

ULLMANN'S Seventh Edition ENCYCLOPEDIA OF INDUSTRIAL CHEMISTRY

Ullmann's Encyclopedia of Industrial Chemistry

7th, Completely Revised Edition

Volume 11

Cyanuric Acid and Cyanuric Chloride
to
Dyes, General Survey



Ullmann's Encyclopedia of Industrial Chemistry is also available online, with regular content updates and including additional content. Please visit <http://onlinelibrary.wiley.com/book/10.1002/14356007> for details.



WILEY-VCH Verlag GmbH & Co. KGaA

All books published by Wiley-VCH are carefully produced. Nevertheless, authors, editors, and publisher do not warrant the information contained in these books, including this book, to be free of errors. Readers are advised to keep in mind that statements, data, illustrations, procedural details or other items may inadvertently be inaccurate.

Library of Congress Card No.:
applied for

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

**Bibliographic information published by
the Deutsche Nationalbibliothek**
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <http://dnb.d-nb.de>.

© 2011 Wiley-VCH Verlag & Co. KGaA, Boschstr. 12,
69469 Weinheim, Germany

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form – by photoprinting, microfilm, or any other means – nor transmitted or translated into a machine language without written permission from the publishers. Registered names, trademarks, etc. used in this book, even when not specifically marked as such, are not to be considered unprotected by law.

Cover Design Grafik-Design Schulz, Fußgönheim
Typesetting Thomson Digital, Noida, India
Printing Strauss GmbH, Mörlenbach
Binding Litges & Dopf Buchbinderei GmbH,
Heppenheim

Printed in the Federal Republic of Germany

Printed on acid-free paper.
The paper used corresponds to both the U.S. standard ANSI Z.39.48 – 1992 and the European standard ISO TC 46.

ISBN: 978-3-527-32943-4

Ullmann's Encyclopedia of Industrial Chemistry

Volume 11

Editor-in-Chief

Barbara Elvers
*Hamburg,
Germany*

Editorial Advisory Board

Giuseppe Bellussi
*Eni S.p.A.,
San Donato Milanese,
Italy*

Matthias Bohnet
*Technical University Braunschweig,
Braunschweig,
Germany*

James Bus
*The Dow Chemical Company,
Midland, MI,
USA*

Karlheinz Drauz
*Evonik Degussa GmbH,
Hanau,
Germany*

Helmut Greim
*Technical University
Munich,
Freising-Weihenstephan,
Germany*

Klaus-Peter Jäckel
*BASF AG,
Ludwigshafen,
Germany*

Trevor Laird
*Scientific Update,
East Sussex,
United Kingdom*

Uwe Karst
*University of Münster,
Münster,
Germany*

Axel Kleemann
*Hanau,
Germany*

Gerhard Kreysa
*DECHEMA e. V.,
Frankfurt am Main,
Germany*

Willi Meier
*DECHEMA e. V.,
Frankfurt am Main,
Germany*

Eckhard Ottow
*Bayer Schering Pharma AG,
Berlin,
Germany*

Michael Röper
*BASF AG,
Ludwigshafen,
Germany*

Japie Scholtz
*Sasol Technology Ltd.,
Sasolburg,
South Africa*

Kai Sundmacher
*Max Planck Institute
Dynamics of Complex
Technical Systems,
Magdeburg,
Germany*

