

THE PREPARATION, PROPERTIES,
CHEMICAL BEHAVIOR, AND IDENTIFICATION OF
**ORGANIC CHLORINE
COMPOUNDS**

*Tables of Data on
Selected Compounds of Order III*

By
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By ERNEST HAMLIN HUNTRESS

A Brief Introduction to the Use of Beilstein's
Handbuch der organischen Chemie

The Preparation, Properties, Chemical Behavior, and
Identification of Organic Chlorine Compounds
Tables of Data on Selected Compounds of Order III

By ERNEST HAMLIN HUNTRESS and the late SAMUEL PARSONS MULLIKEN

Identification of Pure Organic Compounds

Tables of Data on Selected Compounds of Order I

(Compounds of Carbon with Hydrogen or with Hydrogen and Oxygen)

PREFACE

This volume represents the second to appear in the series of Tables of Data prepared by the present author. It presents in organized and conveniently usable form a summary of data on a selected list of organic compounds containing carbon and chlorine, or carbon, oxygen, and chlorine, or carbon, hydrogen, and chlorine, or carbon, hydrogen, oxygen, and chlorine. Such compounds may more briefly be described as comprising Order 3.

Although users of its predecessor will immediately recognize many aspects of similarity in this book, they will also note in this volume certain differences. These distinctions are more fully discussed in Chapter I, but certain general aspects may be noted here.

Whereas the treatment of Order 1 compounds was directed mainly toward the aspect of identification, and though this point of view is vigorously continued, the present treatment of compounds of Order 3 has been expanded to include also the preparation, properties, and general chemical behavior of the individuals selected for treatment.

A second major difference from the earlier volume is in the extent of reference to the original literature or the corresponding abstracts thereof. This documentation is carried to a degree which may suggest to organic chemists that this volume comprises a Beilstein. The author hastens to disclaim any such degree of completeness for this work but does admit that for each compound selected a meticulous search of the literature through 1945 has furnished the basis for appropriate selection and systematic grouping of the aspects to be treated.

A third important difference from the earlier volume is the inclusion of references to patents as well as scientific articles. Though such patent references are treated with reserve, it is believed that they will be of interest to all users and of special value to industrial chemists. Throughout the book emphasis is given to industrial aspects since the rapid growth of this field during the last two decades, particularly in the United States, has resulted in the production and large-scale utilization of many individual compounds of this order (3).

A fourth type of difference in the present treatment as compared with that of Order 1 is seen in the tabulation of physical constants. In the earlier volume an attempt was made to select the "best" values. This process tended to conceal the magnitude and nature of the available constants from

which such selection was made and thus somewhat to weaken the degree of reliance to which the final selection was entitled. In the present volume all the relevant data on boiling points, melting points, densities, and refractive indices have been included, thus permitting the user to make such interpretation of their consonance (or lack of it) as his particular needs may require. With certain exceptions, the amount of such physical data is surprisingly small, and no attempt to assess its reliability has been made except that instances where little effort to obtain pure products was demonstrated have usually been disregarded.

A merely superficial inspection of this volume by a nonchemical user might give the erroneous impression that the text comprised only a compilation of reported data. Careful examination by organic chemists, however, will immediately disclose that its form of organization and mode of treatment are largely influenced by the nature of the chemistry involved. This is conspicuously shown by what might be called "negative entries." Definite knowledge that a particular reaction has not been reported or that an individual compound does not appear in the systematic literature is often of real value. Many entries of this type appear in the current record. In this connection the dependence of chemists upon adequate and complete indexes to their original and especially to their abstract journals deserves emphasis. The term "unreported" as used in this book signifies that the compound in question cannot be found by systematic use of the usual index sources. Undoubtedly, instances will arise in which a substance so characterized will be found to have been embedded in details of work with other principal objectives and thus to have escaped proper indexing in the abstract journals. The author will be grateful for information on any cases of this sort.

An extended exposition of the principles involved in the formulation of this volume will be found in Chapter I. Special attention, however, may be directed to the exceptional care taken to facilitate the use of this book. For example, the volume includes (as Chapter XXIII) five kinds of indexes. These comprise not only the conventional alphabetical name index but also indexes of compounds by empirical formulas, by chemical types, and even by percentage chlorine and molecular weights. Moreover, throughout the text of the individual compounds there are inserted extremely frequent references to the related compounds which are necessarily involved. If these other compounds are themselves given detailed treatment in either this book (Order 3) or its precursor (Order 1), they are indicated by appropriate serial numbers so that no reference to either index is necessary. If, however, such secondary compounds are not themselves treated in either book, reference to the corresponding volume and page of Beilstein's *Handbuch der organischen Chemie* is made instead.

A brief statistical survey of the content of this volume may be of interest.

