SIXTH EDITION

PATTY'S TOXICOLOGY

VOLUME 2

EDITED BY

EULA BINGHAM

BARBARA COHRSSEN

WILEY

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Sixth Edition

Volume 2

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WILEY

A JOHN WILEY & SONS, INC., PUBLICATION

Published by John Wiley & Sons, Inc., Hoboken, New Jersey
Published simultaneously in Canada

Library of Congress Cataloging-in-Publication Data:

Patty's toxicology / edited by Eula Bingham, Barbara Cohrssen.— 6th ed.
p. ; cm.
Toxicology
Includes bibliographical references and indexes.
ISBN 978-0-470-41081-3 (cloth) – ISBN 978-1-118-16581-2 (v. 1) – ISBN 978-1-118-16580-5 (v. 2)
– ISBN 978-1-118-16579-9 (v. 3) – ISBN 978-1-118-16577-5 (v. 4) – ISBN 978-1-118-16578-2 (v. 5)
– ISBN 978-1-118-16576-8 (v. 6)
I. Bingham, Eula. II. Cohrssen, Barbara. III. Patty, F. A. (Frank Arthur), 1897–1981. IV. Title: Toxicology.
[DNLM: 1. Occupational Medicine. 2. Occupational Diseases. 3. Poisons. 4. Toxicology. WA 400]
613.6′2–dc23 2012002020

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

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Hydrocarbons
Organic Nitrogen Compounds

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Preface

In this Preface to the Sixth Edition, we acknowledge and note that it has been built on the work of previous editors. We especially need to note that Frank Patty's words in the Preface of the second edition are cogent:

> This book was planned as a ready, practical reference for persons interested in or responsible for safeguarding the health of others working with the chemical elements and compounds used in industry today. Although guidelines for selecting those chemical compounds of sufficient industrial importance for inclusion are not clearly drawn, those chemicals found in carload price lists seem to warrant first consideration.
>
> When available information is bountiful, an attempt has been made to limit the material presented to that of a practical nature, useful in recognizing, evaluating, controlling possible harmful exposures. Where the information is scanty, every fragment of significance, whether negative or positive, is offered the reader. The manufacturing chemist, who assumes responsibility for the safe use of his product in industry and who employs a competent staff to this end, as well as the large industry having competent industrial hygiene and medical staffs, are in strategic positions to recognize early and possibly harmful exposures in time to avoid any harmful effects by appropriate and timely action. Plant studies of individuals and their exposures regardless of whether or not the conditions caused recognized ill effects offer valuable experience. Information gleaned in this manner, though it may be fragmentary, is highly important when interpreted in terms of the practical health problem.

While we have not insisted that chemical selection be based on carload quantities, we have been most concerned about agents (chemical and physical) in the workplace that are toxicological concerns for workers. We have attempted to follow the guide as expressed by Frank Patty in 1962 regarding practical information.

This edition includes toxicological information on flavorings, metal working fluids, pharmaceuticals, and nanoparticles which were not previously covered, and reflects our concern with their technology and potential for adverse health effects in workers. It also continues to include the toxicology of physical and biological agents which were in the Fifth Edition. In the workplace of this new century, physical agents and human factors continue to be of concern as well as, nanotechnology. Traditionally, the agents or factors such as ergonomics, biorhythms, vibration, heat and cold stress were centered on how one measures them. Today, understanding the toxicology of these agents (factors) is of great importance because it can assist in the anticipation, recognition, evaluation and control of them. The mechanisms of actions and the assessment of the adverse health effects are as much a part of toxicology as dusts and heavy metals. As noted in Chapter 74 in Volume 5, the trend in toxicology is increasingly focused on molecular biology, mechanisms of action, and, molecular genetics.

The thinking and planning of this edition was a team effort by Barbara and Eula based on the framework that was established for the Fifth Edition by us and Charles H. Powell who died in September 1998. The three of us have had a long professional association with the Kettering Laboratory: Charles H. Powell received his ScD., Barbara Cohrssen received a MS, and Eula Bingham, has been a lifetime faculty member. Many of the authors were introduced to us through this relationship and association.