Roland Ulber
*Technical University
Kaiserslautern,
Kaiserslautern,
Germany*

Ulrich Wietelmann
*Chemetall GmbH,
Frankfurt am Main,
Germany*

Volume Overview

Vol. 1	Abrasion and Erosion <i>to</i> Air, 1. Emissions and Atmosphere
Vol. 2	Air, 2. Effects of Air Pollutants <i>to</i> Amines, Aromatic
Vol. 3	Amino Acids <i>to</i> Antiepileptics
Vol. 4	Antifreezes <i>to</i> Basic Principles of Chromatography
Vol. 5	Batteries <i>to</i> Biotechnology, 1. General
Vol. 6	Biotechnology, 2. Metabolic Engineering <i>to</i> Carbon, 5. Activated Carbon
Vol. 7	Carbon, 6. Carbon Black <i>to</i> Cereal Products
Vol. 8	Cereals <i>to</i> Chloroformic Esters
Vol. 9	Chlorohydrins <i>to</i> Concrete
Vol. 10	Confectionery <i>to</i> Cyano Compounds, Inorganic
Vol. 11	Cyanuric Acid and Cyanuric Chloride <i>to</i> Dyes, General Survey
Vol. 12	Ecology and Ecotoxicology, Fundamentals <i>to</i> Enzymes, 4. Non-food Application
Vol. 13	Enzymes, 5. Enzymes in Organic Synthesis <i>to</i> Explosives
Vol. 14	Fats and Fatty Oils <i>to</i> Filtration
Vol. 15	Fire Extinguishing Agents <i>to</i> Formaldehyde
Vol. 16	Formamides <i>to</i> Glass, 2. Production
Vol. 17	Glass, 3. Forming <i>to</i> High-Throughput Screening
Vol. 18	HIV and AIDS Therapeutics <i>to</i> Immunotherapy and Vaccines
Vol. 19	Inclusion Compounds <i>to</i> Iron, 3. Direct Reduction Processes
Vol. 20	Iron, 4. Smelting Reduction Processes <i>to</i> Leather
Vol. 21	Leather Imitates <i>to</i> Luminescent Materials
Vol. 22	Magnesium <i>to</i> Metals, Surface Treatment
Vol. 23	Methacrylic Acid and Derivatives <i>to</i> Natural Gas
Vol. 24	Nematicides <i>to</i> Nuclear Technology
Vol. 25	Nucleic Acids <i>to</i> Paints and Coatings, 2. Types
Vol. 26	Paints and Coatings, 3. Paint Systems <i>to</i> Phosphorus
Vol. 27	Phosphorus Compounds, Inorganic <i>to</i> Plastics, Additives
Vol. 28	Plastics, Analysis <i>to</i> Polyesters
Vol. 29	Polyethylene <i>to</i> Potassium Compounds
Vol. 30	Powder Metallurgy and Sintered Materials <i>to</i> Quasicrystals
Vol. 31	Quinoline and Isoquinoline <i>to</i> Rubber, 8. Synthesis by Polymer Modification
Vol. 32	Rubber, 9. Chemicals and Additives <i>to</i> Silicones
Vol. 33	Silk <i>to</i> Sorbic Acid
Vol. 34	Spasmolytics <i>to</i> Sulfones and Sulfoxides
Vol. 35	Sulfonic Acids, Aliphatic <i>to</i> Tellurium and Tellurium Compounds
Vol. 36	Temperature Measurement <i>to</i> Thyrotherapeutic Agents
Vol. 37	Tin, Tin Alloys, and Tin Compounds <i>to</i> Urea
Vol. 38	Urea Derivatives <i>to</i> Wastewater
Vol. 39	Water <i>to</i> Zirconium and Zirconium Compounds
Vol. 40	Index

Symbols and Units

Symbols and units agree with SI standards (for conversion factors see page X). The following list gives the most important symbols used in the encyclopedia. Articles with many specific units and symbols have a similar list as front matter.

Symbol	Unit	Physical Quantity
a_B		activity of substance B
A_r		relative atomic mass (atomic weight)
A	m^2	area
c_B	mol/m^3 , mol/L (M)	concentration of substance B
C	C/V	electric capacity
c_p , c_v	$J\text{ kg}^{-1}\text{ K}^{-1}$	specific heat capacity
d	cm , m	diameter
d		relative density (ρ/ρ_{water})
D	m^2/s	diffusion coefficient
D	Gy ($=J/kg$)	absorbed dose
e	C	elementary charge
E	J	energy
E	V/m	electric field strength
E	V	electromotive force
E_A	J	activation energy
f		activity coefficient
F	C/mol	Faraday constant
F	N	force
g	m/s^2	acceleration due to gravity
G	J	Gibbs free energy
h	m	height
$\hbar$	$W \cdot s^2$	Planck constant
H	J	enthalpy
I	A	electric current
I	cd	luminous intensity
k	(variable)	rate constant of a chemical reaction
k	J/K	Boltzmann constant
K	(variable)	equilibrium constant
l	m	length
m	g , kg , t	mass
M_r		relative molecular mass (molecular weight)
n_D^{20}		refractive index (sodium D-line, 20°C)
n	mol	amount of substance
N_A	mol^{-1}	Avogadro constant ($6.023 \times 10^{23}\text{ mol}^{-1}$)
P	Pa , bar^*	pressure
Q	J	quantity of heat
r	m	radius
R	$JK^{-1}\text{ mol}^{-1}$	gas constant
R	Ω	electric resistance
S	J/K	entropy
t	s , min , h , d , month , a	time
t	$^\circ\text{C}$	temperature
T	K	absolute temperature
u	m/s	velocity
U	V	electric potential

