ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

VOLUME 12

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

Edited by RAYMOND E. KIRK
Head, Department of Chemistry, Polytechnic Institute of Brooklyn
and DONALD F. OTHMER
Head, Department of Chemical Engineering, Polytechnic Institute of Brooklyn

Assistant Editors
JANET D. SCOTT *and* ANTHONY STANDEN

VOLUME 12

SABADINE
to
STILBESTROL

THE INTERSCIENCE ENCYCLOPEDIA, INC. • NEW YORK

Distributed by
INTERSCIENCE PUBLISHERS, INC.
250 Fifth Avenue, New York 1, N. Y.

PRINTED IN U.S.A. BY
MACK PRINTING CO., EASTON, PA.

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

VOLUME 12

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ABBREVIATIONS AND SYMBOLS

A.	Ångström unit(s)
A	anion; as, H*A*
abs.	absolute
a.c.	alternating current
ac-	alicyclic; as, *ac*-derivatives of tetrahydronaphthalene
A.C.S.	American Chemical Society
addn.	addition
A.G.A.	American Gas Association
A.I.Ch.E.	American Institute of Chemical Engineers
A.I.M.E.	American Institute of Mining and Metallurgical Engineers
alc.	alcohol, alcoholic
alk.	alkaline (not alkali)
Alk	alkyl
amp.	ampere(s)
amp.-hr.	ampere-hour(s)
amt.	amount (noun)
anhyd.	anhydrous
A.P.I.	American Petroleum Institute
app.	apparatus
approx.	approximate (adj.), approximately
aq.	aqueous
Ar	aryl
ar-	aromatic; as, *ar*-derivatives of tetrahydronaphthalene
as-	asymmetric; as, *as-m*-xylidine
ASA	American Standards Association
A.S.M.	American Society for Metals
A.S.M.E.	American Society of Mechanical Engineers
A.S.T.M.	American Society for Testing Materials
atm.	atmosphere(s), atmospheric
at. no.	atomic number
at. wt.	atomic weight
av.	average
b. (as, b_{11})	boiling (at 11 mm.)
B	base; as, *B*.2HCl
bbl.	barrel(s)
Bé.	Baumé
b.p.	boiling point
B.t.u.	British thermal unit(s)
bu.	bushel(s)
C.	centigrade
C-	denoting attachment to carbon; as, *C*-alkyl derivatives of aniline
cal.	calorie(s)
calcd.	calculated
c.f.m.	cubic foot (feet) per minute
cg.	centigram(s)
c.g.s.	centimeter-gram-second
chem.	chemical
C.I.	*Colour Index* no.
cks.	centistokes
c.l.	car lots
cm.	centimeter(s)
coeff.	coefficient
com.	commercial
compd.	compound (noun)
compn.	composition
concd.	concentrated
concn.	concentration
cond.	conductivity
const.	constant
cor.	corrected