We are grateful for the help of our expert contributors, many of whom we have known for 10, 20 or 30 years, to complete this edition. The team effort was fostered between the current editors by many of the first contributors to Patty's such as Robert A. Kehoe, Francis F. Heyroth, William B. Deichmann, and Joseph Treon, all of whom were at the University of Cincinnati, Kettering Laboratory, sometime during their professional lives.

The authors have performed a difficult task in a short period of time for a publication that is as comprehensive as this one is. We want to thank Meghan Lobaugh whose assistance is greatly appreciated. We would like to express our deep appreciation and thanks to everyone who has helped us with this publication.

EULA BINGHAM, Ph.D

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San Francisco, California

USEFUL EQUIVALENTS AND CONVERSION FACTORS

1 kilometer = 0.6214 mile
1 meter = 3.281 feet
1 centimeter = 0.3937 inch
1 micrometer = 1/25,4000 inch = 40 microinches = 10,000 Angstrom units
1 foot = 30.48 centimeters
1 inch = 25.40 millimeters
1 square kilometer = 0.3861 square mile (U.S.)
1 square foot = 0.0929 square meter
1 square inch = 6.452 square centimeters
1 square mile (U.S.) = 2,589,998 square meters = 640 acres
1 acre = 43,560 square feet = 4047 square meters
1 cubic meter = 35.315 cubic feet
1 cubic centimeter = 0.0610 cubic inch
1 cubic foot = 28.32 liters = 0.0283 cubic meter = 7.481 gallons (U.S.)
1 cubic inch = 16.39 cubic centimeters
1 U.S. gallon = 3,7853 liters = 231 cubic inches = 0.13368 cubic foot
1 liter = 0.9081 quart (dry), 1.057 quarts (U.S., liquid)
1 cubic foot of water = 62.43 pounds (4°C)
1 U.S. gallon of water = 8.345 pounds (4°C)
1 kilogram = 2.205 pounds
1 gram = 15.43 grains
1 pound = 453.59 grams
1 ounce (avoir.) = 28.35 grams
1 gram mole of a perfect gas ≈ 24.45 liters (at 25°C and 760 mm Hg barometric pressure)
1 atmosphere = 14.7 pounds per square inch
1 foot of water pressure = 0.4335 pound per square inch
1 inch of mercury pressure = 0.4912 pound per square inch
1 dyne per square centimeter = 0.0021 pound per square foot
1 gram-calorie = 0.00397 Btu
1 Btu = 778 foot-pounds
1 Btu per minute = 12.96 foot-pounds per second
1 hp = 0.707 Btu per second = 550 foot-pounds per second
1 centimeter per second = 1.97 feet per minute = 0.0224 mile per hour
1 footcandle = 1 lumen incident per square foot = 10.764 lumens incident per square meter
1 grain per cubic foot = 2.29 grams per cubic meter
1 milligram per cubic meter = 0.000437 grain per cubic foot

To convert degrees Celsius to degrees Fahrenheit: °C (9/5) + 32 = °F
To convert degrees Fahrenheit to degrees Celsius: (5/9) (°F − 32) = °C
For solutes in water: 1 mg/liter ≈ 1 ppm (by weight)
Atmospheric contamination: 1 mg/liter ≈ 1 oz/1000 cu ft (approx)
For gases or vapors in air at 25°C and 760 mm Hg pressure:
To convert mg/liter to ppm (by volume): mg/liter (24,450/mol. wt.) = ppm
To convert ppm to mg/liter: ppm (mol. wt./24,450) = mg/liter

CONVERSION TABLE FOR GASES AND VAPORS[a]

(Milligrams per liter to parts per million, and vice versa; 25°C and 760 mm Hg barometric pressure)

