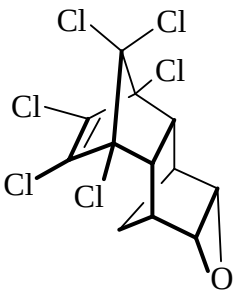
Dichlordiphenyltrichlorethan (DDT)
P. Müller, Medizin-Nobelpreis 1948

LD_{50} = 113 mg/kg (Ratte, oral)
in der BRD seit 1972 verboten



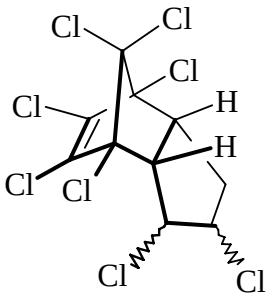
γ-Hexachlorcyclohexan (Lindan)

LD_{50} = 88 mg/kg
in der BRD nicht mehr hergestellt



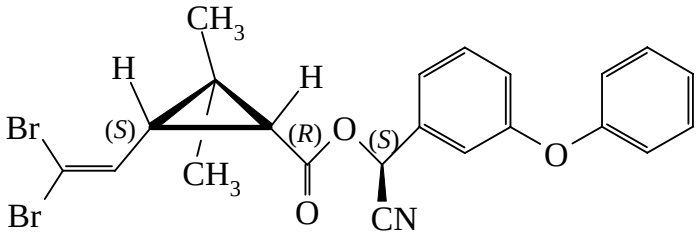
Dieldrin

LD_{50} = 10 mg/kg
Kontakt- und Fraßgift, in der BRD verboten



Chlordan

LD_{50} = 460 mg/kg
in der BRD verboten



Deltamethrin

LD_{50} = 139 mg/kg

7.19

Akute Toxizität einiger Substanzen

Giftklasse	toxische Substanz	akute tödliche Dosis LD_{50} [mg/kg]
sehr giftig	Botulinus-Toxin	0.000 000 03
LD_{50} < 25 mg/kg Körpergewicht	Tetanus-Toxin	0.000 000 1
	Diphterie-Toxin	0.000 3
	TCDD (am Meerschweinchen ermittelt)	0.001
	γ-Amanitin (Knollenblätterpilz)	0.2 – 0.4
	Muscarin (Fliegenpilz)	1
	Blausäure	1
	Arsen(III)-oxid	1 – 4
	Parathion (Insektizid)	2
	TCDD (am Hamster ermittelt)	3
	Strychnin (Alkaloid)	5
	Aflatoxin B_1 (Mykotoxin)	7
	Quecksilber(II)-chlorid	3 – 14
	Dieldrin (Insektizid)	10
giftig	Nikotin (Alkaloid)	50
LD_{50} = 25 – 200 mg/kg Körpergewicht	Natriumnitrit	60 – 90
	Barbitursäure-Derivate	60 – 140
	DDT (Insektizid)	113
mindergiftig	Methanol	360 – 1100
LD_{50} = 200 – 2000 mg/kg Körpergewicht		
nicht giftig	Ethanol	3300
LD_{50} > 2000 mg/kg Körpergewicht	Natriumchlorid	7000 – 1400

Quelle: Nachr. Chem. Techn. Lab. **1991**, 39, 648.