TECHNIQUES OF CHEMISTRY

VOLUME II

ORGANIC SOLVENTS

PHYSICAL PROPERTIES AND METHODS OF PURIFICATION

Third Edition

BY

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On the basis of the First Edition

by ARNOLD WEISSBERGER *and* ERIC S. PROSKAUER

and

the completely revised Second Edition

by JOHN A. RIDDICK *and* EMORY E. TOOPS, *Jr.*

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INTRODUCTION TO THE SERIES

Techniques of Chemistry is the successor to the Technique of Organic Chemistry Series and its companion—Technique of Inorganic Chemistry. Because many of the methods are employed in all branches of chemical science, the division into techniques for organic and inorganic chemistry has become increasingly artificial. Accordingly, the new series reflects the wider application of techniques, and the component volumes for the most part provide complete treatments of the methods covered. Volumes in which limited areas of application are discussed can be easily recognized by their titles.

Like its predecessors, the series is devoted to a comprehensive presentation of the respective techniques. The authors give the theoretical background for an understanding of the various methods and operations and describe the techniques and tools, their modifications, their merits and limitations, and their handling. The series should contribute to a better understanding and a more rational and effective application of the respective techniques.

Authors and editors hope that readers will find the volumes in this series useful and will communicate to them any criticisms and suggestions for improvements.

Research Laboratories
Eastman Kodak Company
Rochester, New York

ARNOLD WEISSBERGER

FROM THE PREFACE TO THE FIRST EDITION

In recent years improvements in the methods of organic chemistry and the enhanced interest in the chemical physics of non-aqueous solutions have led to an ever-increasing demand for variety and purity in purification.

For this reason it has seemed desirable to make a collection of physical constants and of methods of purification for these solvents. The aim of this book is to make readily accessible the abundant material which has been accumulated by chemists and physicists in recent years. To this end an organic chemist and a physical chemist have collaborated.

The success of physical and chemical work, both preparation and measurement, is often decided by choice of solvent, and this choice is sometimes not at all simple. We hope that a study of the systematic list of solvents and of the numerical data, classified systematically, contained in this book will make this task easier. The selection of solvents treated is inevitably somewhat arbitrary although we have tried to cater for as many different requirements as possible: we shall be glad of any suggestions for extension or limitation of the list or other amendments. We should be particularly grateful for copies of papers which contain measurements of physical constants of solvents or methods of their organic solvents.

A. WEISSBERGER

Oxford and Leipzig

E. S. PROSKAUER

PREFACE TO THE THIRD EDITION

Since the appearance of the Second Edition of *Organic Solvents* the role of the solvent has become much more significant and better understood. Many more solvents are available for industrial use, generally in a good to high grade of purity, and numerous additional solvents have become available for research.

One hundred solvents have been added to the Third Edition; we could not find justification for deleting any that were listed in the Second Edition. Readers of the Second Edition suggested many compounds and properties to be added in the Third Edition. Of these suggestions those were accepted that were in keeping with the aim of the book provided sufficient information was available. Primary consideration was given to the uniqueness of the solvent property and to present and possible future uses of the solvent, particularly in the newer fields of application such as electrochemical reactions, thin layer chromatography, and preparative solvent extraction. Several solvents were added to complete groups of isomers and to expand homologous series to include a reasonable number of compounds, for instance in the C_nH_{2n+2} and C_nH_{2n} series. The pentane isomers are complete. The *n*-alkyl alcohols through hexanol are given, as are the isomers of the C_3, C_4, and C_5 alcohols.

In most of the functional group classes unsaturated compounds have been added. The amides have been increased from two to nine in keeping with the expanding interest in research and in industrial use. The number of sulfur compounds has been doubled and includes dimethyl sulfoxide and sulfolane. Several heterocyclic solvents have been added. Newly included unique compounds of limited availability are 1,1,2,2-tetramethylurea and hexamethylphosphoric triamide.