Molecular Weight	1 mg/liter ppm	1 ppm mg/liter	Molecular Weight	1 mg/liter ppm	1 ppm mg/liter	Molecular Weight	1 mg/liter ppm	1 ppm mg/liter
1	24,450	0.0000409	39	627	0.001595	77	318	0.00315
2	12,230	0.0000818	40	611	0.001636	78	313	0.00319
3	8,150	0.0001227	41	596	0.001677	79	309	0.00323
4	6,113	0.0001636	42	582	0.001718	80	306	0.00327
5	4,890	0.0002045	43	569	0.001759	81	302	0.00331
6	4,075	0.0002454	44	556	0.001800	82	298	0.00335
7	3,493	0.0002863	45	543	0.001840	83	295	0.00339
8	3,056	0.000327	46	532	0.001881	84	291	0.00344
9	2,717	0.000368	47	520	0.001922	85	288	0.00348
10	2,445	0.000409	48	509	0.001963	86	284	0.00352
11	2,223	0.000450	49	499	0.002004	87	281	0.00356
12	2,038	0.000491	50	489	0.002045	88	278	0.00360
13	1,881	0.000532	51	479	0.002086	89	275	0.00364
14	1,746	0.000573	52	470	0.002127	90	272	0.00368
15	1,630	0.000614	53	461	0.002168	91	269	0.00372
16	1,528	0.000654	54	453	0.002209	92	266	0.00376
17	1,438	0.000695	55	445	0.002250	93	263	0.00380
18	1,358	0.000736	56	437	0.002290	94	260	0.00384
19	1,287	0.000777	57	429	0.002331	95	257	0.00389
20	1,223	0.000818	58	422	0.002372	96	255	0.00393
21	1,164	0.000859	59	414	0.002413	97	252	0.00397
22	1,111	0.000900	60	408	0.002554	98	249.5	0.00401
23	1,063	0.000941	61	401	0.002495	99	247.0	0.00405
24	1,019	0.000982	62	394	0.00254	100	244.5	0.00409
25	978	0.001022	63	388	0.00258	101	242.1	0.00413
26	940	0.001063	64	382	0.00262	102	239.7	0.00417
27	906	0.001104	65	376	0.00266	103	237.4	0.00421
28	873	0.001145	66	370	0.00270	104	235.1	0.00425
29	843	0.001186	67	365	0.00274	105	232.9	0.00429
30	815	0.001227	68	360	0.00278	106	230.7	0.00434
31	789	0.001268	69	354	0.00282	107	228.5	0.00438
32	764	0.001309	70	349	0.00286	108	226.4	0.00442
33	741	0.001350	71	344	0.00290	109	224.3	0.00446
34	719	0.001391	72	340	0.00294	110	222.3	0.00450
35	699	0.001432	73	335	0.00299	111	220.3	0.00454
36	679	0.001472	74	330	0.00303	112	218.3	0.00458
37	661	0.001513	75	326	0.00307	113	216.4	0.00462
38	643	0.001554	76	322	0.00311	114	214.5	0.00466

CONVERSION TABLE FOR GASES AND VAPORS *(Continued)*

(Milligrams per liter to parts per million, and vice versa; 25°C and 760 mm Hg barometric pressure)