c.p.	chemically pure
cps.	centipoise
crit.	critical
cryst.	crystalline
crystd.	crystallized
crystn.	crystallization
cu.	cubic
d (as, d_4^{20})	density (conveniently, specific gravity)
d	differential operator
d-	*dextro-*, dextrorotatory
D-	denoting configurational relationship, as to *dextro*-glyceraldehyde
d.c.	direct current
dec., decomp.	decompose(s)
decompn.	decomposition
deriv.	derivative
detd.	determined
detn.	*determination*
diam.	diameter
dielec.	dielectric (adj.)
dil.	dilute
distd.	distilled
distn.	distillation
DL-, *dl-*	racemic
dm.	decimeter
e	electron
ed.	edition, editor
elec.	electric, electrical
elev.	elevated
e.m.f.	electromotive force
eng.	engineering
eq.	equation
equil.	equilibrium
equiv.	equivalent
esp.	especially
estd.	estimated
estn.	estimation
e.s.u.	electrostatic unit(s)
e.u.	entropy unit(s)
e.v.	electron volt(s)
expt.	experiment
exptl.	experimental
ext.	extract
extd.	extracted
extn.	extraction
F.	Fahrenheit
Fedl.	Federal
ff.	following (pages)
fig.	figure
fl.oz.	fluid ounce(s)
f.o.b.	free on board
f.p.	freezing point
ft.	foot (feet)
ft.-lb.	*foot-pound*(s)
g.	gram(s)
gal.	gallon(s)
g.p.m.	gallons per minute
hp.	horsepower
hr.	hour(s)
hyd.	hydrated, hydrous
i.	insoluble
i-	inactive; as, *i*-methionine
i.b.p.	initial boiling point
I.C.C.	Interstate Commerce Commission
I.D.	inner diameter
in.	inch(es)
insol.	insoluble
I.P.T.	Institute of Petroleum Technologists
I.U.	International Unit(s)
I.U.C., I.U.P.A.C.	International Union of Chemistry, International Union of Pure and Applied Chemistry
j.	joule
K.	Kelvin
K	dissociation constant
Kev	kilo electron volt
kg.	kilogram(s)
kg.-cal.	kilogram-calorie(s)
kv.	kilovolt(s)
kv.-amp.	kilovolt-ampere(s)
kw.	kilowatt(s)
kw.-hr.	kilowatt-hour(s)
l.	liter(s)
l-	*levo-*, levorotatory
L-	denoting configurational relationship, as to *levo*-glyceraldehyde
lb.	pound(s)
LC_{50}	concentration lethal to 50% of animals tested

l.c.l.	less than car lots
LD_{50}	dose lethal to 50% of animals tested
ln	logarithm (natural)
log	logarithm (common)
m.	meter(s)
m-	meta; as, *m*-xylene
M	metal
M	molar (as applied to concn.; not molal, which is written out)
ma.	milliampere(s)
manuf.	manufacture
manufd.	manufactured
manufg.	manufacturing
max.	maximum
M.C.A.	Manufacturing Chemists' Association
m.c.f.	million cubic feet
m.e., meq.	milliequivalent(s)
mech.	mechanical
M.e.v.	million electron volts
mg.	milligram(s)
m.g.d.	million gallons per day
min.	minimum; minute(s)
misc.	miscellaneous
mixt.	mixture
ml.	milliliter(s)
M.L.D.	minimum lethal dose
mm.	millimeter(s)
mM	millimole(s)
mol.	molecule, molecular
m.p.	melting point
m.p.h.	miles per hour
M.R.	molar refraction
mv.	millivolt(s)
mμ	millimicron(s)
n (as, n_D^{20})	index of refraction (for 20°C. and sodium light)
n-	normal; as, *n*-butyl
N	normal (as applied to concn.)
N-	denoting attachment to nitrogen; as, *N*-methylaniline
neg.	negative (adj.)
no.	number
N.O.I.B.N.	not otherwise indexed by name
o-	ortho; as, *o*-xylene
O-	denoting attachment to oxygen; as, *O*-acetylhydroxylamine
O.D.	outer diameter
oz.	ounce(s)
p., pp.	page, pages
p-	para; as, *p*-xylene
pos.	positive (adj.)
powd.	powdered
p.p.m.	parts per million
ppt.	precipitate
pptd.	precipitated
pptn.	precipitation
prepd.	prepared
prepn.	preparation
Pr. no.	Foreign Prototype no. (for dyes)
p.s.i.(g.), (a.)	pound(s) per square inch (gage), (absolute)
pt.	point
pts.	parts
quad. pt.	quadruple point
qual.	qualitative
quant.	quantitative
q.v.	"which see"
R	univalent hydrocarbon radical (or hydrogen)
R.	Rankine
ref.	reference
resp.	respectively
r.h.	relative humidity
R.I.	*Ring Index* no.
r.p.m.	revolutions per minute
r.p.s.	revolutions per second
s.	soluble
s-	symmetric(al); as, *s-m*-xylidine
S-	denoting attachment to sulfur; as, *S*-methylcysteine
S.A.E.	Society of Automotive Engineers
satd.	saturated
satn.	saturation