Water is a solvent of reference and a standard for calibration and comparison; the physical properties of water have been listed at the beginning of the tables in Chapter III as Tables Oa, Ob, and Oc. We know of no other place where so many of the properties of water are collected in easy-to-use tables.

The number of properties tabulated has been increased by twelve, not including the references to spectra and some properties that have synonymous

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methods of expression such as the ionization constant, K_i, and the negative logarithm of the acid dissociation constant, pK_a. The newly added properties were selected from a study of the scientific literature beginning in 1960 to determine which properties were used most frequently. Several properties that were of limited academic interest have become useful in newer areas such as electronics and space science.

Eight Index Tables appear in Chapter III, including four new ones—Ebullioscopic Constants, Cryoscopic Constants K_f and A for Equation 2.72 in Chapter II, and Density.

The format of the book remains the same as in the First and Second Editions, as does the aim, "to make readily accessible the abundant material" that has accumulated in the literature on organic solvents.

Chapter II, "Discussion of Properties and Criteria for their Selection," has been completely revised to facilitate the use of the tables in Chapter III. The newer concepts relating to purity have been included in Chapter IV, and the more recent methods for characterizing purity are discussed.

We have calculated many values to make the tables more useful. Some of the calculated values, such as the temperature coefficients of density and of the refractive index, were used during the evaluation of the data prior to inclusion in the tables.

We express our gratitude for their suggestions for the third edition to Dr. Paul D. Bartlett, Harvard University; Professor G. Cauquis, Centre d'Études Nucleaires de Grenoble; Dr. G. L. Covert, Eastman Kodak Company; Dr. Lyman C. Craig, Rockefeller Institute; Mr. P. B. Dalton, General Aniline and Film Corporation; the late Dr. Henry de Laszlo, Koch-Light Laboratories; the late Dr. J. B. Dickey, Tennessee Eastman Company; Mr. Hugh J. Hagemeyer, Texas Eastman Company; Dr. Dan H. Moore, South Jersey Medical Research Foundation; Dr. L. J. Roll and Dr. I. F. Salminen, Eastman Kodak Company; Dr. Dietmar Seyferth, Massachusetts Institute of Technology; Dr. Howard Steinberg, U.S. Borax Research Corporation; Dr. W. West and Mr. C. C. Unruh, Eastman Kodak Company; Dr. D. S. Young, Tennessee Eastman Company; and Dr. C. W. Zuehlke, Eastman Kodak Company.

Our sincere thanks also go to Professor Thomas F. Fagley and Dr. Ray Oglukian of Tulane University, Dr. T. C. Wehman of Michigan State University, and Dr. Robert West of Lehigh University for unpublished information from their research, and to Dr. Arthur and Elizabeth Rose of Applied Science Laboratories for their many helpful suggestions and enlightening discussions. We are grateful to Dr. Arthur and Wanda L. Campbell for their assistance during the first two years of the preparation of this edition. We are especially grateful to Mr. Gene Seidel of Crown Zellerbach Corporation for his generous help in supplying extensive information on dimethyl

sulfoxide and dimethyl sulfide and his offer to furnish information on other solvents, and to Commercial Solvents Corporation for providing facilities for our work and for freely allowing the use of previously unpublished information.

To our wives we express our appreciation for their patience during the five years of preparation of this book and for their help in tabulation and proofreading.

Baton Rouge, Louisiana
Terre Haute, Indiana
January 1970

JOHN A. RIDDICK
WILLIAM B. BUNGER

CONTENTS

Chapter I

CLASSIFICATION OF THE SOLVENTS

The choice of compounds not only includes the common solvents but other compounds whose properties might render them suitable as solvents in special cases.

The solvents are arranged in the order of increasing chemical complexity under the following major classes:

Hydrocarbons
Compounds with one type of characteristic atom or group (hydroxy compounds, esters, halogenateds, etc.)
Compounds with more than one type of characteristic atom or group (ether alcohols, amino alcohols, esters of keto acids, etc.)

