SPEX CertiPrep App Note

History of Pesticides and Pesticide Solubility

Modern pesticides are a product of the birth of the first synthetic organic chemicals (organochloride compounds) in the late 19th and early 20th centuries. Many organochloride compounds, such as BHC and DDT, were first synthesized in the 1800s', but their properties as insecticides were not fully discovered and exploited until the late 1930's. The organochloride class of pesticides grew out of those initial discoveries and, through the 1930's-1970's, developed into the range of organochloride pesticides known today.

Primarily, there are two groups of organochloride pesticides: chlorinated alicyclic and cyclodiene compounds (aldrin, dieldrin, endrin, heptachlor, chlordane, and endosulfan), and the DDT compounds (DDD, DDE, etc.). The discovery of DDT for pesticide use was a huge boon to the war efforts. Prior to the discovery of DDT, pyrethrins were one of the major insecticides in use. However, pyrethrins were extracted from natural sources, primarily from flowers of the genus Chrysanthemum (Pyrethrum), supplies of which were limited and could not meet demands of wartime needs.

At the time, DDT was seen as a broad spectrum insecticide with low toxicity to mammals. DDT targets the peripheral nervous system of invertebrates and is insoluble in water and thereof was not washed away by weather making reapplication unnecessary. Early pesticide development saw limited solubility in water and persistence as beneficial traits in a pesticide. It allowed the pesticide to stay where it was applied for a long period of time. These traits also allowed bioaccumulation over the decades in highly soluble lipid tissues of higher animals.

By 1945, DDT was made available for agricultural applications. By the 1950's, the first signs of insect resistance to DDT began to appear. DDT was in widespread use around the world until the 1970's and 1980's. The EPA canceled most uses of DDT by 1972 due to impact of bioaccumulation on higher animals and the environment. Many other countries shortly followed suit by removing DDT from most agricultural applications.

Since the start of the production boom in the 1940's to present day, a huge catalog of thousands of insecticides, herbicides, and general pesticides was developed, including organochlorides (DDT, BHC), organophosphates (parathion, malathion, azinphos methyl), carbamates (aldicarb, carbofuran, etc.), and neonicotinoids (imidacloprid & acetamiprid). As modern pesticides develop there has been a shift to understand and apply the chemical properties and interactions of pesticides with both the environment and animals other than the target pests. Early pesticides were, for the most part, persistent chemicals that affected the nervous system of invertebrates. These pesticides had, in many cases, limited solubility and persisted for years or decades after delivery. More modern pesticides take into consideration the half-life of pesticides and how they degrade in the environment.

One of the more modern developments in the pesticide arsenal is the synthetic nicotinoids and neonicotinoids. These pesticides are neuro-active insecticides, similar to nicotine compounds, and were developed in the 1980's and 1990's. Of all of the neonicotinoids, imidacloprid has become one of the most abundantly used insecticides in the world. Imidacloprid works by disrupting the transmission of nerve impulses in insects by binding to an insect's nicotine acetylcholine receptors in paralysis and death of the insect. Imidacloprid is highly toxic to insects and other arthropods, including marine invertebrates. It is considered to be moderately toxic to mammals, if ingested at high dosages. The acute toxicity and environmental fate of imidacloprid and other neonicotinoid pesticides have been greatly debated since their adaptation in the 1990's. Many studies question the persistence of neonicotinoids in water supplies and the ecological impacts to other environmentally and economically important arthropods.

Chemical pesticides are now an integral part of the world's agricultural arsenal, offering protection to crops from destructive pests. However, some disastrous side effects of their use include probable leaching of these often harmful chemicals into the environment and their ultimate presence in the human food chain. Because of this, pesticide residue analysis has become a serious testing process for several different types of laboratories. Each pesticide group in historical or modern use has their own set of physical and chemical properties which can make pesticide analysis a challenge. Some pesticides have low solvent solubility, making them difficult to place in solution (see Pesticide Chemical Property Tables below). Other pesticides degrade at lower temperatures which makes them only amenable to specific analytical applications such as LC/MS. SPEX CertiPrep has compiled the common properties and solubilities for the most common pesticide groups in order to aid in your pesticide analysis.