Molecular Weight	1 mg/liter ppm	1 ppm mg/liter	Molecular Weight	1 mg/liter ppm	1 ppm mg/liter	Molecular Weight	1 mg/liter ppm	1 ppm mg/liter
115	212.6	0.00470	153	159.8	0.00626	191	128.0	0.00781
116	210.8	0.00474	154	158.8	0.00630	192	127.3	0.00785
117	209.0	0.00479	155	157.7	0.00634	193	126.7	0.00789
118	207.2	0.00483	156	156.7	0.00638	194	126.0	0.00793
119	205.5	0.00487	157	155.7	0.00642	195	125.4	0.00798
120	203.8	0.00491	158	154.7	0.00646	196	124.7	0.00802
121	202.1	0.00495	159	153.7	0.00650	197	124.1	0.00806
122	200.4	0.00499	160	152.8	0.00654	198	123.5	0.00810
123	198.8	0.00503	161	151.9	0.00658	199	122.9	0.00814
124	197.2	0.00507	162	150.9	0.00663	120	122.3	0.00818
125	195.6	0.00511	163	150.0	0.00667	201	121.6	0.00822
126	194.0	0.00515	164	149.1	0.00671	202	121.0	0.00826
127	192.5	0.00519	165	148.2	0.00675	203	120.4	0.00830
128	191.0	0.00524	166	147.3	0.00679	204	119.9	0.00834
129	189.5	0.00528	167	146.4	0.00683	205	119.3	0.00838
130	188.1	0.00532	168	145.5	0.00687	206	118.7	0.00843
131	186.6	0.00536	169	144.7	0.00691	207	118.1	0.00847
132	185.2	0.00540	170	143.8	0.00695	208	117.5	0.00851
133	183.8	0.00544	171	143.0	0.00699	209	117.0	0.00855
134	182.5	0.00548	172	142.2	0.00703	210	116.4	0.00859
135	181.1	0.00552	173	141.3	0.00708	211	115.9	0.00863
136	179.8	0.00556	174	140.5	0.00712	212	115.3	0.00867
137	178.5	0.00560	175	139.7	0.00716	213	114.8	0.00871
138	177.2	0.00564	176	138.9	0.00720	214	114.3	0.00875
139	175.9	0.00569	177	138.1	0.00724	215	113.7	0.00879
140	174.6	0.00573	178	137.4	0.00728	216	113.2	0.00883
141	173.4	0.00577	179	136.6	0.00732	217	112.7	0.00888
142	172.2	0.00581	180	135.8	0.00736	218	112.2	0.00892
143	171.0	0.00585	181	135.1	0.00740	219	111.6	0.00896
144	169.8	0.00589	182	134.3	0.00744	220	111.1	0.00900
145	168.6	0.00593	183	133.6	0.00748	221	110.6	0.00904
146	167.5	0.00597	184	132.9	0.00753	222	110.1	0.00908
147	166.3	0.00601	185	132.2	0.00757	223	109.6	0.00912
148	165.2	0.00605	186	131.5	0.00761	224	109.2	0.00916
149	164.1	0.00609	187	130.7	0.00765	225	108.7	0.00920
150	163.0	0.00613	188	130.1	0.00769	226	108.2	0.00924
151	161.9	0.00618	189	129.4	0.00773	227	107.7	0.00928
152	160.9	0.00622	190	128.7	0.00777	228	107.2	0.00933

CONVERSION TABLE FOR GASES AND VAPORS (*Continued*)

(Milligrams per liter to parts per million, and vice versa; 25°C and 760 mm Hg barometric pressure)

Molecular Weight	1 mg/liter ppm	1 ppm mg/liter	Molecular Weight	1 mg/liter ppm	1 ppm mg/liter	Molecular Weight	1 mg/liter ppm	1 ppm mg/liter
229	106.8	0.00937	253	96.6	0.01035	227	88.3	0.01133
230	106.3	0.00941	254	96.3	0.01039	278	87.9	0.01137
231	105.8	0.00945	255	95.9	0.01043	279	87.6	0.01141
232	105.4	0.00949	256	95.5	0.01047	280	87.3	0.01145
233	104.9	0.00953	257	95.1	0.01051	281	87.0	0.01149
234	104.5	0.00957	258	94.8	0.01055	282	86.7	0.01153
235	104.0	0.00961	259	94.4	0.01059	283	86.4	0.01157
236	103.6	0.00965	260	94.0	0.01063	284	86.1	0.01162
237	103.2	0.00969	261	93.7	0.01067	285	85.8	0.01166
238	102.7	0.00973	262	93.3	0.01072	286	85.5	0.01170
239	102.3	0.00978	263	93.0	0.01076	287	85.2	0.01174
240	101.9	0.00982	264	92.6	0.01080	288	84.9	0.01178
241	101.5	0.00986	265	92.3	0.01084	289	84.6	0.01182
242	101.0	0.00990	266	91.9	0.01088	290	84.3	0.01186
243	100.6	0.00994	267	91.6	0.01092	291	84.0	0.01190
244	100.2	0.00998	268	91.2	0.01096	292	83.7	0.01194
245	99.8	0.01002	269	90.9	0.01100	293	83.4	0.01198
246	99.4	0.01006	270	90.6	0.01104	294	83.2	0.01202
247	99.0	0.01010	271	90.2	0.01108	295	82.9	0.01207
248	98.6	0.01014	272	89.9	0.01112	296	82.6	0.01211
249	98.2	0.01018	273	89.6	0.01117	297	82.3	0.01215
250	97.8	0.01022	274	89.2	0.01121	298	82.0	0.01219
251	97.4	0.01027	275	88.9	0.01125	299	81.8	0.01223
252	97.0	0.01031	276	88.6	0.01129	300	81.5	0.01227