Subdivisions are made according to the nature of the hydrocarbon residue (saturated, aromatic, unsaturated); the number of times the characteristic atom or group occurs; heterocyclic or open chain structure; and the primary, secondary, or tertiary nature of amines.

Code numbers have been assigned to compounds for easy identification and reference. The same number appears in boldface type with each compound in every tabulation of the solvents, and each relevant use of the name throughout the book.

The names of the solvents included in this book are, in general, those used by *Chemical Abstracts*. The exceptions are mainly those compounds whose *Chemical Abstracts*' name is not well enough known to be recognized readily: for example, **336.** triethanolamine, **320.** sulfolane, and **311.** ϵ-caprolactam.

Asterisks designate listings in *Chemical Abstracts*. The listing name for many compounds has changed over the years. Former names are followed in parentheses by the last year of use: for example, **272.** 4-Methylvaleronitrile*, isocapronitrile* (through 1952).

WATER

0. Water

HYDROCARBONS

Saturated Aliphatic Hydrocarbons

1. Cyclopentane*, pentamethylene
2. Pentane*, *n*-pentane

3. 2-Methylbutane*, ethyldimethylmethane
4. 2,2-Dimethylpropane*, neopentane, tetramethylmethane
5. Methylcyclopentane*
6. Cyclohexane*, hexahydrobenzene, hexamethylene
7. Hexane*, *n*-hexane
8. 2-Methylpentane*, dimethylpropylmethane
9. 3-Methylpentane*, diethylmethylmethane
10. 2,2-Dimethylbutane*, ethyltrimethylmethane, neohexane
11. 2,3-Dimethylbutane*, diisopropyl, isopropyldimethylmethane
12. Methylcyclohexane*, hexahydrotoluene, cyclohexylmethane
13. Heptane*, *n*-heptane
14. 2-Methylhexane*, ethylisobutylmethane
15. 3-Methylhexane*, ethylmethylpropylmethane
16. 2,3-Dimethylpentane*, ethylisopropylmethylmethane
17. 2,4-Dimethylpentane*, diisopropylmethane
18. Ethylcyclohexane*
19. Octane*, *n*-octane
20. 2,2,3-Trimethylpentane*, *tert*-butylethylmethylmethane
21. 2,2,4-Trimethylpentane*, isooctane, isobutyltrimethylmethane
22. Nonane*, *n*-nonane
23. 2,2,5-Trimethylhexane*
24. Decahydronaphthalene*, decalin, bicyclo[4.4.0]decane, naphthalane, naphthane
25. *cis*-Decahydronaphthalene*, *cis*-decalin, *cis*-bicyclo[4.4.0]decane
26. *trans*-Decahydronaphthalene*, *trans*-decalin, *trans*-bicyclo[4.4.0]-decane
27. Decane*, *n*-decane
28. Bicyclohexyl*, cyclohexylcyclohexane
29. Dodecane*, duodecane, bihexyl

Aromatic Hydrocarbons

30. Benzene*, benzol, benzole, phene
31. Toluene*, methylbenzene, phenylmethane
32. *o*-Xylene*, 1,2-dimethylbenzene, 2-xylene
33. *m*-Xylene*, 1,3-dimethylbenzene, 3-xylene
34. *p*-Xylene*, 1,4-dimethylbenzene, 4-xylene
35. Ethylbenzene*, phenylethane
36. Isopropylbenzene, cumene*, cumol, 2-phenylpropane
37. Mesitylene*, 1,3,5-trimethylbenzene, *sym*-trimethylbenzene
38. Naphthalene*, naphthene
39. 1,2,3,4-Tetrahydronaphthalene*, naphthalene-1,2,3,4-tetrahydride, tetrahydronaphthalene, tetralin