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≥ 1000	Excellent Solubility
< 1000	Good Solubility
< 500	Moderate Solubility
< 100	Low Solubility
< 10	Insoluble

Red text – SPEX data shows minimum solubility @ 1,000 µg/mL
Yellow text – Minimum solubility based on similar solvents cited
N/D – No Data

	Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
MW	18.02	58.05	32.04	41.05	88.11	84.93	86.18
UV cutoff (nm)	200	330	205	190	260	235	200
BP (°C @ 1 atm)	100.0	56.1	64.7	81.6	77.1	39.5	69.0
Polarity index (Snyder)	9.0	5.1	5.1	5.8	4.4	3.1	0.0
Viscosity (cP)	1.00	0.32	0.60	0.37	0.45	0.44	0.33
Solubility in Water (% wt/wt)	100 %	100%	100%	100%	9%	2%	0%

Carbamates

Compound	CAS #	MW	Class	Molecular Formula	BP (°C @ 1 atm)	MP (°C @ 1 atm)	Density (g/cm³ @ 20°C)	Color	Form	Solubility: Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
Aldicarb	116-06-3	190.3	Acaricide	$C_7H_{14}N_2O_2S$	Decomposes	99 °C	1.20	Colorless to White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Aldicarb sulfone	1646-88-4	222.3	Insecticide	$C_7H_{14}N_2O_4S$	N/D	141 °C	1.35	White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Aldicarb sulfoxide	1646-87-3	206.3	Metabolite	$C_7H_{14}N_2O_3S$	N/D	N/D	1.21	White	Powder Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D	N/D	N/D
Baygon	114-26-1	209.2	Insecticide	$C_{11}H_{15}NO_3$	Decomposes	90 °C	1.18	White to Tan	Crystalline or Waxy Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Carbaryl	63-25-2	201.2	Insecticide	$C_{12}H_{11}NO_2$	210 °C	138 °C	1.21	White or Gray	Crystalline Solid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Carbofuran	1563-66-2	221.3	Acaricide	$C_{12}H_{15}NO_3$	254 °C	153 °C	1.26	White	Crystalline Solid	< 500	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Chlorpropham	101-21-3	213.7	Herbicide	$C_{10}H_{12}ClNO_2$	256 °C	36 °C	1.18	White to Brown	Crystalline Solid	< 500	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Fenobucarb (BPMC)	3766-81-2	207.3	Insecticide	$C_{12}H_{17}NO_2$	Decomposes	31 °C	1.04	Yellow	Oily Liquid	<1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Fenoxycarb	79127-80-3	301.3	Insecticide	$C_{17}H_{19}NO_4$	100 °C	54 °C	1.23	White	Flaky Powder or Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Isoprocarb (MIPC)	2631-40-5	193.2	Insecticide	$C_{11}H_{15}NO_2$	N/D	92 °C	1.04	Colorless	Crystalline Solid	< 500	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Methiocarb	2032-65-7	225.3	Insecticide	$C_{11}H_{15}NO_2S$	311 °C	118 °C	1.25	Colorless to White	Crystalline Solid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Methomyl	16752-77-5	162.2	Insecticide	$C_5H_{10}N_2O_2S$	Decomposes	90 °C	1.32	White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Oxamyl	23135-22-0	219.3	Insecticide	$C_7H_{13}N_3O_3S$	Decomposes	99 °C	1.31	Colorless to White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Pirimicarb	23103-98-2	238.3	Insecticide	$C_{11}H_{18}N_4O_2$	N/D	92 °C	1.18	Colorless to White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D

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	Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
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Polarity index (Snyder)	9.0	5.1	5.1	5.8	4.4	3.1	0.0
Viscosity (cP)	1.00	0.32	0.60	0.37	0.45	0.44	0.33
Solubility in Water (% wt/wt)	100 %	100%	100%	100%	9%	2%	0%