Symbols and Units (Continued from p. VIII)

Symbol	Unit	Physical Quantity
U	J	internal energy
V	m^3 , L, mL, μL	volume
w		mass fraction
W	J	work
x_B		mole fraction of substance B
Z		proton number, atomic number
α		cubic expansion coefficient
α	$\text{Wm}^{-2}\text{K}^{-1}$	heat-transfer coefficient (heat-transfer number)
α		degree of dissociation of electrolyte
$[\alpha]$	$10^{-2}\text{deg cm}^2\text{g}^{-1}$	specific rotation
η	$\text{Pa}\cdot\text{s}$	dynamic viscosity
θ	$^{\circ}\text{C}$	temperature
κ		c_p/c_v
λ	$\text{Wm}^{-1}\text{K}^{-1}$	thermal conductivity
λ	nm, m	wavelength
μ		chemical potential
ν	Hz , s^{-1}	frequency
ν	m^2/s	kinematic viscosity (η/ρ)
π	Pa	osmotic pressure
ρ	g/cm^3	density
σ	N/m	surface tension
τ	Pa (N/m^2)	shear stress
φ		volume fraction
χ	Pa^{-1} (m^2/N)	compressibility

*The official unit of pressure is the pascal (Pa).

Conversion Factors

SI unit	Non-SI unit	From SI to non-SI multiply by
<i>Mass</i>		
kg	pound (avoirdupois)	2.205
kg	ton (long)	9.842×10^{-4}
kg	ton (short)	1.102×10^{-3}
<i>Volume</i>		
m ³	cubic inch	6.102×10^4
m ³	cubic foot	35.315
m ³	gallon (U.S., liquid)	2.642×10^2
m ³	gallon (Imperial)	2.200×10^2
<i>Temperature</i>		
°C	°F	$^{\circ}\text{C} \times 1.8 + 32$
<i>Force</i>		
N	dyne	1.0×10^5
<i>Energy, Work</i>		
J	Btu (int.)	9.480×10^{-4}
J	cal (int.)	2.389×10^{-1}
J	eV	6.242×10^{18}
J	erg	1.0×10^7
J	kW·h	2.778×10^{-7}
J	kp·m	1.020×10^{-1}
<i>Pressure</i>		
MPa	at	10.20
MPa	atm	9.869
MPa	bar	10
kPa	mbar	10
kPa	mm Hg	7.502
kPa	psi	0.145
kPa	torr	7.502

Powers of Ten

E (exa)	10 ¹⁸	d (deci)	10 ⁻¹
P (peta)	10 ¹⁵	c (centi)	10 ⁻²
T (tera)	10 ¹²	m (milli)	10 ⁻³
G (giga)	10 ⁹	μ (micro)	10 ⁻⁶
M (mega)	10 ⁶	n (nano)	10 ⁻⁹
k (kilo)	10 ³	p (pico)	10 ⁻¹²
h (hecto)	10 ²	f (femto)	10 ⁻¹⁵
da (deca)	10	a (atto)	10 ⁻¹⁸

Abbreviations

The following is a list of the abbreviations used in the text. Common terms, the names of publications and institutions, and legal agreements are included along with their full identities. Other abbreviations will be defined wherever they first occur in an article. For further abbreviations, see page VIII, Symbols and Units; page XV, Frequently Cited Companies (Abbreviations), and page XVI, Country Codes in patent references. The names of periodical publications are abbreviated exactly as done by Chemical Abstracts Service.