40. Butylbenzene*
41. *sec*-Butylbenzene*, 2-phenylbutane
42. *tert*-Butylbenzene*, 2-methyl-2-phenylpropane, pseudobutylbenzene, trimethylphenylmethane
43. *p*-Cymene*, cymene, 4-isopropyl-1-methylbenzene, *p*-isopropyltoluene
44. Cyclohexylbenzene*, phenylcyclohexane* (through 1950)

Unsaturated Hydrocarbons

45. 1-Pentene*, amylene, α-*n*-amylene, propylethylene
46. 2-Pentene* (mixed isomers), β-*n*-amylene, *sym*-ethylmethylethylene
47. *cis*-2-Pentene*
48. *trans*-2-Pentene*
49. 1-Hexene*, α-hexene
50. 1-Heptene*, α-heptene
51. 1-Octene*, α-octene, caprylene, α-octylene
52. 1-Nonene*, α-nonene, *n*-heptylethylene, 1-nonylene
53. 1-Decene*, α-decene
54. Cyclohexene*, 1,2,3,4-tetrahydrobenzene, tetrahydrobenzene
55. Styrene*, styrol, vinylbenzene, cinnamene, ethenylbenzene, phenylethylene
56. 2-Pinene*, pinene* (through 1956), α-pinene, 2,6,6-trimethylbicyclo[3.1.1]-2-heptene
57. 2(10)-Pinene*, nopinene* (through 1956), β-pinene, 6,6-dimethyl-2-methylenenorpinene

COMPOUNDS WITH ONE TYPE OF CHARACTERISTIC ATOM OR GROUP

HYDROXY COMPOUNDS

MONOHYDRIC ALCOHOLS

Aliphatic Alcohols

58. Methanol*, methyl alcohol, wood alcohol, carbinol
59. Ethanol, ethyl alcohol*, methylcarbinol, alcohol
60. 1-Propanol, propyl alcohol*, *n*-propyl alcohol, ethylcarbinol
61. 2-Propanol, isopropyl alcohol*, dimethylcarbinol, *sec*-propyl alcohol, isopropanol

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Butyls

62. 1-Butanol, butyl alcohol*, *n*-butyl alcohol, butanol, butan-1-ol, *n*-propylcarbinol
63. 2-Butanol, *sec*-butyl alcohol*, methylethylcarbinol
64. 2-Methyl-1-propanol, isobutyl alcohol*, isobutanol, isopropylcarbinol
65. 2-Methyl-2-propanol, *tert*-butyl alcohol*, trimethylcarbinol

Pentyls

66. 1-Pentanol, pentyl alcohol*, amyl alcohol* (through 1961), pri-*n*-amyl alcohol, *n*-amyl alcohol, *n*-butylcarbinol
67. 2-Pentanol*, *sec*-amyl alcohol, *sec*-*n*-amyl alcohol, 1-methyl-1-butanol, methylpropylcarbinol
68. 3-Pentanol*, diethylcarbinol, 1-ethyl-1-propanol
69. 2-Methyl-1-butanol*, *act*-amyl alcohol, *d-pri-act*-amyl alcohol, *d-act*-butylcarbinol
70. 3-Methyl-1-butanol, isopentyl alcohol*, isoamyl alcohol* (through 1951), *pri*-isoamyl alcohol, isobutylcarbinol
71. 2-Methyl-2-butanol* (1952 through 1956), *tert*-pentyl alcohol*, *tert*-amyl alcohol* (through 1951), dimethylethylcarbinol
72. 3-Methyl-2-butanol*, *sec*-isoamyl alcohol, methylisopropylcarbinol
73. 2,2-Dimethyl-1-propanol*, neopentyl alcohol, neopentanol, *tert*-butylcarbinol

Other Aliphatic Alcohols

74. Cyclohexanol*, cyclohexyl alcohol, hexahydrophenol, Hexalin
75. 1-Hexanol, hexyl alcohol*, *n*-hexyl alcohol, amylcarbinol, pentylcarbinol
76. 2-Methyl-1-pentanol*,
77. 4-Methyl-2-pentanol*, methylamyl alcohol, methylisobutylcarbinol
78. 2-Ethyl-1-butanol*, *sec*-hexyl alcohol, 2-ethylbutyl alcohol, *pseudo*-hexyl alcohol