Neonicotinoids

Compound	CAS #	MW	Class	Molecular Formula	BP (°C @ 1 atm)	MP (°C @ 1 atm)	Density (g/cm³ @ 20°C)	Color	Form	Solubility						
										Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
Acetamiprid	135410-20-7	222.7	Insecticide	$C_{10}H_{11}ClN_4$	Decomposes	99 °C	1.33	White to Yellow	Crystalline or Waxy Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	< 10
Imidacloprid	138261-41-3	255.7	Insecticide	$C_9H_{10}ClN_5O_2$	Decomposes	144 °C	1.54	Colorless to Off-White	Crystalline Solid	< 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	< 100
Thiacloprid	111988-49-9	252.7	Insecticide	$C_8H_{10}ClN_5O_3S$	Decomposes	136 °C	1.46	Colorless to Off-White	Crystalline Solid	< 500	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D	< 100
Thiamethoxam	153719-23-4	291.7	Fungicide & Insecticide	$C_8H_{10}ClN_5O_3S$	Decomposes	139 °C	1.57	Light Brown	Solid Powder	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	< 10

Organochlorines

Compound	CAS #	MW	Class	Molecular Formula	BP (°C @ 1 atm)	MP (°C @ 1 atm)	Density (g/cm³ @ 20°C)	Color	Form	Solubility						
										Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
Aldrin	309-00-2	364.9	Insecticide	$C_{12}H_8Cl_6$	145 °C	104 °C	1.60	Colorless to Brown	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Chlordecone	143-50-0	490.6	Insecticide	$C_{10}Cl_{10}O$	Decomposes	Decomposes	1.60	Colorless to Tan	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
DDD (o-p)	53-19-0	320.0	Insecticide	$C_{14}H_{10}Cl_4$	N/D	77 °C	N/D	Colorless	Powder	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
DDD (p-p')	72-54-8	320.0	Insecticide	$C_{14}H_{10}Cl_4$	350 °C	110 °C	1.39	Colorless to White	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
DDE (o-p)	3424-82-6	318.0	Insecticide	$C_{14}H_8Cl_4$	N/D	75 °C	N/D	Colorless to Yellow	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
DDE (p-p')	72-55-9	318.0	Insecticide	$C_{14}H_8Cl_4$	N/D	89 °C	1.40	White	Crystal or Powder	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
DDT (o-p')	789-02-6	354.5	Insecticide	$C_{14}H_9Cl_5$	N/D	N/D	N/D	Colorless to White	Crystalline or Oily Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
DDT (p-p')	50-29-3	354.5	Insecticide	$C_{14}H_9Cl_5$	185 °C	109 °C	0.99	Colorless to White	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Dieldrin	60-57-1	380.9	Insecticide	$C_{12}H_8Cl_6O$	Decomposes	177 °C	1.75	Colorless to Tan	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Endrin	72-20-8	380.9	Insecticide	$C_{12}H_8Cl_6O$	Decomposes	200 °C	1.84	Colorless to Off-White	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Mirex	2385-85-5	545.5	Insecticide	$C_{10}Cl_{12}$	Decomposes	485 °C	N/D	White	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000

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Polarity index (Snyder)	9.0	5.1	5.1	5.8	4.4	3.1	0.0
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Solubility in Water (% wt/wt)	100 %	100%	100%	100%	9%	2%	0%