[a] A. C. Fieldner, S. H. Katz, and S. P. Kinney, "Gas Masks for Gases Met in Fighting Fires," *U.S. Bureau of Mines, Technical Paper No. 248*, 1921.

PATTY'S TOXICOLOGY

Sixth Edition

Volume 2

Hydrocarbons
Organic Nitrogen Compounds

Contents

Aliphatic Hydrocarbons

Tania Carreón, Ph.D. and Robert L. Herrick, MS

Aliphatic hydrocarbons are open-chain compounds that may be saturated or unsaturated. The saturated compounds, known as *paraffin hydrocarbons* or *alkanes*, include methane and its homologs having the empirical formula C_nH_{2n+2}. The unsaturated compounds fall into a number of homologous series: (*1*) those containing one double bond (ethylene and its homologs) and having the formula C_nH_{2n} are known as *olefins* or *alkenes*; (*2*) those containing one triple bond (acetylene and its homologs) are called *acetylenes* or *alkynes* and have the formula C_nH_{2n-2}; (*3*) those having two double bonds (allene, 1,3-butadiene, and 1,4-pentadiene represent three types) are *diolefins* or *alkadienes* and also have the formula C_nH_{2n-2}; (*4*) those having a large number of double or triple bonds or both double and triple bonds are named in analogous fashion as *alkatrienes*, *alkatetraenes*, *alkadiynes*, *alkenynes*, and *alkadienynes*.

Aliphatic hydrocarbons are asphyxiants and central nervous system (CNS) depressants. Serious toxic effects of aliphatic hydrocarbons include asphyxia and chemical pneumonitis for many paraffins, axonal neuropathy for *n*-hexane, and cancer for 1,3-butadiene.

ALKANES (SATURATED HYDROCARBONS, PARAFFINS)

The alkanes have the generic formula of C_nH_{2n+2}. All the carbons have single covalent bonds between them. They are also called *saturated hydrocarbons*, which means that all the carbons have the maximum number of bonds (four). The alkane series is composed of gases (methane, ethane, propane, and butanes), liquids from pentanes (C5–C16 compounds), and longer chain solids (1).

The toxicity of the alkanes is generally related to vapor pressure, viscosity, surface tension, and lipid solubility. Physical properties of saturated aliphatic hydrocarbons are listed in Table 27.1.

In general, the saturated hydrocarbons from propane through the octanes show increasingly narcotic properties. The onset of narcosis is above the lower flammability point for methane, ethane, and propane, at the lower flammability limit for butanes, and generally below the lower flammability limit for higher order saturated hydrocarbons (2). The margin between narcosis and lethal depression of vital centers is too narrow, and because of their explosive characteristics, these compounds are not used as surgical anesthetics. Narcotic effects may be accompanied by exhilaration, dizziness, and headache (1).

Virtually all paraffins will cause nausea, vomiting, abdominal pain, and occasionally diarrhea when ingested (3–5). Dermatitis, CNS depression, anesthesia, and cardiac sensitization have also been noted for many paraffins. Acutely, the most common toxic effects are CNS depression, asphyxia, or ventricular tachycardia following inhalation and chemical pneumonitis after the aspiration of ingested alkanes. Asphyxia occurs when the oxygen in air is displaced by high concentrations of a gas or vapor. When the oxygen concentration is lowered from ambient levels to $\leq 10\%$, hypoxia results and the body is starved for oxygen. At this level of oxygen deprivation, death occurs swiftly. Ventricular tachycardia occurs due to the sensitization of the heart to epinephrine following saturated alkane exposure. The mechanism of this cardiac sensitization is not well understood and most research on epinephrine-induced tachycardia after exposure to volatile chemicals has focused on halocarbons, not saturated alkanes (6, 7). Whether saturated alkanes work through similar or different mechanisms is not known.

