ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

VOLUME 15

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

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VOLUME 15

WAXES
to
ZYMOSTEROL
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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
dist.	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)
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.d.	grams per denier
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	$\lesssim$	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 Prikladnoĭ Khimii (Journal of Applied Chemistry (U.S.S.R.)
Z. physik. Chem.	Zeitschrift für physikalische Chemie

W *continued*

WAXES

The term wax is now generally applied to all waxlike materials found naturally, as well as synthetic materials of a waxy nature, since their uses are usually based on their physical characteristics. These characteristics include: resistance to water and water vapor, tensile strength, ductility, gloss, hardness, ability to emulsify, solvent retention, moldability, and melting range. Originally, wax denoted beeswax, which is probably the oldest wax known, and later only products with characteristics similar to beeswax. Today, in addition to the broadening of the classification on the basis of physical properties, a chemical basis is sometimes recognized. Thus waxes can be distinguished from fats (*q.v.*) not only by their greater hardness and brittleness and lesser greasiness, but also by their composition. Lipide waxes contain esters, acids, and alcohols of higher molecular weight than those of fats (which are glycerides), and in addition higher saturated hydrocarbons. Wool grease (*q.v.*) is classed chemically as a wax, and sperm oil (see p. 9) as a *liquid wax*, whereas Japan wax (see p. 8) and bayberry wax are fats.

The major classes of waxes are vegetable, animal (and insect), petroleum (see Vol. **10,** p. 211), and the naturally occurring mineral waxes, and synthetic waxes. The origins of the more important of the naturally occurring waxes are shown in Table I. Wax products are used for a wide variety of applications in many industries; the largest uses, however, are in paper coating, candles, polishes, electrical insulation and coating, carbon paper, textiles, and leather. (Modern sealing wax is not a wax, and contains no wax. It consists chiefly of shellac and Venice turpentine, an oleoresin. Medieval sealing wax contained beeswax.)

PROPERTIES

As with any naturally occurring product, the physical and chemical properties of a natural wax vary over rather wide limits, and are further accentuated by differences in grades and processing (5). Table II lists the principal physical and chemical properties of the commercial natural waxes (13).

Composition. The main constituents of vegetable and animal waxes are high-molecular-weight acids, alcohols, esters, and saturated hydrocarbons, the esters usually

TABLE I. Commercial Natural Waxes.

Wax	Source	Locality of origin	Original appearance	Commercial grades
		Animal waxes		
Beeswax	*Apis mellifica*, Ghedda, *Melipona*	World-wide	Light yellow to dark greenish brown	Crude; yellow refined; bleached white
Chinese (insect wax)	*Coccus ceriferus*	Western China	White, opaque	Crude, refined
Shellac	*Carteria lacca*	India	Yellow	Crude
Spermaceti	*Physeter Macrocephalus*	—	White, crystalline	Technical; U.S.P.
		Mineral waxes		
Ceresin	Purified ozocerite from lignite	—	Yellow, white	Sold according to melting point range
Montan	Lignite	Germany (Saxony, Thuringia), California	Dark brown, brownish black	Crude; refined; distilled
Ozocerite	Lignite	Chiefly Galicia, Tcheleken Islands; also Utah, Austria, Egypt, Serbia	Yellow, dark brown, dark amber	Crude; natural yellow; white; purified grade called ceresin
		Vegetable waxes		
Candelilla	*Pedilanthus pavonis*	Mexico and Southwest Texas	Dark brown to greenish	Technical; refined; bleached
Carnauba	*Copernicia cerifera*	Northeastern Brazil	Sulfur yellow to dark brown-black	No. 1 (No. 1 Yellow) No. 2 (No. 2 Yellow) No. 3 (Light Fatty Grey or Cauhype) No. 4 (No. 4 North Country or Fatty Grey) No. 5 (Chalky) Crude; refined; bleached
Douglas fir bark	*Pseudotsuga taxifolia*	Oregon, Washington	Yellow-brown	Refined
Japan	*Rhus surcedanea*, *Rhus vernicifera*, *Rhus sylvestris*	Western Japan, China	Greenish, pale yellow or light brown	Kitagumi, Chichusan
Ouricury	*Syageus cororata*	Brazil	Dark brown, black	Crude; refined; bleached
Palm	*Ceroxylon andicolum*	Columbian Andes	White	Lump; powder; crude
Sugar cane	*Saccharum officinarum*	Cuba, Puerto Rico, Louisiana	Dark brown	Crude, refined (various grades)

TABLE II. Chemical and Physical Properties of Commercial Natural Waxes.