The 1320 individual compounds of Order 3 to which detailed text treatment is given are distributed among 366 groups of isomers. Of these 1320 compounds 366, i.e., 26.7% of the group, have been prepared so recently that they do not appear in the Fourth Edition of Beilstein at all. A total of 164 cross-reference headings facilitate recognition of the melting points of high-boiling liquids, or the boiling points of compounds normally met with as solids.

The total number of literature references in this volume is more than 22,000, of which total 67% represent publications since 1919 (the last year for which both the main and first supplementary series of Beilstein's *Handbuch* are complete), and 47% represent publications since 1929. The number of references associated with a given compound naturally varies widely. The highest number of references (621) is given for chloroacetic acid, followed by 405 each for trichloroacetaldehyde and ethylene chlorohydrin. More than 50 references are associated with each of 68 numbered compounds.

The preparation of this volume has been a long and laborious operation. The author wishes to place on permanent record his deep appreciation of the conscientious, faithful, and accurate secretarial assistance given him over long periods by both Miss Shirley Ridgway and Miss Mildred Capodilupo and for a shorter period by Miss Ruth Volinn.

The author is keenly aware that he cannot hope to satisfy in full the particular interests of every user. There must necessarily exist differences of opinion on the relative importance of this or that compound, reaction, or derivative. However, if all possible objections were first to be overcome nothing would ever be accomplished, and the author hopes that any deficiencies of this volume may to some extent be compensated by its merits.

Furthermore, in a work of this kind and magnitude it is inevitable that, despite every good intention and every earnest and painstaking effort, actual errors of fact will still have escaped detection and correction. The author invites the friendly cooperation of all who discover any such flaws, meanwhile being consoled by the view expressed by the ancient Chinese writer Tai T'ung, who, some seven hundred years ago, issued his *History of Chinese Writing* with this statement: "Were I to await perfection my book would never be finished. . . . The book awaits a wise and lofty spirit to correct and suppress where the text is in error, to add where it is defective, and to supply new facts where it is altogether silent."

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ABBREVIATIONS

$[\alpha]_D^{20}$	specific rotation at 20° for D line	aq.	water or aqueous
\bar{A}	represents acid residue in whose description it occurs	arom.	aromatic
abs.	absolute; absolutely	assoc.(d) (n)	associate(s) (associated) (association)
abt.	about	B	represents a molecule of the "basic" salt-forming compound in whose description it occurs
abund.	abundant	B.B.No.	bromide-bromate number
abv.	above	bibl.	bibliography
Ac	acetyl radical, i.e., $\text{CH}_3\text{CO}-$	bkn.	"broken" (cf. color terminology)
AcOEt	ethyl acetate	boilg.	boiling
AcOH	acetic acid (glacial acetic acid when unmodified)	b.p.	boiling point (at atm. pressure unless specified)
Ac ₂ O	acetic anhydride	Bu	n-butyl
ac.	acid	bril.	brilliant
acc.	according	brn.	brown
acid.	acidify, acidified, acidification	Bz	benzoyl, i.e., $\text{C}_6\text{H}_5\text{CO}-$
act.	active	BzOH	benzoic acid
addn.(l)	addition (additional)	C	Centigrade degrees
adj.	adjacent (e.g., 1,2,3)	\bar{C}	used to designate the compound in whose description it occurs
alc.	alcohol (95% unless otherwise stated); alcoholic	calc.(d) (n)	calculate(d) (calculation)
ald.	aldehyde	cap.	capillary
alk.(y)	alkali; alkaline; (alkalinity)	cat.	catalyst; catalytic; catalyzed
alm.	almost	cc.	cubic centimeter(s)
Am	amyl	cf.	compare
ammon.	ammoniacal	cg.	centigram(s)
amorph.	amorphous	charac.	characteristic
amt.(s)	amount(s)	chem.	chemical
anal.	analysis; analyses	cis-	stereochemical opposite of trans-
anhyd.	anhydrous	cm.	centimeter(s)
anti-	anti (stereomeric opposite of <i>syn</i> -)		
apprec.	appreciable; appreciably		
approx.	approximate; approximately		