abs.	absolute	BGA	Bundesgesundheitsamt (Federal Republic of Germany)
a.c.	alternating current	BGB1.	Bundesgesetzblatt (Federal Republic of Germany)
ACGIH	American Conference of Governmental Industrial Hygienists	BIOS	British Intelligence Objectives Subcommittee Report (see also FIAT)
ACS	American Chemical Society	BOD	biological oxygen demand
ADI	acceptable daily intake	<i>bp</i>	boiling point
ADN	accord européen relatif au transport international des marchandises dangereuses par voie de navigation intérieure (European agreement concerning the international transportation of dangerous goods by inland waterways)	B.P.	British Pharmacopeia
		BS	British Standard
		ca.	circa
ADNR	ADN par le Rhin (regulation concerning the transportation of dangerous goods on the Rhine and all national waterways of the countries concerned)	calcd.	calculated
		CAS	Chemical Abstracts Service
ADP	adenosine 5'-diphosphate	cat.	catalyst, catalyzed
ADR	accord européen relatif au transport international des marchandises dangereuses par route (European agreement concerning the international transportation of dangerous goods by road)	CEN	Comité Européen de Normalisation
		cf.	compare
AEC	Atomic Energy Commission (United States)	CFR	Code of Federal Regulations (United States)
a.i.	active ingredient	cfu	colony forming units
AICHE	American Institute of Chemical Engineers	Chap.	chapter
AIME	American Institute of Mining, Metallurgical, and Petroleum Engineers	ChemG	Chemikaliengesetz (Federal Republic of Germany)
ANSI	American National Standards Institute	C.I.	Colour Index
AMP	adenosine 5'-monophosphate	CIOS	Combined Intelligence Objectives Subcommittee Report (see also FIAT)
APhA	American Pharmaceutical Association	CNS	central nervous system
API	American Petroleum Institute	Co.	Company
ASTM	American Society for Testing and Materials	COD	chemical oxygen demand
ATP	adenosine 5'-triphosphate	conc.	concentrated
BAM	Bundesanstalt für Materialprüfung (Federal Republic of Germany)	const.	constant
BAT	Biologischer Arbeitsstofftoleranzwert (biological tolerance value for a working material, established by MAK Commission, see MAK)	Corp.	Corporation
		crit.	critical
Beilstein	Beilstein's Handbook of Organic Chemistry, Springer, Berlin – Heidelberg – New York	CTFA	The Cosmetic, Toiletry and Fragrance Association (United States)
		DAB	Deutsches Arzneibuch, Deutscher Apotheker-Verlag, Stuttgart
BET	Brunauer – Emmett – Teller	d.c.	direct current
		decomp.	decompose, decomposition
		DFG	Deutsche Forschungsgemeinschaft (German Science Foundation)
		dil.	dilute, diluted
		DIN	Deutsche Industrienorm (Federal Republic of Germany)
		DMF	dimethylformamide
		DNA	deoxyribonucleic acid
		DOE	Department of Energy (United States)

DOT	Department of Transportation – Materials Transportation Bureau (United States)		gefährlicher Güter auf der Straße (regulation in the Federal Republic of Germany concerning the transportation of dangerous goods by road)
DTA	differential thermal analysis		
EC	effective concentration	GGVSee	Verordnung in der Bundesrepublik Deutschland über die Beförderung gefährlicher Güter mit Seeschiffen (regulation in the Federal Republic of Germany concerning the transportation of dangerous goods by sea-going vessels)
EC	European Community		
ed.	editor, edition, edited		
e.g.	for example		
emf	electromotive force		
EmS	Emergency Schedule		
EN	European Standard (European Community)	GLC	gas-liquid chromatography
EPA	Environmental Protection Agency (United States)	Gmelin	Gmelin's Handbook of Inorganic Chemistry, 8th ed., Springer, Berlin – Heidelberg – New York
EPR	electron paramagnetic resonance	GRAS	generally recognized as safe
Eq.	equation	Hal	halogen substituent (–F, –Cl, –Br, –I)
ESCA	electron spectroscopy for chemical analysis	Houben-Weyl	Methoden der organischen Chemie, 4th ed., Georg Thieme Verlag, Stuttgart
esp.	especially		
ESR	electron spin resonance	HPLC	high performance liquid chromatography
Et	ethyl substituent (–C ₂ H ₅)	IAEA	International Atomic Energy Agency
et al.	and others	IARC	International Agency for Research on Cancer, Lyon, France
etc.	et cetera	IATA-DGR	International Air Transport Association, Dangerous Goods Regulations
EVO	Eisenbahnverkehrsordnung (Federal Republic of Germany)	ICAO	International Civil Aviation Organization
exp (...)	e ^(...) , mathematical exponent	i.e.	that is
FAO	Food and Agriculture Organization (United Nations)	i.m.	intramuscular
FDA	Food and Drug Administration (United States)	IMDG	International Maritime Dangerous Goods Code
FD&C	Food, Drug and Cosmetic Act (United States)	IMO	Inter-Governmental Maritime Consultative Organization (in the past: IMCO)
FHSA	Federal Hazardous Substances Act (United States)	Inst.	Institute
FIAT	Field Information Agency, Technical (United States reports on the chemical industry in Germany, 1945)	i.p.	intraperitoneal
Fig.	figure	IR	infrared
<i>fp</i>	freezing point	ISO	International Organization for Standardization
Friedländer	P. Friedländer, Fortschritte der Teerfarbenfabrikation und verwandter Industriezweige Vol. 1–25, Springer, Berlin 1888–1942	IUPAC	International Union of Pure and Applied Chemistry
FT	Fourier transform	i.v.	intravenous
(g)	gas, gaseous	Kirk-Othmer	Encyclopedia of Chemical Technology, 3rd ed., 1991–1998, 5th ed., 2004–2007, John Wiley & Sons, Hoboken
GC	gas chromatography	(1)	liquid
GefStoffV	Gefahrstoffverordnung (regulations in the Federal Republic of Germany concerning hazardous substances)	Landolt-Börnstein	Zahlenwerte u. Funktionen aus Physik, Chemie, Astronomie, Geophysik u. Technik, Springer, Heidelberg 1950–1980; Zahlenwerte und Funktionen aus Naturwissenschaften und Technik, Neue Serie, Springer, Heidelberg, since 1961
GGVE	Verordnung in der Bundesrepublik Deutschland über die Beförderung gefährlicher Güter mit der Eisenbahn (regulation in the Federal Republic of Germany concerning the transportation of dangerous goods by rail)	LC ₅₀	lethal concentration for 50 % of the test animals
GGVS	Verordnung in der Bundesrepublik Deutschland über die Beförderung	LCLo	lowest published lethal concentration