Wax	Melting range, °C.	Saponification number	Acid number	Iodine number	Sp.gr.	Acetyl number	Main constituents
Beeswax	62–70	86–96	17–21	8–11	0.955–0.975	15	Myricyl palmitate, cerotic acid, hydrocarbons
Candelilla	65–69	46–65	15–16	14–37	0.969–0.993	—	Hydrocarbons, melissic acid, myricyl alcohol, resins
Carnauba	83–91	73–86	1–8	8–13	0.990–0.999	55	See Table IV
Ceresin	64–77	0	0	0	0.88–0.92	—	Aliphatic hydrocarbons
Chinese	65–80	78–93	0.2–13	1.4–2	0.926–0.970	—	Ceryl cerotate
Japan	50–56	207–237	20	4–15	0.975–0.990	27–31	Glycerides of mono- and dibasic acids
Montan	Crude 76–92	Crude 58	Crude 25	Crude 16	Crude	—	Esters of wax acids, free wax acids,
	Distd. 72–77	Distd. 75–89	Distd. 73–85	Distd. 10–15	1.0		free wax alcohols, resins
	Refd. 77–84	Refd. 70–80	Refd. 15–20				
Ouricury	79–84	62–85	3–24	7–15	0.99–1.06	—	Myricyl cerotate, hentriacontane, free wax acids, resins
Ozocerite	58–100	0	0	0	0.85–0.95	0	Aliphatic hydrocarbons
Shellac	74–78	100–126	12.5–16.0	1.2	0.97–0.98	—	Esters of wax acids, free wax alcohols
Spermaceti	41–49	121–135	0.5	2.6–3.8	0.905–0.960	2.6	Cetyl palmitate
Sugar cane (refined wax)	76–79	65–77	23–28	5–10	0.997	30–40	Alkyl and steryl esters of fatty acids
Wool wax	31–42	82–140	0.2–40	15–47	0.924–0.960	—	Esters of cholesterol and lanosterol

being predominant. Table III lists some of the common wax acids and alcohols (13); these are all straight-chain compounds (see also *Fatty acids*). Some of the other components of natural waxes are resins, lactones, and sterols. As an example, the approxi-

TABLE III. Some Common Wax Acids and Alcohols.

Name	Formula	M.p., °C.	Occurrence
		Acids	
Cerotic acid	$C_{25}H_{51}COOH$	87.7	Free in beeswax, montan, carnauba; as ester in Chinese wax and carnauba
Lauric acid	$C_{11}H_{23}COOH$	44.2	As laurin in Japan wax
Montanic acid	$C_{27}H_{55}COOH$	90	Free in montan wax
Melissic acid	$C_{29}H_{59}COOH$	93.6	Free in beeswax and montan
Palmitic acid	$C_{15}H_{31}COOH$	63.1	As palmatin in Japan wax; cetyl palmitate in spermaceti; myricyl palmitate in beeswax
		Alcohols	
Cetyl alcohol (see Vol. 1, p. 320)	$C_{16}H_{33}OH$	49	As cetyl palmitate in spermaceti
Ceryl alcohol	$C_{26}H_{53}OH$	79	As ceryl cerotate in Chinese wax
n-Octadecyl alcohol (stearyl alcohol see Vol. 6, p. 255)	$C_{18}H_{37}OH$	59	In spermaceti
Montanyl alcohol	$C_{28}H_{57}OH$	—	In montan wax
Myricyl alcohol	$C_{30}H_{61}OH$	85	As esters in beeswax, carnauba

mate composition of carnauba wax is given in Table IV (the composition is that of Warth (13) modified to conform to Findley and Brown's functional group analysis and fractionation by molecular distillation of unhydrolyzed carnauba wax (2a)).

TESTING

Testing of waxes consists of the determination of physical and chemical properties by well-recognized test procedures, the specific details of which have not been standardized in many cases for the natural waxes and vary throughout the industry. The tests include: Physical constants: melting point, refractive index, specific gravity, and hardness. Chemical constants: saponification number, acid number, unsaponifiables, hydrocarbon content, iodine number, and acetyl number (1,4,13). (See also Vol. 6, pp. 151–56.)

Other test procedures consist of actual formulation and performance tests, such as emulsifying a wax in a no-rub floor polish formula, and evaluating the product.

METHODS OF PROCESSING

The most important physical operations used in the processing of natural wax are: separation of wax from fiber by heating, shredding, or maceration; selective and nonselective solvent extraction; filtration with and without filter aid; destructive and vacuum distillation; and bleaching by adsorption. Chemical processing (including that used for the manufacture of synthetic waxes) consists of: chemical bleaching; esterification; chlorination; oxidation; condensation; and hydrogenation.