S.C.F.	standard cubic foot (feet)	t.s.i.	tons per square inch
Sch.	Schultz no. (for dyes)	Twad.	Twaddell
sec.	second(s)	u.v.	ultraviolet
sec-	secondary; as, *sec*-butyl	v.	volt(s)
S.F.s.	Saybolt Furol second(s)	var.	variety
sl.s.	slightly soluble	*vic-*	vicinal; as, *vic-m*-xylidine
sol.	soluble	vol.	volume(s) (not volatile)
soln.	solution	v.s.	very soluble
soly.	solubility	w.	watt(s)
sp.	specific	wt.	weight
sp., spp.	species	X.U. (10^{-10} mm.)	X-unit
spec.	specification	yd.	yard(s)
sp.gr.	specific gravity	yr.	year(s)
sq.	square	$[\alpha]_D^{20}$	optical rotation (for 20°C. and sodium light)
S.T.P.	standard temperature and pressure	γ	microgram(s)
subl.	sublime(s), subliming	∂	differential operator (partial)
S.U.s.	Saybolt Universal second(s)	Δ	finite difference
sym-	symmetric(al); as, *sym-m*-xylidine	η	viscosity
T.A.P.P.I.	Technical Association of the Pulp and Paper Industry	λ	wave length
		μ	micron(s)
tech.	technical	Ω	ohm(s)
temp.	temperature	$<$	less than
tert-	tertiary; as, *tert*-butyl	$>$	more than
theoret.	theoretical	$\sim$	cycle(s)
t.p.h.	tons per hour	$\approx$	approximately equal to

Other letter symbols may be found in "Standard System of Nomenclature for Chemical Engineering Unit Operations" adopted by the American Institute of Chemical Engineers.

SHIPPING REGULATIONS

Complete information for the U.S. is given in "Tariff No. 9 Publishing Interstate Commerce Commission Regulations for Transportation of Explosives and Other Dangerous Articles by Land and Water in Rail Freight Service and by Motor Vehicle (Highway) and Water Including Specifications for Shipping Containers," with supplements, issued by H. A. Campbell, Agent, 30 Vesey Street, New York 7, N.Y. (1954). The following terms for labeling explosives and other dangerous articles have been used in the Encyclopedia:

Red label (for inflammable liquids)
Yellow label (for inflammable solids and oxidizing materials)
White label (for acids and corrosive liquids)
Red label (for inflammable compressed gases)
Green label (for noninflammable compressed gases)
N.O.I.B.N. (not otherwise indexed by name)

In the text of the Encyclopedia the preferred terms "flammable" and "nonflammable" are used in place of "inflammable" and "noninflammable," respectively.

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PERIODICAL ABBREVIATIONS

The abbreviations used are, for the most part, those given in the "List of Periodicals Abstracted by Chemical Abstracts" (Vol. **45,** No. 24, Pt. 2 (1951), also published separately). See also *Literature (survey)*, especially the sections on "Reviews, yearbooks, and monographs" and "Periodicals," Vol. 8, pp. 437–40.