Patty's Toxicology, Sixth Edition. Volume 2, Edited by Eula Bingham and Barbara Cohrssen.

Dermal irritation and CNS depression are common problems with liquid aliphatic hydrocarbons in chronic exposures. Dermal irritation occurs in workers repeatedly exposed to liquid hydrocarbons as solvents. The paraffins are lipid solvents and dissolve or extract the fats from the skin, resulting in painful drying and cracking of the skin, that is, chronic eczematoid dermatitis, with itching and inflammation.

CNS depression occurs as the inhaled vapor or gas crosses the alveolar–capillary membrane to be absorbed into the bloodstream. At levels that cause CNS depression, the lung itself is spared injury (3–5). The CNS depressant properties of some alkanes have led to substance abuse in the form of "glue sniffing," usually toluene or *n*-hexane. Other abusers have utilized gasoline; paints containing solvents such as xylene, methyl ethyl ketone, acetone, ethyl acetate, ethyl benzene, and isobutyl acetate; typewriter correction fluids; aerosol can propellants, including propane, butane, and isobutane; and exhaust emissions. Abusers often exhibit a drunken appearance and suffer from learning or memory impairment, personality disorders, seizures, neuropsychological disorders, and tachycardia (3–5).

In general, branched-chain derivatives are less toxic than the corresponding parent straight-chain alkanes. Odorant properties increase whereas analgesic properties decrease with the increasing chain length. Both dermal and pulmonary irritant properties increase with increasing chain length up to C14 derivatives (8).

1.0 Methane

1.0.1 CAS Number

[*74–82-8*]

1.0.2 Synonyms

Methyl hydride; fire damp; marsh gas; biogas; natural gas; fire damp; r 50 (refrigerant); methane, various grades

1.0.3 Trade Names

NA

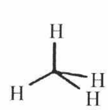
1.0.4 Molecular Weight

16.042

1.0.5 Molecular Formula

CH_4

1.0.6 Molecular Structure



1.1 Chemical and Physical Properties

1.1.1 General

Methane, CH_4, is a colorless, extremely flammable, and explosive gas that occurs in natural gas (9). Its specific gravity is 0.72, and its vapor pressure is 760 Torr. Measurements of the partition coefficient of methane between olive oil and air (a measure of the solubility of a gas in blood) at 37°C range between 0.31 and 0.89 (2, 10). Selected physical and chemical properties are presented in Table 27.1.

1.1.2 Odor and Warning Properties

Methane has a sweet, oil-like odor (11). An odor threshold of 200 ppm has been reported (12).

1.2 Production and Use

Methane is the end product of anaerobic decay. It is the major constituent of natural gas, present at concentrations between 600,000 and 800,000 ppm 60 to 80% of natural gas. Methane collects in coal mines or geologically similar earth deposit sites, evolves as marsh gas, and forms during certain fermentation and sludge degradation processes. Methane is also produced by decomposition in municipal landfills; concentrations can be as high as 250,000 ppm. It is often accompanied by other low molecular weight hydrocarbons (11).

Major uses of methane include power generation and chemical production. Methane gas is used as a power source in sewage treatment plants. Methane is used in the manufacture of methanol, hydrogen, hydrogen cyanide, halogenated hydrocarbons, ammonia, and acetylene. Methane is a source of petrochemicals by conversion to hydrogen and carbon monoxide and a starting material for the manufacture of synthetic proteins (13–15).

Methane is a major constituent of natural gas, which is used for power generation, chemical feedstocks, cooking and residential heating. Residential and commercial use of natural gas comprises nearly half the total sales. The second most common use of natural gas is petroleum and polymer intermediate production (11).