Organophosphates

Compound	CAS #	MW	Class	Molecular Formula	BP (°C @ 1 atm)	MP (°C @ 1 atm)	Density (g/cm³ @ 20°C)	Color	Form	Solubility: Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
Azinphos-methyl	86-50-0	317.3	Acaricide	$C_{10}H_{12}N_3O_3PS_2$	Decomposes	73 °C	1.44	White to Brown	Crystalline or Waxy Solid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Carbophenothion	786-19-6	342.9	Acaricide	$C_{11}H_{16}ClO_2PS_3$	N/D	N/D	1.27	Off-White to Amber	Liquid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Dicrotophos	141-66-2	237.2	Acaricide	$C_8H_{16}NO_5P$	N/D	N/D	1.22	Yellow to Brown	Liquid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Dimethoate	60-51-5	229.2	Acaricide	$C_5H_{12}NO_3PS_2$	Decomposes	50.5 °C	1.31	White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	< 500
Dyfonate	944-22-9	246.3	Insecticide	$C_{10}H_{15}OPS_2$	130 °C	30 °C	1.16	Colorless to Yellow	Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Ethoprophos	13194-48-4	242.3	Nematicide	$C_8H_{19}O_2PS_2$	244 °C	70 °C	1.09 WC	Yellow	Oily Liquid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Malathion	121-75-5	330.4	Acaricide	$C_{10}H_{19}O_6PS_2$	Decomposes	-20 °C	1.21 CRC	Colorless to Amber	Liquid	< 500	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Methamidophos	10265-92-6	141.1	Acaricide	$C_2H_8NO_2PS$	Decomposes	45 °C	1.27	Colorless to Off-White	Crystalline Solid	≥1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Methidathion	950-37-8	302.3	Acaricide	$C_6H_{11}N_2O_4PS_3$	N/D	39.5 °C	1.51	Colorless	Crystalline Solid	< 500	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Monocrotophos	6923-22-4	223.2	Acaricide	$C_7H_{14}NO_5P$	125 °C	54 °C	1.22	Colorless to Red Brown	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D	N/D
Oxydemeton-methyl	301-12-2	246.3	Acaricide	$C_6H_{15}O_4PS_2$	Decomposes	-49 °C	1.29	Colorless to Yellow	Oily Liquid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	< 100
Phenthoate	2597-03-7	320.4	Acaricide	$C_{12}H_{17}O_4PS_2$	NA	17 °C	1.23	Colorless	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Phorate	298-02-2	260.4	Insecticide	$C_7H_{17}O_2PS_3$	75-78 °C	-15 °C	1.17	Colorless to Yellow	Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Phosalone	2310-17-0	367.8	Acaricide	$C_{12}H_{15}ClNO_4PS_2$	Decomposes	49.6 °C	1.49	Colorless to White	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Phosmet	732-11-6	317.3	Insecticide	$C_{11}H_{12}NO_4PS_2$	Decomposes	71.8 °C	1.44	Off-While	Crystalline Solid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Pirimiphos-methyl	29232-93-7	305.3	Acaricide	$C_{11}H_{20}N_3O_3PS$	Decomposes	21 °C	1.17	Yellow	Liquid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Profenofos	41198-08-7	373.6	Insecticide	$C_{11}H_{15}BrClO_3PS$	N/D	N/D	1.46	Yellow to Brown	Oily Liquid	<100	≥1000	≥1000	≥1000	≥1000	N/D	≥1000
Quinalphos	13593-03-8	298.3	Insecticide	$C_{12}H_{15}N_2O_3PS$	N/D	31 °C	1.24	Red Brown	Liquid	<100	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000

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Organophosphates (cont'd)

	Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
MW	18.02	58.05	32.04	41.05	88.11	84.93	86.18
UV cutoff (nm)	200	330	205	190	260	235	200
BP (°C @ 1 atm)	100.0	56.1	64.7	81.6	77.1	39.5	69.0
Polarity index (Snyder)	9.0	5.1	5.1	5.8	4.4	3.1	0.0
Viscosity (cP)	1.00	0.32	0.60	0.37	0.45	0.44	0.33
Solubility in Water (% wt/wt)	100 %	100%	100%	100%	9%	2%	0%

Compound	CAS #	MW	Class	Molecular Formula	BP (°C @ 1 atm)	MP (°C @ 1 atm)	Density (g/cm³ @ 20°C)	Color	Form	Solubility: Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
Terbufos	13071-79-9	288.4	Insecticide	C9H21O2PS3	N/D	-29 °C	1.11	Colorless to Yellow	Liquid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Triazophos	24017-47-8	313.3	Acaricide	C12H16N-3O3PS	Decomposes	2.5 °C	1.24	Yellow to Brown	Oily Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Trichlorfon	52-68-6	257.4	Insecticide	C4H8Cl3O4P	Decomposes	80 °C	1.68	Colorless to Yellow	Crystalline or Semi-Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	N/D
Acephate	30560-19-1	183.2	Insecticide	C4H10NO3PS	Decomposes	89 °C	1.35	Colorless to White	Crystalline Solid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	< 100
Chlorpyriphos	2921-88-2	350.6	Acaricide	C9H11Cl3NO3PS	Decomposes	41 °C	1.43	Colorless to Amber	Crystalline Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Diazinon	333-41-5	304.3	Acaricide	C12H21N2O3PS	Decomposes	N/D	1.11	Colorless to Amber	Oily Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Dichlorvos	62-73-7	221.0	Acaricide	C4H7C12O4P	Decomposes	N/D	1.42	Colorless to Amber	Liquid	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Disulfoton	298-04-4	274.4	Insecticide	C8H19O2PS3	128 °C	-25 °C	1.14	Colorless to Yellow	Oily Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Edifenphos	17109-49-8	310.4	Fungicide	C14H15O2PS2	154 °C	-25 °C	1.25	Yellow to Brown	Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Epn	2104-64-5	323.3	Acaricide	C14H14NO4PS	N/D	34.5 °C	1.27	Yellow	Crystalline or Waxy Solid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Ethion	563-12-2	384.5	Acaricide	C9H22O4P2S4	165 °C	-12 °C	1.22	Colorless to Amber	Liquid	< 10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Fenitrothion	122-14-5	277.2	Acaricide	C9H12NO5PS	Decomposes	3 °C	1.33	Yellow to Brown	Liquid	< 100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Fenthion	55-38-9	278.3	Insecticide	C10H15O3PS2	90 °C	7 °C	1.25	Colorless to Amber	Oily Liquid	<10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Methyl parathion	298-00-0	263.2	Insecticide	C8H10NO5PS	N/D	35 °C	1.36	Colorless to White	Crystalline Solid	<100	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000
Parathion	56-38-2	291.3	Insecticide	C10H14NO5PS	375 °C	6.1 °C	1.26	Yellow to Brown	Liquid	<10	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000	≥ 1000