Am. Soc. Testing Materials, Proc.	American Society for Testing Materials, Proceedings
Anal. Chem. (superseding *Ind. Eng. Chem., Anal. Ed.*)	Analytical Chemistry
Angew. Chem. (superseding *Die Chemie; Z. angew. Chem.*)	Angewandte Chemie
Ann. Chem., Justus Liebigs	Annalen der Chemie, Justus Liebigs
Arch. Biochem. and Biophys. (superseding *Arch. Biochem.*)	Archives of Biochemistry and Biophysics
Arch. Ind. Hyg. and Occupational Med. (superseding *J. Ind. Hyg. Toxicol.*)	Archives of Industrial Hygiene and Occupational Medicine
Biochem. J. (London)	Biochemical Journal, The
Biochem. Z.	Biochemische Zeitschrift
Biochim. et Biophys. Acta	Biochimica et Biophysica Acta
BIOS Repts.	British Intelligence Objectives Subcommittee Reports
Bull. Chem. Soc. Japan	Bulletin of the Chemical Society of Japan
Bull. soc. chim. or *Bull. soc. chim. France*	Bulletin de la société chimique de France
C.A.	Chemical Abstracts
Can. J. Research	Canadian Journal of Research
Chem. Ber. (superseding *Ber.*)	Chemische Berichte
Chem. Eng. (superseding *Chem. & Met. Eng.*)	Chemical Engineering with Chemical & Metallurgical Engineering
Chem. Eng. News (superseding *News Ed. (Am. Chem. Soc.); Ind. Eng. Chem., News Ed.*)	Chemical and Engineering News
Chem. Eng. Progress (superseding *Trans. Am. Inst. Chem. Engrs.*)	Chemical Engineering Progress with Transactions of American Institute of Chemical Engineers
Chem. Eng. Science	Chemical Engineering Science
Chemische Industrie	Chemische Industrie
Chemistry & Industry (formerly part of *J. Soc. Chem. Ind.*)	Chemistry & Industry
Chem. Revs.	Chemical Reviews
Chem. Tech. (Berlin) (superseding *Chem. Fabrik*)	Chemische Technik, Die (Berlin)
Chem. Week (superseding *Chem. Inds. Week*)	Chemical Week
Chem. Zentr.	Chemisches Zentralblatt
Chem.-Ztg.	Chemiker-Zeitung mit dem Sonderteil, Die Chemische Praxis und der Beilage, Chemisch-technische Übersicht
Chimica e industria (Italy) or *Chimica e industria (Milan)*	Chimica, La, e l'industria (Italy) or (Milan)
Chimie & industrie	Chimie & industrie
CIOS Repts.	Combined Intelligence Objectives Subcommittee Reports
Compt. rend.	Comptes rendus hebdomadaires des séances de l'académie des sciences
FIAT Repts.	Field Information Agency Technical Reports
Fortschr. chem. Forsch.	Fortschritte der chemischen Forschung
Gazz. chim. ital.	Gazzetta chimica italiana
Helv. Chim. Acta	Helvetica Chimica Acta