coeff.	coefficient	diam.	diameter
col.(n)	color (coloration)	dif.	different; difference;
comb.(d)(n) (g)	combine(d) (combination) (combining)	dil.(td) (tg) (n)	difficultly
comm.	commercial		dilute (diluted) (diluting) (dilution)
compd.	compound	dimin.	diminish; diminishing; diminished; diminutive
compn.	composition		
conc.(d) (n)	concentrate(d) (concentration)	dis.(lvd)	dissolve (dissolved)
condens.	condensation	dissoc.(d) (g) (n)	dissociate(d) (dissociating) (dissociation)
cond.	condition(s)		
confrm.(n)	confirm; confirmatory (confirmation)	dist.(d) (g) (n)	distil(led) (distilling) (distillation)
const.	constant	distrib.(n)	distribute (distribution)
cont.(s) (g)	contain(s) (containing)	div.(n)	divide (division)
conv.(n)	convert (conversion)	dk.	dark
cor.	corrected	d,l-	racemic (by external compensation as contrasted with <i>meso</i>)
corresp.	corresponding		
C.P.	chemically pure	D.V.	Duclaux Value
cpd.	compound		
crit.	critical		E
cryst.(n) (d)	crystal(s); crystallize(s) (d); crystalline (crystallization)	eas.	easily
		efferv.	effervesce(s); effervescent
C.S.T.	critical solubility temperature		
	D	equiv.	equivalent
⑩	derivative (used to introduce important derivatives for specific characterizations)	espec.	especially
(D)	dark (following name of a broken color)	est.(d) (g) (n)	estimate(s) (estimated) (estimating) (estimation)
D ₄ ²⁰	density at 20° referred to water at 4°	Et	ethyl, i.e., CH ₃ .CH ₂ —
d-	dextrorotatory	EtOH	ethyl alcohol (generally refers to 95% if unmodified)
dec.(d) (n)	decompose(s) (decomposed) (decomposition)	eth.	ether (generally means ordinary diethylether)
deliq.	deliquesce(s), deliquescent	evap.(d) (g) (n)	evaporate(d) (evaporating) (evaporation)
depoly.(d) (n)	depolymerize(s) (depolymerized) (depolymerization)	evol.(n)	evolve(s) (evolution)
deriv.(s) (d) (n)	derivative(s) (derived) (derivation)	exam.(d) (n)	examine(d) (examination)
desic.	desiccator; desiccated	expt.(l)	experiment(al)
detectn.	detection	ext.(d) (g) (n)	extract(s) (extracted) (extracting) (extraction)
detn.(d)	determine; determination (determined)		F
		filt.(n)	filter(s); filtrate (filtration)
		floc.	flocculate; flocculent
		fluores.	fluoresce(s); fluorescent

ABBREVIATIONS

f.p.	freezing point	insol.(y)	insoluble (insolubility)
freq.	frequently	irreg.	irregular
fract.(n) (nl)	fraction; fractionate (fractionation) (fractional)	irrit.(n)	irritating (irritation)
fum.	fumaroid (stereochemical opposite of maleinoid)	isom.(d) (n)	isomer; isomerize (isomerized) (isomerization)
fumg.	fuming		K
fus.(n)	fuse(s), melt(s); fusible; fusing (fusion)	k	ionization constant
	G		L
g.	gram(s)	(L)	Light (modifying name of a broken color)
gem.	geminate (said of two like groups attached to same atom)	l-	laevorotatory
geom.	geometrical	l.	liter(s)
glac.	glacial	lft(s).	leaflet(s)
gr.	green	lgr.	ligroin
grad.	graduate; graduated; gradually	liq.	liquid; liquefy
gran.	granular; granulated	lt.	light (of a color)
	H		M
H.E.	hydrolysis equivalent	(M)	medium (modifying name of a broken color)
hexag.	hexagon; hexagonal	m.	melt(s)
hr.(s)	hour(s)	m-	meta
ht.(d) (g)	heat(ed) (heating)	mal.	maleinoid (stereochemical opposite of fumaroid)
hydrol.(g) (zd)	hydrolyze; hydrolysis; (hydrolyzing) (hydrolyzed)	max.	maximum
hygros.	hygroscopic	Me	methyl, i.e., CH ₃ —
	I	MeOH	methanol, i.e., CH ₃ OH
ibid.	in the same place	m.e.	milliequivalent
ident.	identical; identity	mg.	milligram(s)
identif.(d) (n)	identify (identified) (identification)	mic.	micro
i.e.	that is	microcryst.	microcrystalline
immed.	immediate; immediately	min.	minute(s); minimum
impt.	important	minl.	mineral
inact.	inactive; inactivated	misc.	miscellaneous; miscible
indef.	indefinite	mixt.	mixture(s)
indic.	indicate; indicator; indicated	mod.	moderate
inf.	infinite	modifn.	modification
inorg.	inorganic	mol.	molecular
		monoclin.	monoclinic
		ml.	milliliter
		mm.	millimeter
		m.p.	melting point
		ms	meso-