LD ₅₀	lethal dose for 50 % of the test animals	OSHA	Occupational Safety and Health Administration (United States)
LDLo	lowest published lethal dose	p., pp.	page, pages
ln	logarithm (base e)	Patty	G.D. Clayton, F.E. Clayton (eds.): Patty's Industrial Hygiene and Toxicology, 3rd ed., Wiley Interscience, New York
LNG	liquefied natural gas	PB	Publication Board Report (U.S. Department of Commerce, Scientific and Industrial Reports)
log	logarithm (base 10)	PEL	permitted exposure limit
LPG	liquefied petroleum gas	Ph	phenyl substituent ($-\text{C}_6\text{H}_5$)
M	mol/L	Ph. Eur.	European Pharmacopoeia, Council of Europe, Strasbourg
M	metal (in chemical formulas)	phr	part per hundred rubber (resin)
MAK	Maximale Arbeitsplatzkonzentration (maximum concentration at the workplace in the Federal Republic of Germany); cf. Deutsche Forschungsgemeinschaft (ed.): Maximale Arbeitsplatzkonzentrationen (MAK) und Biologische Arbeitsstofftoleranzwerte (BAT), WILEY-VCH Verlag, Weinheim (published annually)	PNS	peripheral nervous system
max.	maximum	ppm	parts per million
MCA	Manufacturing Chemists Association (United States)	q.v.	which see (quod vide)
Me	methyl substituent ($-\text{CH}_3$)	ref.	refer, reference
Methodicum	Methodicum Chemicum, Georg Thieme Chimicum Verlag, Stuttgart	resp.	respectively
MFAG	Medical First Aid Guide for Use in Accidents Involving Dangerous Goods	R_f	retention factor (TLC)
MIK	maximale Immissionskonzentration (maximum immission concentration)	R.H.	relative humidity
min.	minimum	RID	réglement international concernant le transport des marchandises dangereuses par chemin de fer (international convention concerning the transportation of dangerous goods by rail)
mp	melting point	RNA	ribonucleic acid
MS	mass spectrum, mass spectrometry	R phrase	risk phrase according to ChemG and GefStoffV (Federal Republic of Germany)
NAS	National Academy of Sciences (United States)	(R-Satz)	
NASA	National Aeronautics and Space Administration (United States)	rpm	revolutions per minute
NBS	National Bureau of Standards (United States)	RTECS	Registry of Toxic Effects of Chemical Substances, edited by the National Institute of Occupational Safety and Health (United States)
NCTC	National Collection of Type Cultures (United States)	(s)	solid
NIH	National Institutes of Health (United States)	SAE	Society of Automotive Engineers (United States)
NIOSH	National Institute for Occupational Safety and Health (United States)	s.c.	subcutaneous
NMR	nuclear magnetic resonance	SI	International System of Units
no.	number	SIMS	secondary ion mass spectrometry
NOEL	no observed effect level	S phrase	safety phrase according to ChemG and GefStoffV (Federal Republic of Germany)
NRC	Nuclear Regulatory Commission (United States)	(S-Satz)	
NRDC	National Research Development Corporation (United States)	STEL	Short Term Exposure Limit (see TLV)
NSC	National Service Center (United States)	STP	standard temperature and pressure (0°C, 101.325 kPa)
NSF	National Science Foundation (United States)	T_g	glass transition temperature
NTSB	National Transportation Safety Board (United States)	TA Luft	Technische Anleitung zur Reinhaltung der Luft (clean air regulation in Federal Republic of Germany)
OECD	Organization for Economic Cooperation and Development	TA Lärm	Technische Anleitung zum Schutz gegen Lärm (low noise regulation in Federal Republic of Germany)
		TDLo	lowest published toxic dose