Ind. Chemist	Industrial Chemist and Chemical Manufacturer, The
Ind. Eng. Chem. (superseding *J. Ind. Eng. Chem.*)	Industrial and Engineering Chemistry
J. Agr. Food Chem.	Journal of Agricultural and Food Chemistry
J. Am. Chem. Soc.	Journal of the American Chemical Society, The
J. Am. Med. Assoc.	Journal of the American Medical Association, The
J. Am. Pharm. Assoc.	Journal of the American Pharmaceutical Association
J. Appl. Chem. (U.S.S.R.) (see also *Zhur. Priklad. Khim.*)	Journal of Applied Chemistry (U.S.S.R.)
J. Appl. Phys. (superseding *Physics*)	Journal of Applied Physics
J. Assoc. Offic. Agr. Chemists	Journal of the Association of Official Agricultural Chemists
J. Biol. Chem.	Journal of Biological Chemistry, The
J. Chem. Phys.	Journal of Chemical Physics, The
J. Chem. Soc.	Journal of the Chemical Society (London)
J. Colloid Sci.	Journal of Colloid Science
J. Electrochem. Soc. (superseding *Trans. Electrochem. Soc.; Trans. Am. Electrochem. Soc.*)	Journal of the Electrochemical Society
J. Gen. Chem. (U.S.S.R.) (see also *Zhur. Obshchet Khim.*)	Journal of General Chemistry (U.S.S.R.)
J. Indian Chem. Soc.	Journal of the Indian Chemical Society
J. Inst. Metals	Journal of the Institute of Metals and Metallurgical Abstracts
J. makromol. Chem. (superseding *J. prakt. Chem.*)	Journal für makromolekulare Chemie
J. Org. Chem.	Journal of Organic Chemistry, The
J. Phys. Chem. (superseding *J. Phys. & Colloid Chem.*)	Journal of Physical Chemistry, The
J. Polymer Sci. (superseding *J. Polymer Research*)	Journal of Polymer Science
J. Research Natl. Bur. Standards (superseding *Bur. Standards J. Research*)	Journal of Research of the National Bureau of Standards
J. Sci. Food Agr.	Journal of the Science of Food and Agriculture
J. Soc. Chem. Ind. or *J. Soc. Chem. Ind. (London)* (formerly containing *Chemistry & Industry*)	Journal of the Society of Chemical Industry (London)
J. Soc. Chem. Ind., Japan	Journal of the Society of Chemical Industry, Japan
Kolloid-Z.	Kolloid-Zeitschrift
Mfg. Chemist	Manufacturing Chemist and Pharmaceutical and Fine Chemical Trade Journal Incorporating Manufacturing Perfumer
Monatsh. Chem.	Monatshefte für Chemie und verwandte Teile anderer Wissenschaften
Nature	Nature
Nucleonics	Nucleonics
Office Tech. Services (OTS) Repts. (superseding *Office Publication Board Repts.*)	Office of Technical Services Reports
Oil, Paint Drug Reptr.	Oil, Paint and Drug Reporter
Phys. Rev.	Physical Review, The
Rec. trav. chim.	Recueil des travaux chimiques des Pays-Bas
Research (London)	Research, A Journal of Science and Its Applications
Revs. Mod. Phys.	Reviews of Modern Physics
Science	Science
Trans. Am. Inst. Mining Met. Engrs.	Transactions of the American Institute of Mining and Metallurgical Engineers
Trans. Am. Soc. Metals (superseding *Trans. Am. Soc. Steel Treating*)	Transactions of the American Society for Metals
Trans. Inst. Chem. Engrs. (London)	Transactions of the Institution of Chemical Engineers (London)
Z. anorg. u. allgem. Chem. (superseding *Z. anorg. Chem.*)	Zeitschrift für anorganische und allgemeine Chemie
Z. Elektrochem.	Zeitschrift für Elektrochemie und angewandte physikalische Chemie
Zhur. Obshchet Khim.	Zhurnal Obshchet Khimii (Journal of General Chemistry (U.S.S.R.))
Zhur. Priklad. Khim.	Zhurnal Prikladnoi Khimii (Journal of Applied Chemistry (U.S.S.R.))
Z. physik. Chem.	Zeitschrift für physikalische Chemie

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SABADINE, $C_{29}H_{51}NO_8$. See *Alkaloids*, Vol. **7,** p. 502.

SABINANE, $C_{10}H_{18}$. See "Thujane" under *Hydrocarbons*, Vol. **7,** p. 609; *Terpenes.*

SABINENE, $C_{10}H_{16}$. See *Terpenes.*

SABINIC ACID, $CH_2OH(CH_2)_{10}COOH$. See *Fatty acids (hydroxy and keto)*, Vol. **6,** p. 288.

SACCHARATED IRON OXIDE. See *Iron preparations*, Vol. **8,** p. 70.

SACCHARIC ACID, $COOH(CHOH)_4COOH$. See *Sugar derivatives.*

SACCHARIDES. See *Carbohydrates*; *Polysaccharides*; *Sugars.*

SACCHARIMETRY. See *Polarimetry*; *Sugar analysis.*

SACCHARIN, $C_6H_4.SO_2.NH.CO$. See *Sweetening agents.*

S ACID. See *Amino naphthols and amino naphtholsulfonic acids*, Vol. **1,** p. 733; *Naphthylamines and naphthylaminesulfonic acids*, Vol. **9,** p. 267.