N		pr.	prism(s)
N	normal (equivalents per liter)	pract.	practically
n	normal	prep.(d) (g) (n)	prepare(d) (preparing) (preparation)
n_D²⁰	refractive index at 20° for D line of sodium	pres.	presence
ndl.(s)	needle(s)	press.	pressure
neg.	negative	prim.	primary
Neut. Eq.	neutralization equivalent	prin.	principal
neut.(zd)	neutral (neutralized)	prismat.	prismatic
no.	number	prob.	probably
non-fus.	non-fusible	proc.	procedure
non-vol.	non-volatile	prod.	product; produce; produced
O		prop.	property; properties
o-	ortho	pt.(s)	part(s)
obs.(d) (n)	observe(d) (observation)	pulv.(d)	pulverize(d)
obt.(d)	obtain(ed)	pung.	pungent
opt.	optical	purif.(d) (g) (n)	purify (purified) (purifying) (purification)
optim.	optimum	Q	
or.	orange	quad.	quadratic
ord.	ordinary	qual.	qualitative; qualitatively
orig.	original; originally	quant.	quantity; quantitative; quantitatively
org.	organic	quat.	quaternary
oxid.(g) (n)	oxidize(s) (oxidizing) (oxidation)	q.v.	quod vide (which see)
P		R	
Ⓟ	preliminary test	rac.	racemic
p-	para	rap.	rapid; rapidly
perm.	permanent	reactn.	reaction(s)
pet.	petroleum	reagt.(s)	reagent(s)
Ph	phenyl, i.e., C ₆ H ₅ —	rearr.	rearrange(s); rearrangement
phys.	physical	recommd.	recommend; recommended
physiol.	physiological	recryst.(d) (g) (n)	recrystallize(d) (recrystallizing) (recrystallization)
Pk	picryl, i.e., 2,4,6-trinitrophenyl-	rect.	rectangular
PkOH	picric acid	redis.	redissolve
pl.	plate(s)	reduc.(d) (g) (n)	reduce(d) (reducing) (reduction)
polym.(n)	polymer; polymerize; polymerized (polymerization)	ref.	reference
pos.	positive	reminis.	reminiscent
powd.	powder; powdered	reppt.(d) (g) (tn)	reprecipitate(d) (reprecipitating) (reprecipitation)
ppt.(d) (g) (n)	precipitate(d) (precipitating) (precipitation)		
Pr	propyl		

[illegible]

MEMORANDUM OF CERTAIN 1946-1947 REFERENCES NOT INCORPORATED IN REGULAR TEXT

The regular text of this book is made up of references selected from the chemical literature through the year 1945. Owing to the disturbed postwar conditions of the publishing and printing trades, and also to the exceptional difficulty and magnitude of this work, almost three years have elapsed since the termination of the period of writing of the organized text. Inevitably, there have appeared during this period many scientific papers whose content would gladly have been incorporated appropriately in the regular text. For practical reasons, however, such continuous adjustment was obviously impossible.

In an effort to avoid so far as possible complete loss of such material, however, certain of the more important papers which have come to the attention of the author during the 1946-1947 period have been listed in the following supplementary bibliography. Articles relevant to more than a single numbered compound are cited under the first in such a numerical series, cross-references being given under subsequent compounds to avoid excess duplication of references. In the interests of brevity, clarity, and consistency of nomenclature, slight modifications of the actual titles of the original papers have sometimes been made for purposes of this listing.

General

- (1) Table of azeotropes and nonazeotropes
Horsley, *Ind. Eng. Chem., Anal. Ed.* **19**, 508-600 (1947)
This extraordinary 92-page compilation with its accompanying formula index and bibliography of 172 references is so generally valuable and includes so many of the serially numbered compounds of this book that it is placed at the head of this supplementary reference list without further cross-reference to it from subsequent entries below.
- 3:0075** δ -Chloro-*n*-valeric acid
- (2) Isomeric chlorinated long-chain esters
Guest, *J. Am. Chem. Soc.* **69**, 300-302 (1947)
—Methyl δ -chloro-*n*-valerate: b.p. 89-92° at 18 mm. [From δ -chloro-*n*-valeronitrile 80% H_2SO_4 refluxed 50 hr.]
- 3:0235** α -Chloroisobutyric acid
- (3) The chloro- and bromoisobutyronitriles
Stevens, *J. Am. Chem. Soc.* **70**, 166 (1948)
Ⓓ α -Chloroisobutyramide: cryst. from EtOAc, m.p. 115-118°; from aq., m.p. 117-119°. [From α -chloroisobutyl chloride (3:5385) with conc. NH_4OH at 10° in 70% yield.]
- 3:0280** Chloromaleic anhydride
- (4) Use of \bar{C} in determination of conjugated diolefins
Putnam, Moss, Hall, *Ind. Eng. Chem., Anal. Ed.* **18**, 628-630 (1946)