1.3 Exposure Assessment

1.3.1 Air

Headspace gas chromatography is used to determine the concentration of methane in the atmosphere. Detector tubes using a colorimetric assay and direct reading instruments (e.g., flame ionization detection, catalytic combustion, and thermal conductivity detection) are also used to determine methane concentrations in the air (13). A hydrocarbon fast-response gas sensor has been developed to measure methane in liquefied natural-gas spills (16).

Table 27.1. Physicochemical Properties of Alkanes

Compound	Molecular Formula	Molecular Weight	Boiling Point (°C)	Melting Point (°C)	Density (mg/cm^3) (at °C)	Refractive Index (n_D)	Solubility	Flash Point (°C)	Flammability Limits (%)
Methane	CH_4	16.042	−161.5	−182.5	0.4228 (−162)	–	w 3, al 3, et 3, ac 2	−187.8 (open cup)	5.0–15.0
Ethane	C_2H_6	30.07	−88.63	−183.23	0.5446 (−89)	–	bz 4	−135	3.0–12.5
Propane	C_3H_8	44.09	−42.1	−187.7	0.493 (25)	–	w 3, al 3, et 4, ac 2	−104.0	2.1–9.5
Butane	C_4H_{10}	58.12	−0.5	−138.35	0.573 (25)	1.3326 (20)	w 3, al 4, et 4, ch 4	−60.0 (closed cup)	1.9–8.5
2-Methylpropane	C_4H_{10}	58.12	−11.7	−159.6	0.5510 (25)	1.3518 (−25)	w 2, al 3, et 3, ch 3	−82.8 (closed cup)	1.8–8.4
Pentane	C_5H_{12}	72.15	36.1	−129.8	0.6262 (20)	1.3575 (20)	w 2, al 5, et 5, ac 5	−49.0	1.4–8.0
2-Methylbutane	C_5H_{12}	72.15	27.8	−159.8	0.6201 (20)	1.3537 (20)	w 1, al 5, et 5	−51.0	1.4–7.6
2,2-Dimethylbutane	C_6H_{14}	86.177	49.7	−100	0.6444 (25)	1.3688 (20)	w 1, al 3, et 3, ac 4	−48.0	1.2–7.0
2,3-Dimethylbutane	C_6H_{14}	86.177	58	−128.5	0.6616 (20)	1.3750 (20)	w 1, al 3, et 3, ac 4	−29.0	1.2–7.0
2,2-Dimethylpropane	C_5H_{12}	72.15	9.5	−16.6	0.5258 (25)	1.3476 (6)	w 1, al 3, et 3, ct 3	−6.67	1.4–7.5
Hexane	C_6H_{14}	86.10	68.95	−95	0.6548 (25)	1.3749 (20)	w 1, al 4, et 3, ch 3	−22.0 (closed cup)	1.1–7.5
2-Methylpentane	C_6H_{14}	86.177	62	−154	0.650 (25)	1.3715 (20)	w 1, al 3, et 3, ac 5	−23.0	1.0–7.0
3-Methylpentane	C_6H_{14}	86.177	64	−118.0	0.6598 (25)	1.3765 (20)	w 1, al 3, et 5, ac 5	−6.0	1.2–7.0
Heptane	C_7H_{16}	100.20	98.4	−90.7	0.6837 (20)	1.3878 (20)	w 1, al 4, et 5, ac 5	−4.4 (closed cup)	1.05–6.7
2-Methylhexane	C_7H_{16}	100.20	90.0	−118.2	0.6787 (20)	1.3848 (20)	w 1, al 3, et 5, ac 5	−1.0	1.0–6.0
3-Methylhexane	C_7H_{16}	100.20	92.0	−119.0	0.6860 (20)	1.3887 (20)	w 1, al 3, et 5, ac 5	−4.0	–
Octane	C_8H_{18}	114.22	125.7	−56.8	0.6986 (25)	1.3974 (20)	w 1, al 3, et 3, ac 5	−13.0 (closed cup) 22 (open cup)	1.0–6.5