Methylcyclohexanols

79. 1-Methylcyclohexanol*
80. 2-Methylcyclohexanol* (mixed isomers), *o*-methylcyclohexyl alcohol
81. *cis*-2-Methylcyclohexanol*
82. *trans*-2-Methylcyclohexanol*
83. 3-Methylcyclohexanol* (mixed isomers), *m*-methylcyclohexyl alcohol

84. *cis*-3-Methylcyclohexanol*
85. *trans*-3-Methylcyclohexanol*
86. 4-Methylcyclohexanol* (mixed isomers), *p*-methylcyclohexyl alcohol
87. *cis*-4-Methylcyclohexanol*
88. *trans*-4-Methylcyclohexanol*

Other Aliphatic Alcohols

89. 2-Heptanol*, *n-sec*-heptyl alcohol, *n*-heptan-2-ol, *n*-heptanol-2, methylamylcarbinol
90. 1-Octanol, octyl alcohol*, caprylic alcohol, *n*-octyl alcohol, heptylcarbinol
91. 2-Ethyl-1-hexanol*, 2-ethylhexyl alcohol, 1-ethyl-*n*-amylcarbinol

Aromatic Alcohols

92. Benzyl alcohol*, phenylmethyl alcohol, α-hydroxytoluene, phenylcarbinol

Phenols

93. Phenol*, carbolic acid, hydroxybenzene, phenic acid

Cresols

94. *o*-Cresol*, *o*-cresylic acid, *o*-hydroxytoluene, *o*-methylphenol, 2-methylphenol, 1-hydroxy-2-methylbenzene
95. *m*-Cresol*, *m*-cresylic acid, *m*-hydroxytoluene, *m*-methylphenol, 3-methylphenol, 1-hydroxy-3-methylbenzene
96. *p*-Cresol*, *p*-cresylic acid, *p*-hydroxytoluene, *p*-methylphenol, 4-methylphenol, 1-hydroxy-4-methylbenzene

Unsaturated Alcohols

97. 2-Propen-1-ol, allyl alcohol*, propene(1)-ol(3), Δ^3-1-propenol, vinylcarbinol
98. *cis*-2-Buten-1-ol*, *cis*-crotonyl alcohol* (1917 through 1926), Δ^2-1-butenol* (through 1916), crotyl alcohol, γ-methylallyl alcohol, propenylcarbinol
99. *trans*-2-Buten-1-ol*
100. 2-Propyn-1-ol*, 2-propin-1-ol* (through 1936), propargylic alcohol* (through 1934), propargyl alcohol, acetylenecarbinol

POLYHYDRIC ALCOHOLS

101. *cis*-2-Butene-1,4-diol*
102. *trans*-2-Butene-1,4-diol*
103. 1,2-Ethanediol, ethyleneglycol*, glycol, ethylene alcohol, 1,2-dihydroxyethane
104. 1,2-Propanediol*, propylene glycol, α-propylene glycol, 1,2-dihydroxypropane
105. 1,3-Propanediol*, trimethylene glycol, isopropylene glycol
106. 1,3-Butanediol*, 1,3-butylene glycol
107. Glycerol*, 1,2,3-propanetriol, glycerin, 1,2,3-trihydroxypropane