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Polarity index (Snyder)	9.0	5.1	5.1	5.8	4.4	3.1	0.0
Viscosity (cP)	1.00	0.32	0.60	0.37	0.45	0.44	0.33
Solubility in Water (% wt/wt)	100 %	100%	100%	100%	9%	2%	0%

Pyrethroids

Compound	CAS #	MW	Class	Molecular Formula	BP (°C @ 1 atm)	MP (°C @ 1 atm)	Density (g/cm³ @ 20°C)	Color	Form	Solubility: Water	Acetone	Methanol	Acetonitrile	Ethyl Acetate	Methylene Chloride	n-Hexane
Bifenthrin	82657-04-3	422.9	Insecticide	C23H22ClF3O2	Decomposes	80 °C	1.26	Off-White to Brown	Semi-Solid or Liquid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Cyfluthrin	68359-37-5	434.3	Insecticide	C22H18Cl2F-NO3	Decomposes	79 °C	1.28	Yellow to Brown	Semi-Solid or Liquid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Cypermethrin	52315-07-8	416.3	Insecticide	C22H19Cl-2NO3	Decomposes	41 °C	1.25	Yellow	Crystalline or Waxy Solid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Etofenprox	80844-07-1	376.5	Insecticide	C25H28O3	Decomposes	37 °C	1.17	White	Crystalline Solid	<10	≥1000	≥1000	≥1000	≥1000	N/D	N/D
Fenpropathrin	39515-41-8	349.4	Acaricide	C22H23NO3	N/D	47 °C	1.15	Yellow to Brown	Oily Liquid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Fenvalerete	51630-58-1	419.9	Insecticide	C25H22ClNO3	Decomposes	39 °C	1.18	Yellow to Brown	Crystalline or Waxy Solid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Permethrin (mix of isomers)	52645-53-1	391.3	Insecticide	C21H20Cl2O3	200 °C	34 °C	1.29	Colorless to Brown	Oily Liquid or Crystals	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Prallethrin (mix of isomers)	23031-36-9	300.4	Insecticide	C19H24O3	313 °C	-25 °C	1.03	Yellow to Brown	Oily Liquid	<10	≥1000	≥1000	≥1000	≥1000	N/D	≥1000
Pyrethrin (mix of isomers)	8003-34-7	328.4	Insecticide	C21H28O3	N/D	142 °C	0.85	Yellow to Brown	Oily Liquid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000
Resmethrin (mix of isomers)	10453-86-8	338.4	Insecticide	C22H26O3	Decomposes	56 °C	0.96	Colorless to Tan	Oily Liquid or Crystals	<10	≥1000	≥1000	≥1000	≥1000	≥1000	N/D
Tetramethrin	7696-12-0	331.4	Insecticide	C19H25NO4	N/D	69 °C	1.11	Colorless	Crystalline Solid	<10	≥1000	≥1000	≥1000	≥1000	≥1000	≥1000

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