THF	tetrahydrofuran	UVV	Unfallverhütungsvorschriften der Berufsgenossenschaft (workplace safety regulations in the Federal Republic of Germany)
TLC	thin layer chromatography	VbF	Verordnung in der Bundesrepublik Deutschland über die Errichtung und den Betrieb von Anlagen zur Lagerung, Abfüllung und Beförderung brennbarer Flüssigkeiten (regulation in the Federal Republic of Germany concerning the construction and operation of plants for storage, filling, and transportation of flammable liquids; classification according to the flash point of liquids, in accordance with the classification in the United States)
TLV	Threshold Limit Value (TWA and STEL); published annually by the American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, Ohio	VDE	Verband Deutscher Elektroingenieure (Federal Republic of Germany)
TOD	total oxygen demand	VDI	Verein Deutscher Ingenieure (Federal Republic of Germany)
TRK	Technische Richtkonzentration (lowest technically feasible level)	vol	volume
TSCA	Toxic Substances Control Act (United States)	vol.	volume (of a series of books)
TÜV	Technischer Überwachungsverein (Technical Control Board of the Federal Republic of Germany)	vs.	versus
TWA	Time Weighted Average	WGK	Wassergefährdungsklasse (water hazard class)
UBA	Umweltbundesamt (Federal Environmental Agency)	WHO	World Health Organization (United Nations)
Ullmann	Ullmann's Encyclopedia of Industrial Chemistry, 6th ed., Wiley-VCH, Weinheim 2002; Ullmann's Encyclopedia of Industrial Chemistry, 5th ed., VCH Verlagsgesellschaft, Weinheim 1985–1996; Ullmanns Enzyklopädie der Technischen Chemie, 4th ed., Verlag Chemie, Weinheim 1972–1984; 3rd ed., Urban und Schwarzenberg, München 1951–1970	Winnacker-Küchler	Chemische Technologie, 4th ed., Carl Hanser Verlag, München, 1982–1986; Winnacker-Küchler, Chemische Technik: Prozesse und Produkte, Wiley-VCH, Weinheim, 2003–2006
USAEC	United States Atomic Energy Commission	wt	weight
USAN	United States Adopted Names	\$	U.S. dollar, unless otherwise stated
USD	United States Dispensatory		
USDA	United States Department of Agriculture		
U.S.P.	United States Pharmacopeia		
UV	ultraviolet		

Frequently Cited Companies (Abbreviations)