ETHERS

Aliphatic, Open Chain Ethers

108. Ethylvinyl ether*, vinylethyl ether
109. Ethyl ether*, diethyl ether, ethoxyethane, ethyl oxide, sulfuric ether, 3-oxapentane, ether
110. Propyl ether*, di-*n*-propyl ether, 1-propoxypropane
111. Isopropyl ether*, diisopropyl ether, 2-isopropoxypropane
112. Butylvinyl ether*, vinylbutyl ether
113. Butylethyl ether*, *n*-butylethyl ether, 1-ethoxybutane
114. Butyl ether*, dibutyl ether, di-*n*-butyl ether, 1-butoxybutane
115. Pentyl ether*, amyl ether* (through 1951), *n*-amyl ether, di-*n*-amyl ether, 1-pentoxypentane
116. Isopentyl ether*, isoamyl ether* (through 1951), diisoamyl ether
117. 1,2-Dimethoxyethane*, *sym*-dimethoxyethane* (through 1941), monoglyme, dimethyl Cellosolve, ethylene glycol dimethyl ether
118. Bis(2-methoxyethyl) ether* (after 1940), diglyme, diethylene glycol dimethyl ether

Aliphatic Cyclic Ethers

119. Propylene oxide*, 1,2-epoxypropane, methyloxirane, propene oxide, 2-methyloxacyclopropane
120. 1,2-Epoxybutane*, ethylethylene oxide* (through 1931), ethyloxirane
121. Cineole*, 1,8-epoxy-*p*-menthane* (through 1961), cajeputole, eucalyptole, 1,3,3-trimethyl-2-oxabicyclo(2.2.2)octane
122. Furan*, furfuran, divinylene oxide, oxole, tetrole
123. Tetrahydrofuran*, oxacyclopentane, diethylene oxide, tetramethylene oxide

124. *p*-Dioxane*, diethylene dioxide, 1,4-dioxane
125. Tetrahydropyran*, pentamethylene oxide, oxacyclohexane

Aromatic Ethers

126. Benzylethyl ether*, α-ethoxytoluene
127. Anisole*, methoxybenzene, methylphenyl ether
128. Phenetole*, ethoxybenzene, ethylphenyl ether
129. Benzyl ether*, dibenzyl ether
130. Phenyl ether*, diphenyl ether, diphenyl oxide, phenoxybenzene
131. Veratrole* (through 1961), *o*-dimethoxybenzene*, 1,2-dimethoxybenzene

ACETALS

132. Dimethoxymethane*, methylal* (through 1961)
133. Acetal* (through 1961), acetaldehyde diethyl acetal*, 1,1-diethoxyethane, ethylidine diethyl ether

CARBONYLS

ALDEHYDES

Saturated Aliphatic Aldehydes

134. Acetaldehyde*, ethanal, acetic aldehyde
135. Propionaldehyde*, propanal, methylacetaldehyde
136. Butyraldehyde*, butanal, butaldehyde, butyral, butyric aldehyde
137. Isobutyraldehyde*, 2-methylpropanal, isobutylaldehyde

Aromatic Aldehydes

138. Benzaldehyde*, benzenecarbonal, oil of bitter almond

Unsaturated Aldehydes

139. Acrolein*, 2-propenal, acryl aldehyde, acrylic aldehyde, allyl aldehyde, ethylene aldehyde
140. Crotonaldehyde*, 2-butenal, *trans*-2-butenal, crotonic aldehyde, β-methylacrolein, propenaldehyde, propylene aldehyde

KETONES

Aliphatic Ketones

141. Acetone*, 2-propanone, dimethyl ketone, methyl ketone
142. 2-Butanone*, MEK, ethylmethyl ketone, methylethyl ketone

143. 3-Pentanone*, diethyl ketone, ethyl ketone, *sym*-dimethylacetone
144. Cyclohexanone*, cyclohexyl ketone, hexanon
145. 4-Methyl-2-pentanone*, MIBK, methylisobutyl ketone, isobutylmethyl ketone
146. Camphor, 2-camphanone, 2-bornanone, d-2-keto-1,7,7-trimethylnorcamphane

