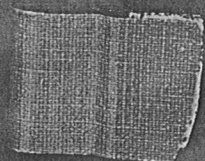


Hawley's
**CONDENSED
CHEMICAL
DICTIONARY**

Richard J. Lewis, Sr.

Thirteenth Edition



35

QD
5
.C5
1997

Hawley's
Condensed Chemical
Dictionary

THIRTEENTH EDITION

Revised by
Richard J. Lewis, Sr.

BAKER BOTTS LLP

SEP 18 2001

HOUSTON LIBRARY

BAKER BOTTS LLP



JOHN WILEY & SONS, INC.

New York • Chichester • Weinheim • Brisbane • Singapore • Toronto

This text is printed on acid-free paper. ∞

Copyright © 1997 by John Wiley & Sons, Inc.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4744. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, (212) 850-6011, fax (212) 850-6008, E-mail: PERMREQ@WILEY.COM.

Library of Congress Cataloging-in-Publication Data

Condensed chemical dictionary.

Hawley's condensed chemical dictionary.—13th ed./revised by
Richard J. Lewis, Sr.

p. cm.
ISBN 0-471-29205-2 (hardcover)

I. Chemistry-Dictionaries. I. Hawley, Gessner Goodrich, 1905-1983.

II. Lewis, Richard J., Sr. III. Title.

QD5.C5 1997

540'.3—dc21

97-35762

CIP

Printed in the United States of America

10 9 8 7 6 5

Grade: Technical.

Use: Manufacture of dyes, production of lakes, indicators, biological stain.

alizarin blue. (CI 67410). $C_{17}H_9NO_4$.

Properties: Violet crystals. Mp 268C. Insoluble in water, soluble in glacial acetic acid and hot benzene.

Use: Indicator.

alizarin yellow R. (*p*-nitrophenylazosalicylate sodium; C.I. 14030).

$O_2NC_6H_4NNC_6H_3OHCOONa$.

Properties: Yellow-brown powder. Soluble in water.

Use: Acid-base indicator, biological stain.

alkadiene. See diolefin.

alkali. Any substance that in water solution is bitter and is irritating or caustic to the skin and mucous membranes, turns litmus blue, and has a pH value greater than 7.0.

The alkali industry produces sodium hydroxide, sodium carbonate (soda ash), sodium chloride, salt cake, sodium bicarbonate, and corresponding potassium compounds.

See base; pH; alkali metal.

alkali blue. Class name for a group of pigment dry powders prepared by the phenylation of *p*-rosaniline or fuchsine, followed by drowning in hydrochloric acid, washing, and sulfonating. Alkali blue on a weight basis has the highest tinting strength of all blue pigments. The presscake may be "flushed" with vehicle to replace the water in the pulp.

Use: Printing inks, interior paints.

alkali cellulose. The product formed by steeping wood pulp with sodium hydroxide, the first step in the manufacture of viscose rayon and other cellulose derivatives.

See carboxymethylcellulose.

alkali metal. A metal in group IA of the periodic table, i.e., lithium, sodium, potassium, rubidium, cesium, and francium. Except for francium, the alkali metals are all soft, silvery metals, which may be readily fused and volatilized; the melting and boiling points becoming lower with increasing atomic weight. The density increases with (but less rapidly than) the atomic weight, the atomic volume therefore becoming greater as the series is ascended. The alkali metals are the most strongly electropositive of the metals. They react vigorously, at times violently, with water; within the group itself, the basicity increases with atomic weight, that of cesium being the greatest.

alkalimetry. The measurement of the concentration of bases or of the amount of free base present

in a solution by titration or some other means of analysis.

alkaline earth. An oxide of an alkaline earth metal (lime).

alkaline-earth metals. Calcium, barium, strontium, and radium (group IIA of the periodic table). In general they are white and differ by shades of color or casts; are malleable, extrudable, and machinable; may be made into rods, wire, or plate; are less reactive than sodium and potassium and have higher melting and boiling points.

alkaloid. A basic nitrogenous organic compound of vegetable origin. Usually derived from the nitrogen ring compounds pyridine, quinoline, isoquinoline, and pyrrole, designated by the ending -ine. Though some are liquids, they are usually colorless, crystalline solids, having a bitter taste, and combine with acids without elimination of water. They are soluble in alcohol, insoluble or sparingly soluble in water. Examples are atropine, morphine, nicotine, quinine, codeine, caffeine, cocaine, and strychnine.

alkane. See paraffin (1).

alkanesulfonic acid, mixed. RSO_3H (R is methyl, ethyl, propyl, mixed). Trade designation for a mixture of methane-, ethane-, and propane sulfonic acids. A strong nonoxidizing, nonsulfonating liquid acid which is thermally stable at moderately high temperatures.