2,5-Dimethylhexane	C_8H_{18}	114.23	109.1	−91.0	0.6901 (25)	1.3925 (20)	w 1, al 5, et 3, ac 5	–	–
2,2,4-Trimethylpentane	C_8H_{18}	114.22	99.2	−116	0.6877 (25)	1.3915 (20)	w 1, al 5, et 3, ac 5	−12.0	–
2,3,4-Trimethylpentane	C_8H_{18}	114.23	113.5	−109.2	0.7191 (20)	1.4042 (20)	w 1, al 4, et 5, ac 5	−12.0	–
Nonane	C_9H_{20}	128.26	150.8	−53.5	0.7176 (20)	1.4054 (20)	w 1, al 4, et 4, ac 5	31.0	0.8–2.9
2,2,5-Trimethylhexane	C_9H_{20}	128.26	124.0	−105.7	0.7072 (20)	1.3997 (20)	w 1, al 4, et 4, ac 4	13.0	–
Decane	$C_{10}H_{22}$	142.28	174.1	−29.7	0.7300 (20)	1.4102 (20)	w 1, al 5, et 3, ct 2	46	0.8–5.4
2,7-Dimethyloctane	$C_{10}H_{22}$	142.28	159.9	−54.9	0.7202 (25)	1.4086 (20)	et 3, aa 3	–	–
Undecane	$C_{11}H_{24}$	156.31	195.9	−25.59	0.7402 (20)	1.4398 (20)	w 1, al 5, et 5	60.0	–
Dodecane	$C_{12}H_{26}$	170.34	216.3	−9.6	0.7487 (20)	1.4216 (20)	w 1, al 4, et 4, ac 4	71.0	0.6–?
Tridecane	$C_{13}H_{28}$	184.36	235.4	−5.5	0.7564 (20)	1.4256 (20)	w 1, al 4, et 4, ct 3	79.0	–
Tetradecane	$C_{14}H_{30}$	198.39	253.7	5.89	0.7628 (20)	1.4290 (20)	w 1, al 4, et 4, ct 3	99	0.5–?
Pentadecane	$C_{15}H_{32}$	212.42	270.63	9.9	0.7685 (20)	1.4315 (20)	w 1, al 4, et 4	132	–
Hexadecane	$C_{16}H_{34}$	226.44	287	18.17	0.7733 (20)	1.4345 (20)	w 1, al 2, et 5, ct 3	135	–
Heptadecane	$C_{17}H_{36}$	240.47	302.0	22.0	0.7780 (20)	1.4369 (20)	w 1, al 2, et 3, ct 2	–	–
Octadecane	$C_{18}H_{38}$	254.50	316.3	28.2	0.7768 (28)	1.4390 (20)	w 1, al 2, et 3, ac 3	> 100.0	–
Nonadecane	$C_{19}H_{40}$	268.53	329.9	32.1	0.7855 (20)	1.4409 (20)	w 1, al 2, et 3, ac 3	–	–
Pristane	$C_{19}H_{40}$	268.53	296.0	–	0.783 (20)	1.4379 (20)	et 4, bz 4, ch 4, pe 4	–	–
Eicosane	$C_{20}H_{42}$	282.55	343.0	36.8	0.7886 (20)	1.4425 (20)	w 1, et 3, ac 4, bz 3	> 100.0	–

Molecular formula, in Hill notation; molecular weight, relative molar mass; density, mass per unit volume in g/cm^3 at the temperature indicated in parentheses; refractive index, at the temperature indicated in parentheses, unless otherwise indicated, all values refer to a wavelength of 589 nm; solubility, solubility in common solvents (w, water; al, ethanol; et, ethyl ether; ac, acetone; bz, benzene; ch, chloroform; ct, carbon tetrachloride; aa, acetic acid; pe, petroleum ether; os, organic solvents) on a relative scale: 1 = insoluble, 2 = slightly soluble, 3 = soluble, 4 = very soluble, 5 = miscible, 6 = decomposes; flammability limits, explosive limits (in percent by volume) at ambient temperature and pressure.