- 3:0460 β -Chloropropionic acid**
(5) Convenient synthesis of β -chloropropionitrile (from acrylonitrile with hydrogen chloride)
Stewart, Clark, *J. Am. Chem. Soc.* **69**, 713-714 (1947)
- 3:0885 α -Chloro-diphenylacetyl chloride**
(6) \bar{C} as reagent for preparation of benzoic acid esters of tertiary amino alcohols
King, Holmes, *J. Chem. Soc.* **1947**, 164-168; *C.A.* **41**, 5121 (1947)
- 3:1150 Trichloroacetic acid**
(7) Kinetics of the decomposition of certain salts of \bar{C} in ethanol-water mixtures
Hall, Verhoek, *J. Am. Chem. Soc.* **69**, 613-616 (1947)
(8) Kinetics of the decomposition of \bar{C} in formamide-water mixtures
Cochran, Verhoek, *J. Am. Chem. Soc.* **69**, 2987-2988 (1947)
- 3:1212 Phenacyl chloride**
(9) The reaction of \bar{C} with phenylhydrazine
van Alphen, *Rec. trav. chim.* **65**, 112-116 (1946); *C.A.* **41**, 409 (1947)
- 3:1370 Chloroacetic acid**
(10) New method for the detection and determination of \bar{C} (using pyridine)
Ramsey, Patterson, *J. Assoc. Offic. Agr. Chemists* **29**, 100-111 (1946); *C.A.* **40**, 3369 (1946)
(11) Effect of pH on rate of hydrolysis of \bar{C}
Berhenke, Britton, *Ind. Eng. Chem.* **38**, 544-546 (1946)
- 3:1420 1,1,1-Trichloro-2,2-diphenylethane**
(12) Derivatives of \bar{C}
Haskelberg, Lavie, *J. Am. Chem. Soc.* **69**, 2267-2268 (1947)
(13) Symmetrical analogues of DDT
Stephenson, Waters, *J. Chem. Soc.* **1946**, 339-343; *C.A.* **40**, 5040 (1946)
- 3:3298 1,1,1-Trichloro-2,2-bis-(*p*-chlorophenyl)ethane ("DDT")**
(14) Methods of preparation of \bar{C}
Bailes, *J. Chem. Education* **22**, 122 (1945); *C.A.* **41**, 3085 (1947)
(15) Preparation of technical \bar{C}
Mosher, Cannon, Conroy, Van Strien, Spalding, *Ind. Eng. Chem.* **38**, 916-923 (1946)
(16) Preparation of \bar{C} using HF as condensing agent
Simons, Bacon, Bradley, Cassaday, Heegberg, Tarrant, *J. Am. Chem. Soc.* **68**, 1613-1615 (1946)
(17) Production of \bar{C}
Castonguay, Ferm, *Trans. Kansas Acad. Sci.* **49**, 167-174 (1946); *C.A.* **41**, 2409 (1947)
(18) Synthesis of \bar{C} with chlorosulfonic acid as condensing agent
W. A. Cook, K. H. Cook, W. H. C. Rueggeberg, *Ind. Eng. Chem.* **39**, 868-870, 1683 (1947)
(19) A colorimetric method for microdetermination of \bar{C} (xanthydrol/KOH/pyridine method)
Stiff, Castillo, *Science* **101**, 440-443 (1945); *C.A.* **39**, 2830 (1945)
(20) Determination of \bar{C} in organs and body fluids after oral administration (xanthydrol/KOH/pyridine method)
Stiff, Castillo, *J. Biol. Chem.* **159**, 545-548 (1945); *C.A.* **39**, 4695 (1945)
(21) Application of xanthydrol/KOH/pyridine method to the determination of \bar{C} in water
Castillo, Stiff, *Military Surgeon* **97**, 500-502 (1945); *C.A.* **40**, 2561 (1946)
(22) Field test for surface \bar{C}
Stiff, Castillo, *Ind. Eng. Chem., Anal. Ed.* **18**, 316-317 (1946)
(23) Chemical methods for analysis of \bar{C}
Ginsberg, *J. Econ. Entomol.* **39**, 174-177 (1946); *C.A.* **40**, 4842 (1946)
(24) Colorimetric determination of *p,p'*-isomer in technical \bar{C}
Charkin, *Ind. Eng. Chem., Anal. Ed.* **18**, 272-273 (1946)
(25) Determination of *p,p'*-isomer in technical \bar{C}
Cristol, Hayes, Haller, *Ind. Eng. Chem., Anal. Ed.* **18**, 339 (1946)
(26) Determination of *p,p'*-isomer in technical \bar{C}
Balaban, Calvert, *Ind. Eng. Chem., Anal. Ed.* **18**, 339 (1946)
(27) Determination of *p,p'*-isomer in technical \bar{C} by a microscopical method
McCrone, Smedal, Gilpin, *Ind. Eng. Chem., Anal. Ed.* **18**, 578-582 (1946)
(28) Determination of \bar{C} in dusts and oil solutions
La Clair, *Ind. Eng. Chem., Anal. Ed.* **18**, 763-766 (1946)