Aromatic Ketones

147. Acetophenone*, methylphenyl ketone, acetylbenzene, hypnone

ACIDS

Saturated Acids

148. Formic acid*, methanoic acid, aminic acid
149. Acetic acid*, ethanoic acid, ethylic acid, methylformic acid
150. Propionic acid*, propanoic acid, methylacetic acid
151. Butyric acid*, butanoic acid, *n*-butyric acid, ethylacetic acid
152. Isobutyric acid*, 2-methylpropionic acid, 2-methylpropanoic acid, dimethylacetic acid, α-methylpropionic acid, isopropylformic acid
153. Valeric acid*, pentanoic acid, *n*-valeric acid
154. Isovaleric acid*, 3-methylbutanoic acid, isopropylacetic acid, 3-methylbutyric acid, β-methylbutyric acid
155. Hexanoic acid*, caproic acid* (through 1950), capronic acid, *n*-hexoic acid, *n*-caproic acid, butylacetic acid
156. Octanoic acid*, caprylic acid* (through 1951)

Unsaturated Acids

157. Acrylic acid*, propenoic acid, acroleic acid, ethylenecarboxylic acid
158. Crotonic acid*, β-methylacrylic acid, *trans*-butenoic acid, α-crotonic acid
159. Methacrylic acid*, 2-methylpropenoic acid, α-methylacrylic acid
160. Oleic acid*, *cis*-octadecen(9)oic acid, *cis*-9-octadecenoic acid

ACID ANHYDRIDES

161. Acetic anhydride*, ethanoic anhydride
162. Propionic anhydride*, propanoic anhydride
163. Butyric anhydride*, butanoic anhydride

ESTERS

Esters of Saturated Aliphatic Monocarboxylic Acids

164. Methyl formate*, methyl methanoate
165. Ethyl formate*, ethyl methanoate
166. Propyl formate*, propyl methanoate
167. Butyl formate*, butyl methanoate
168. Isobutyl formate*, isobutyl methanoate, 2-methyl-1-propyl methanoate
169. Methyl acetate*, methyl ethanoate
170. Vinyl acetate*, ethenyl acetate, ethenyl ethanoate
171. Ethylene glycol diacetate*, glycol diacetate, ethylene acetate, ethylene diacetate
172. Ethyl acetate*, ethyl ethanoate, acetic ester, acetic ether
173. Propargyl acetate*, 2-propyn acetate, propiolic acetate
174. Allyl acetate*, 2-propenyl acetate
175. Propyl acetate*, propyl ethanoate, *n*-propyl acetate
176. Isopropyl acetate*, isopropyl ethanoate, 2-propyl ethanoate
177. Butyl acetate*, butyl ethanoate, butyl acetic ether
178. Isobutyl acetate*, isobutyl ethanoate, 2-methyl-1-propyl ethanoate, β-methylpropyl acetate
179. *sec*-Butyl acetate*, α-methylpropyl acetate, 2-butyl acetate
180. Pentyl acetate*, amyl acetate* (through 1960), pentyl ethanoate, amyl acetic ether, banana oil
181. Isopentyl acetate*, isoamyl acetate* (through 1951), 3-methylbutyl ethanoate, γ-methylbutyl ethanoate, 3-methyl-1-butyl acetate, amyl acetic ether
182. 2-Ethylhexyl acetate*, 2-ethylhexyl ethanoate
183. Benzyl acetate*, benzyl ethanoate
184. Ethyl propionate*, ethyl propanoate
185. Ethyl butyrate*, ethyl butanoate, butyric ether
186. Isobutyl isobutyrate*, 2-methyl-1-propyl 2-methylpropanoate
187. Ethyl isovalerate*, ethyl 3-methylbutanoate, ethyl isopropylacetate
188. Isopentyl isovalerate*, isoamyl isovalerate* (through 1951), 3-methylbutyl-3-methylbutanoate, 3-methyl-1-butyl isovalerate
189. Butyl stearate*, butyl octadecanoate

Esters of Unsaturated Aliphatic Monocarboxylic Acids

190. Methyl acrylate*, methyl propenoate, methyl 2-propenoate
191. Ethyl acrylate*, ethyl propenoate

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