SAFETY

At one time it was assumed that injuries in industries were a matter of chance and were both nonpredictable and nonpreventable. They quite obviously arose from industrial accidents and the dictionary definition of an accident is: "An event which takes place without one's foresight or expectation; an undesigned, sudden, and unexpected event; often an undesigned and unforeseen occurrence of an afflictive or unfortunate character, etc." It is the general experience of safety men that they are constantly predicting that if processes are carried on in a specified way there will be an injury eventually and that it is actually rare to have an accidental injury according to the dictionary definition of an accident. When personal injuries occur under these conditions they are not unforeseen or unpredictable or unusual and they could have been and should have been prevented. Harold Miner, after twenty-five years as head of the safety organization of a large chemical corporation, stated that he had never investigated a single personal injury which could not have been prevented by a little more foresight and a little more constructive thinking.

The prevention of accidents and accidental injuries is largely, if not entirely, a matter of attitude and approach to the problem. If industrial management truly accepts responsibility for accident prevention, and accepts as a fact that accidents can be and should be prevented, then methods will be found and the problem will be solved rather simply. It should also be accepted that the solution must be rather simple, as there are too many people involved for any very complicated solutions to be practical.

If any justification is needed for the acceptance of this type of responsibility there are several compelling reasons:

(*1*) All states now have laws which require managements not only to pay financially for injuries to employees but also require the maintenance of a certain minimum of safety on the operation and provide for inspection to enforce the requirements.

(*2*) Economically, prevention of accidents costs less than the costs of injuries. This has been amply demonstrated many times. One of the outstanding recent examples on a fairly large scale is the program of the Pacific Coast Association of Pulp and Paper Manufacturers which has saved the member companies in the states of Oregon, Washington, and California, in the six years between 1947 and 1952, at least $800,000 annually in an industry with only about 40,000,000 man-hours annual exposure. These savings are in direct medical and compensation costs. They are certainly no greater than the indirect savings, which are just as real although not so easily measured.

(*3*) Long before either of the other reasons was of pressing importance, progressive managements recognized the prevention of accidental injuries as a social obligation and took steps to discharge the responsibility. Thus the United States Steel Corporation organized a central safety committee in 1906, just five years after the formation of the Corporation, and placed a staff man of the rank of plant superintendent in charge of safety activities. By 1910 the Corporation was voluntarily paying workmen's compensation at rates which were fixed and published. Both of these events preceded the first safety or compensation laws in this country. The compensation rates set up in some of the early laws were based upon those in the voluntary plans of the International Harvester Company and the U.S. Steel Corporation.

Many detailed aspects of industrial safety, as well as hygiene, are discussed in other articles. See *Air conditioning*; *Allergens, industrial*; *Carcinogens*; *Dust*; *Explosions (gaseous)*; *Fire-resistant textiles*; *Fire prevention and extinction*; *First aid*; *Industrial hygiene and toxicology*; *Laboratories*; *Lead poisoning*; *Pilot plant.* For protection against hazardous radioactivity see *Isotopes*; *Nucleonics*; *Radioactive elements, natural*; *Radiography, industrial.*

Several organizations, such as those listed in references (1,2,5,8) issue both general and detailed publications on industrial safety. These include many of direct application to chemical industries.

Fundamentals of Safety. There are certain very fundamental requirements for any successful industrial safety program. The details of organization vary, even among the most successful programs, depending mainly upon the variations in the corporate organization, but the following must be done:

(*1*) Both mechanical safeguards and personal protective equipment must be provided in sufficient amounts and appropriate kinds for the operations, and they must be used.

(*2*) Employees must be taught and constantly encouraged to work safely. They must be made to understand that it is the considered attitude of all levels of manage-