- (29) Determination of \bar{C} as spray residue on fresh fruit by three independent methods
Wichmann, Patterson, Clifford, Klein, Claborn, *J. Assoc. Offic. Agr. Chemists* **29**, 188-190 (1946); *C.A.* **40**, 6705 (1946)
Method 1. Organic chlorine determinations
Klein, Wichmann, *ibid.* **29**, 191-195 (1946); *C.A.* **40**, 6705 (1946)
Method 2. The Shechter-Haller colorimetric procedure
Clifford, *ibid.* **29**, 195-206 (1946); *C.A.* **40**, 6705 (1946)
Method 3. 2,4-Dinitrophenylhydrazine method
Claborn, Patterson, *ibid.* **29**, 206-218 (1946); *C.A.* **40**, 6705 (1946)
- (30) Decomposition and volatility of \bar{C} and some of its derivatives
Wichmann, Patterson, Clifford, Klein, Claborn, *J. Assoc. Offic. Agr. Chemists* **29**, 218-233 (1946); *C.A.* **40**, 6740 (1946)
- (31) Colorimetric determination of \bar{C} in milk and fatty materials
Shechter, Pogorelskin, Haller, *Ind. Eng. Chem., Anal. Ed.* **19**, 51-53 (1947)
- (32) Estimation of \bar{C} in milk by determination of organic chlorine
Carter, *Ind. Eng. Chem., Anal. Ed.* **19**, 54 (1947)
- (33) Determination of \bar{C} by Shechter procedure, particularly in milk and fats
Clifford, *J. Assoc. Offic. Agr. Chemists* **30**, 337-349 (1947); *C.A.* **41**, 6839 (1947)
- (34) Nature of the by-products in technical \bar{C}
Gätzl, Stambach, *Helv. Chim. Acta* **29**, 563-572 (1946); *Experientia* **1**, 276 (1945); *C.A.* **40**, 5040-5041 (1946)
- (35) Simple purification procedure for \bar{C}
K. H. Cook, W. A. Cook, *J. Am. Chem. Soc.* **68**, 1663-1664 (1946)
- (36) Applications of infrared spectroscopy to \bar{C}
Downing, Freed, Walker, Patterson, *Ind. Eng. Chem., Anal. Ed.* **18**, 461-467 (1946)
- (37) Some derivatives of \bar{C}
Backeberg, Marais, *J. Chem. Soc.* **1945**, 803-805; *C.A.* **40**, 1156, 5717 (1946)
- (38) Bromine analogs of \bar{C}
Cristol, Haller, *J. Am. Chem. Soc.* **68**, 140-141 (1946)
- (39) Crystal structure of \bar{C} and relatives
Wild, Brandenberger, *Helv. Chim. Acta* **29**, 1024-1040 (1946); *C.A.* **41**, 428 (1947)
- (40) Synthesis of some analogs of \bar{C}
Kirkwood, Dacey, *Can. J. Research* **24-B**, 69-72 (1946); *C.A.* **40**, 5717 (1946)
- (41) Catalytic decomposition of \bar{C}
Flenner, *J. Am. Chem. Soc.* **68**, 2399 (1946)
- (42) Inhibition of catalyzed thermal decomposition of \bar{C}
Gunther, Tow, *J. Soc. Chem. Ind.* **66**, 57-59 (1947); *C.A.* **41**, 5675 (1947)
- (43) Dehydrohalogenation of \bar{C}
Wain, Martin, *Nature* **159**, 68-69 (1947); *C.A.* **41**, 2715 (1947)
- (44) Estimation of \bar{C} by methods depending upon dehydrohalogenation
Wain, Martin, *Analyst* **72**, 1-6 (1947); *C.A.* **41**, 2198 (1947)
- (45) Preparation of di-(*p*-chlorophenyl)acetic acid from \bar{C}
Grummitt, Buck, Egan, *Org. Syntheses* **26**, 21-23 (1946)
- (46) Reactions of \bar{C} and associated compounds
Forrest, Stephenson, Waters, *J. Chem. Soc.* **1946**, 333-339; *C.A.* **40**, 5038-5040 (1946)
- (47) Crystallization of \bar{C} from binary melts
Gilpin, McCrone, Smedal, Grant, *J. Am. Chem. Soc.* **70**, 208-211 (1947)
- 3:3320** 1,1-Dichloro-2,2-bis-(*p*-chlorophenyl)ethane ("DDD")
- (48) Anhydrous $FeCl_3$ as rearrangement catalyst for some chlorinated diphenylethanes
Fleck, *J. Org. Chem.* **12**, 708-712 (1947)
- 3:3330** 4,6-Dichlororesorcinol
- (49) For preparation of isomeric 2,4-dichlororesorcinol see
Peetynin, Kuchina, *J. Gen. Chem. (U.S.S.R.)* **17**, 278-282 (1947); *C.A.* **42**, 534-535 (1948)
- 3:3334** *p*-Phenylphenacyl chloride
- (50) Conversion of \bar{C} to *p*-phenylphenacyl iodide
Rheinboldt, Perrier, *J. Am. Chem. Soc.* **69**, 3148-3149 (1947)
- 3:4095** 2,4-Dichlorophenoxyacetic acid
- (51) Preparation of \bar{C} from phenol and chloroacetic acid
Ebel, Bell, Fries, Kasey, Berkebile, *J. Chem. Education* **24**, 449 (1947)