Air Products	Air Products and Chemicals	IFP	Institut Français du Pétrole
Akzo	Algemene Koninklijke Zout Organon	INCO	International Nickel Company
Alcoa	Aluminum Company of America	3M	Minnesota Mining and Manufacturing Company
Allied	Allied Corporation	Mitsubishi Chemical	Mitsubishi Chemical Industries
Amer.	American Cyanamid Company	Monsanto	Monsanto Company
Cyanamid	BASF Aktiengesellschaft	Nippon Shokubai	Nippon Shokubai Kagaku Kogyo
BASF	Bayer AG	PCUK	Pechiney Ugine Kuhlmann
Bayer	British Petroleum Company	PPG	Pittsburg Plate Glass Industries
BP	Celanese Corporation	Searle	G.D. Searle & Company
Celanese	Daicel Chemical Industries	SKF	Smith Kline & French Laboratories
Daicel	Dainippon Ink and Chemicals Inc.	SNAM	Società Nazionale Metandotti
Dainippon	The Dow Chemical Company	Sohio	Standard Oil of Ohio
Dow Chemical	DSM	Stauffer	Stauffer Chemical Company
DSM	Dutch Staats Mijnen	Sumitomo	Sumitomo Chemical Company
Du Pont	E.I. du Pont de Nemours & Company	Toray	Toray Industries Inc.
Exxon	Exxon Corporation	UCB	Union Chimique Belge
FMC	Food Machinery & Chemical Corporation	Union Carbide	Union Carbide Corporation
GAF	General Aniline & Film Corporation	UOP	Universal Oil Products Company
W.R. Grace	W.R. Grace & Company	VEBA	Vereinigte Elektrizitäts- und Bergwerks-AG
Hoechst	Hoechst Aktiengesellschaft	Wacker	Wacker Chemie GmbH
IBM	International Business Machines Corporation		
ICI	Imperial Chemical Industries		

Country Codes

The following list contains a selection of standard country codes used in the patent references.

AT	Austria	IL	Israel
AU	Australia	IT	Italy
BE	Belgium	JP	Japan*
BG	Bulgaria	LU	Luxembourg
BR	Brazil	MA	Morocco
CA	Canada	NL	Netherlands*
CH	Switzerland	NO	Norway
CS	Czechoslovakia	NZ	New Zealand
DD	German Democratic Republic	PL	Poland
DE	Federal Republic of Germany (and Germany before 1949)*	PT	Portugal
DK	Denmark	SE	Sweden
ES	Spain	SU	Soviet Union
FI	Finland	US	United States of America
FR	France	YU	Yugoslavia
GB	United Kingdom	ZA	South Africa
GR	Greece	EP	European Patent Office*
HU	Hungary	WO	World Intellectual Property Organization
ID	Indonesia		

*For Europe, Federal Republic of Germany, Japan, and the Netherlands, the type of patent is specified: EP (patent), EP-A (application), DE (patent), DE-OS (Offenlegungsschrift), DE-AS (Auslegeschrift), JP (patent), JP-Kokai (Kokai tokkyo koho), NL (patent), and NL-A (application).

Periodic Table of Elements

element symbol, atomic number, and relative atomic mass (atomic weight)

1A "European" group designation and old IUPAC recommendation																	
1 group designation to 1986 IUPAC proposal																	
1A "American" group designation, also used by the Chemical Abstracts Service until the end of 1986																	
1	2A															0	
H	2															18	
1.0079	IIA															VIIIA	He
3	4															2	Ne
Li	Be															7B	F
6.941	9.0122															16	Ne
11	12	3A	4A	5A	6A	7A	8	8	8	1B	2B						
Na	Mg	3	4	5	6	7	8	9	10	11	12						
22.990	24.305	IIIB	IVB	VB	VIB	VII B	VIII	VIII	VIII	IB	II B						
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.098	40.078	44.956	47.867	50.942	51.996	54.938	55.845	58.933	58.693	63.546	65.409	69.723	72.61	74.922	78.96	79.904	83.80
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc*	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
85.468	87.62	88.906	91.224	92.906	95.94	98.906	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.60	126.90	131.29
55	56															85	86
Cs	Ba															At*	Rn*
132.91	137.33															208.98	222.02
87	88															116	118
Fr*	Ra*															Uup*	Uuo*
223.02	226.03																

* provisional IUPAC symbol

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La	Ce	Pr	Nd	Pm*	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
138.91	140.12	140.91	144.24	146.92	150.36	151.97	157.25	158.93	162.50	164.93	167.26	168.93	173.04	174.97
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac*	Th*	Pa*	U*	Np*	Pu*	Am*	Cm*	Bk*	Cf*	Es*	Fm*	Md*	No*	Lr*
227.03	232.04	231.04	238.03	237.05	244.06	243.06	247.07	247.07	251.08	252.08	257.10	258.10	259.10	260.11

* radioactive element; mass of most important isotope given.