- (52) Determination of \bar{C} and its compounds in commercial herbicides
Rooney, *Ind. Eng. Chem., Anal. Ed.* **19**, 475-476 (1947)
- (53) The halogenation of aryloxyacetic acids and their homologs
Haskelberg, *J. Org. Chem.* **12**, 426-433 (1947)
- (54) Preparation of 2,4-dichlorophenoxyacetyl chloride
Freed, *J. Am. Chem. Soc.* **68**, 2112 (1946)
- 3:4375** *p*-Chlorophenoxyacetic acid
(—) See reference (53) under 3:4095 (above).
- 3:4410** *cis*-1,2,3,4,5,6-Hexachlorocyclohexane
(55) Preparation of the benzene hexachlorides
Gunther, *Chemistry & Industry* **1946**, 399; *C.A.* **41**, 1625 (1947)
- (56) Infrared spectroscopic analysis of five isomers of \bar{C}
Daasch, *Ind. Eng. Chem., Anal. Ed.* **19**, 779-785 (1947)
- (57) Kinetics of the alkaline dehydrochlorination of the benzene hexachloride isomers
Cristol, *J. Am. Chem. Soc.* **69**, 338-342 (1947)
- (58) Alkaline degradation of benzene hexachlorides
Gunther, Blinn, *J. Am. Chem. Soc.* **69**, 1215-1216 (1947)
- (59) The gamma isomer of hexachlorocyclohexane
Slade, *Chemistry & Industry* **1945**, 314-319; *C.A.* **40**, 2257-2259 (1946)
- (60) The epsilon isomer of hexachlorocyclohexane
Kauer, DuVall, Alquist, *Ind. Eng. Chem.* **39**, 1334-1338 (1947)
- (61) Determination of hexachlorocyclohexane in impregnated cloth
Goldenson, Sass, *Ind. Eng. Chem., Anal. Ed.* **19**, 320-322 (1947)
- 3:4612** Di-(*p*-chlorophenyl)acetic acid
(—) Preparation from "DDT"; see reference (45) under 3:3298 (above)
- 3:4835** Hexachloroethane
(62) Preparation of \bar{C} by chlorination of liquid 1,1,2,2-tetrachloroethane and pentachloroethane
Pearce, *Can. J. Research* **24-F**, 369-379 (1946); *C.A.* **40**, 7151 (1946)
- 3:4947** Tetrachlorophthalic anhydride
(63) Reactions and uses of \bar{C}
Lawlor, *Ind. Eng. Chem.* **39**, 1419-1423 (1947)
- (64) Tetrachlorophthalic anhydride, acid and salts
Lawlor, *Ind. Eng. Chem.* **39**, 1424-1426 (1947)
- (65) The esterification of \bar{C}
Nordlander, Cass, *J. Am. Chem. Soc.* **69**, 2679-2682 (1947)
- 3:4990** *trans*-1,2,3,4,5,6-Hexachlorocyclohexane
(—) See references (55)-(61), inclusive, under *cis*-isomer (3:4410) (above)
- 3:5000** Carbonyl chloride (Phosgene)
(66) Heat capacity, entropy, vapor pressure, and heats of fusion and vaporization of \bar{C}
Giaque, Jones, *J. Am. Chem. Soc.* **70**, 120-124 (1948)
- (67) Preparation of benzoic acid from \bar{C} with benzene
Rueggeberg, Frantz, Ginsburg, *Ind. Eng. Chem.* **38**, 624-626 (1946)
- (68) Reaction of \bar{C} with tertiary amines under conditions for formation of tetrasubstituted ureas
Lastovskii, *J. Applied Chem. (U.S.S.R.)* **19**, 440-444 (1946); *C.A.* **41**, 1214 (1947)
- (69) Reaction of \bar{C} with *o*-aminobenzoic acid (to give 72-75% yield isatoic anhydride)
Wagner, Fegley, *Org. Syntheses* **27**, 45-47 (1947)
- 3:5028** *trans*-1,2-Dichloroethylene
(70) Condensation of alkyl chlorides with polychloro-olefins
Schmerling, *J. Am. Chem. Soc.* **68**, 1655-1657 (1946)
- (71) Reaction of \bar{C} with isobutane
Schmerling, *J. Am. Chem. Soc.* **70**, 379-381 (1948)
- 3:5042** *cis*-1,2-Dichloroethylene
(—) See references (70) and (71) under *trans*-isomer (3:5028) (above)
- 3:5050** Chloroform
(72) The addition of polyhalomethanes to olefins
Kharasch, Jensen, Urry, *J. Am. Chem. Soc.* **69**, 1100-1105 (1947)
- (73) Compound formation of \bar{C} with pyridine
Davidson, Van der Werf, Boatright, *J. Am. Chem. Soc.* **69**, 3045-3047 (1947)

- 3:5100 Carbon tetrachloride**
 (—) See references (72) and (73) under chloroform (3:5050) (above)
 (74) Analysis of the system benzene/ethanol/carbon tetrachloride (by refractive indices and densities)
 Campbell, Miller, *Can. J. Research* **25-B**, No. 3, 228-242 (1947); *C.A.* **41**, 6839 (1947)
- 3:5110 1,2-Dichloropropene-1 (low-boiling stereoisomer)**
 (—) See reference (70) under 3:5028 (above)
- 3:5130 1,2-Dichloroethane**
 (75) Reaction of \bar{C} with benzene
 Korshak, Kolesnikov, Kharchevnikova, *Compt. rend. acad. sci. U.R.S.S.* **56**, 169-172 (1947); *C.A.* **42**, 545 (1948)
- 3:5150 1,2-Dichloropropene-1 (high-boiling stereoisomer)**
 (—) See reference (70) under 3:5028 (above)
- 3:5170 1,1,2-Trichloroethylene**
 (—) See reference (70) under 3:5028 (above)
 (76) Dimerization of \bar{C}
 Henne, Ruh, *J. Am. Chem. Soc.* **69**, 279-281 (1947)
- 3:5190 2,3-Dichloropropene-1**
 (—) See reference (70) under 3:5028 (above)
- 3:5210 Trichloroacetaldehyde**
 (77) Determination of \bar{C} in technical chloral
 Harrington, Boyd, Cherry, *Analyst* **71**, 97-107 (1946); *C.A.* **40**, 3368 (1946)
 (78) Determination of small amounts of water in \bar{C}
 Shaw, Bruce, *Ind. Eng. Chem., Anal. Ed.* **19**, 884-885 (1947)
 (79) Hydrolysis of \bar{C} in heavy hydrogen water
 Lander, Wright, *Nature* **158**, 381 (1946); *C.A.* **41**, 1998 (1947)
- 3:5220 2,3-Dichlorobutadiene-1,3**
 (80) Preparation of \bar{C} from tri-, tetra-, and pentachlorobutanes
 Klebanskii, Belen'kaya, Chevychalova, *J. Applied Chem. (U.S.S.R.)* **19**, 200-206 (1946); *C.A.* **41**, 685 (1947)
 (—) See reference (85) under 3:5350 (below)
- 3:5280 1,3-Dichloropropene-1**
 (81) The *cis*- and *trans*-isomers of \bar{C}
 Andrews, Kepner, *J. Am. Chem. Soc.* **69**, 2230-2231 (1947)
 (82) The catalytic hydrolysis and characterization of \bar{C}
 Hatch, Roberts, *J. Am. Chem. Soc.* **68**, 1196-1198 (1946)
 (—) See reference (70) under 3:5028 (above)
- 3:5330 1,1,2-Trichloroethane**
 (83) Ternary liquid and binary vapor equilibrium of the system: acetone/water/ \bar{C}
 Treybal, Weber, Daley, *Ind. Eng. Chem.* **38**, 817-821 (1946)
- 3:5350 3,4-Dichlorobutene-1**
 (84) Preparation of \bar{C} from butadiene-1,3 with chlorine
 Taylor, Morey, *Ind. Eng. Chem.* **40**, 432-435 (1948)
 (85) Dehydrochlorination of \bar{C} to 2-chlorobutadiene-1,3
 Klebanskii, Sorokina, Khavin, *J. Gen. Chem. (U.S.S.R.)* **17**, 235-252 (1947); *C.A.* **42**, 514-516 (1948)
- 3:5358 3-Chloro-1,2-epoxypropane ("Epichlorohydrin")**
 (86) Condensation of \bar{C} with phenols in presence of BF_3
 E. Levas, H. LeFebvre, *Compt. rend.* **222**, 555-557 (1946); *C.A.* **40**, 3737 (1946)
 H. LeFebvre, E. Levas, Mme. E. Levas, *Compt. rend.* **222**, 1439-1440 (1946); *C.A.* **40**, 5712 (1946)
- 3:5425 Chloroacetone**
 (87) Condensation of \bar{C} with formaldehyde
 Hurd, McPhee, Morey, *J. Am. Chem. Soc.* **70**, 329-331 (1948)
- 3:5430 α,α -Dichloroacetone**
 (—) See reference (87) under 3:5425 (above)