Volume Contents

Cyanuric Acid and Cyanuric Chloride.....	1	Dimethyl Ether	305
Cyclodextrins	23	Dioxane	309
Cyclododecanol, Cyclododecanone, and Lauro lactam	33	Disinfectants	315
Cyclododecatriene, Cyclooctadiene, and 4-Vinylcyclohexene	37	Disperse Dyes	331
Cyclohexane.....	41	Disperse Systems and Dispersants	345
Cyclohexanol and Cyclohexanone	49	Disperse Systems, Characterization and Analysis.....	371
Cyclopentadiene and Cyclopentene	61	Display Technology.....	389
Dairy Products, Imitation	75	Distillation, 1. Fundamentals.....	425
Dense-Medium Separation	87	Distillation, 2. Equipment	455
Dental Materials	95	Distillation, 3. Processes	477
Dermatotherapeutic Agents	147	Dithiocarbamic Acid and Derivatives.....	495
Design of Experiments	165	Drawing and Writing Materials	523
Dextran.....	203	Dry Cleaning.....	535
Diagnostic Reagents	211	Dry Mortars	541
Dialkyl Sulfates and Alkylsulfuric Acids .	251	Drying of Solid Materials.....	581
Diazo Compounds and Diazo Reactions...	265	Drying Oils and Related Products.....	621
Dicarboxylic Acids, Aliphatic.....	287	Dust Separation.....	637
		Dyes, General Survey	675

Cross References

Cyclooctadiene → Cyclododecatriene, Cyclooctadiene, and 4-Vinylcyclohexene 11	1,2-Dibromoethane → Bromine Compounds 6
Cystine, Cysteine → Amino Acids 3	Dichloroacetic Acid → Chloroacetic Acids 8
Dairy Products → Milk and Dairy Products 23	Dichloroethanes → Chloroethanes and Chloroethylenes 8
DDT → Insect Control 19	Dichloroethylene → Chloroethanes and Chloroethylenes 8
Decalin → Naphthalene and Hydronaphthalenes 23	Dichloromethane → Chloromethanes 9
Decanol → Fatty Alcohols 14	Dicyandiamide → Cyanamides 10
Defoaming Agents → Foams and Foam Control 15	Dicyanogen → Cyano Compounds, Inorganic 10
Dehydrogenation → Hydrogenation and Dehydrogenation 18	Diesel Fuel → Automotive Fuels 4
Dentrifices → Oral Hygiene Products 25	Diethanolamine → Ethanolamines and Propanolamines 13
Deodorants → Skin Cosmetics 33	Diethyl Ether → Ethers, Aliphatic 13
Depilatories → Hair Preparations 17	Diethyl Sulfate → Dialkyl Sulfates and Alkylsulfuric Acids 11
Desalting of Water → Water, 3. Treatment by Ion Exchange Processes 39; → Water, 5. Treatment by Membrane Separation Processes 39	Diffusion Separation Methods → Isotopes, Natural 20; → Separation Processes, Introduction 32
Desensitization → Antiallergic Agents 3	Digital Displays → Display Technology 11
Desiccants: Drying → Drying of Solid Materials 11	Digitonin → Saponins 32
Desulfurization of Coal → Coal 9	Diglyme → Ethylene Glycol 13
Desulfurization of Waste Gas → Sulfuric Acid and Sulfur Trioxide 35	Diketene → Ketenes 20
Detergents → Laundry Detergents 20	Dimer Acid → Dicarboxylic Acids, Aliphatic 11
Deuterium → Hydrogen 18	Dimethylamine → Methylamines 23
Dextrose → Glucose and Glucose-Containing Syrups 17	Dimethylformamide → Formamides 16
Diacetone Alcohol → Acetone 1	Dimethyl Sulfate → Dialkyl Sulfates and Alkylsulfuric Acids 11
Diacyl Peroxides → Peroxy Compounds, Organic 26	Dimethyl Sulfoxide → Sulfones and Sulfoxides 34
Dialkyl Peroxides → Peroxy Compounds, Organic 26	Dimethylterephthalate → Terephthalic Acid, Dimethyl Terephthalate, and Isophthalic Acid 36
Diallyl Phthalates → Polyesters 28	Diols → Alcohols, Polyhydric 2; → Ethylene Glycol 13
Diamines → Amines, Aliphatic 2	Diosgenin → Saponins 32
Diaminotoluenes → Phenylene- and Toluenediamines 26	Diphenyl → Hydrocarbons 18
Diaphragm Cell → Chlorine 8	Diphenylamine → Aniline 3
Diatomite → Silica 32	Diphenylmethane → Hydrocarbons 18
	Direct Dyes → Dyes, General Survey 11