Properties: Light amber liquid; sour odor. Mp below $-40C$, bp 120–140C (1 mm), d 1.38 (20C), pH (1% solution) 1.15. Very corrosive. Miscible with water and saturated fatty acids.

Use: Catalyst; intermediate, reaction medium.

"Alkanol" [Du Pont]. TM for a series of fatty alcohol-ethylene oxide condensation products used as nonionic surface-active agents in detergents and dispersing and emulsifying agents in paper, leather, and textiles. These include grades OA, OE, OJ, OP, and HC. 189-S is a saturated hydrocarbon sodium sulfonate. B and BG are sodium alkylnaphthalene sulfonates. Sulfur is tetrahydronaphthalene sodium sulfonate.

alkanolamine. (alkylolamine).

A compound such as ethanolamine, $HOCH_2CH_2NH_2$, or triethanolamine, $(HOCH_2CH_2)_3N$, in which nitrogen is attached directly to the carbon of an alkyl alcohol. See specific compound.

"Alkamuls" [Rhône-Poulenc]. TM for nonyl, octyl, dodecyl, dinonyl, and dianyl phenol ethoxylates.

Use: As primary detergents, emulsifiers, wetting agent, suspending agents, and dispersants in nearly every conceivable application.

alkene. See olefin.

"Alkor" [Atlas]. TM for a synthetic, furan-type resin cement which is acid- and alkali-proof and used as a mortar cement where temperatures do not exceed 380F.

alkoxyaluminum hydrides. (H_nAlOR_{3-n}).

A group of reducing agents especially useful in converting epoxides to alcohols. Derived by reaction of aluminum hydride with the corresponding alcohol in tetrahydrofuran.

alkyd resin. A thermosetting coating polymer, chemically similar to polyester resins, conventionally made by condensation and polymerization of a dihydric or polyhydric alcohol (ethylene glycol or glycerol) and a polybasic acid (phthalic anhydride), usually with a drying oil modifier. The process requires heating at 230–250C for up to 12 hours. A new and quite different method utilizes epoxy addition polymerization, in which a mixture of glycidyl esters and organic acid anhydrides is heated with a metallic catalyst at 100C or less for only two to four hours. Cost and energy savings and improved application performance are realized by this process.

Use: Alkyd resins are used as vehicles in exterior house paints, marine paints, and baking enamels. Molded alkyd resins are used for electrical components, distributor caps, encapsulation, and a variety of similar applications.

alkyl. A paraffinic hydrocarbon group which may be derived from an alkane by dropping one hydrogen from the formula. Examples are methyl CH_3^- , ethyl $C_2H_5^-$, propyl $CH_3CH_2CH_2^-$, isopropyl $(CH_3)_2CH_2^-$. Such groups are often represented in formulas by the letter R and have the generic formula C_nH_{2n+1} .
See aryl.

alkylaryl polyethyleneglycol ether.

Use: In surface-active agents.

See iso-octylphenoxypolyoxyethylene ethanol for a typical example of this class of compound.

alkylaryl sulfonate. An organic sulfonate of combined aliphatic and aromatic structure, e.g., alkylbenzene sulfonate.

alkylate. (1) A product of alkylation. (2) A term used in the petroleum industry to designate a branched-chain paraffin derived from an isoparaffin and an olefin, e.g., isobutane reacts with ethylene (with catalyst) to form 2,2-dimethylbutane (neohexane). The product is used as a high-octane blending component of aviation and civilian gasolines. (3) In the detergent industry, the term is applied to the reaction product of benzene or its homologs with a long-chain olefin to form an

intermediate, e.g., dodecylbenzene, used in the manufacture of detergents. It also designates a product made from a long-chain normal paraffin that is chlorinated to permit combination with benzene to yield a biodegradable alkylate. The adjectives *hard* and *soft* applied to detergents refer to their ease of decomposition by microorganisms.
See biodegradability; detergent.

alkylation. (1) The introduction of an alkyl radical into an organic molecule. This was one of the early chemical processes used in Germany to furnish intermediates for improved dyes, e.g., dimethylaniline. Other alkylation products are cumene, dodecylbenzene, ethylbenzene, and nonylphenol. (2) A process whereby a high-octane blending component for gasolines is derived from catalytic combination of an isoparaffin and an olefin.
See alkylate (2); neohexane.

alkylbenzene sulfonate. (ABS).

A branched-chain sulfonate type of synthetic detergent, usually a dodecylbenzene or tridecylbenzene sulfonate. Such compounds are known as "hard" detergents because of their resistance to breakdown by microorganisms. They are being replaced by linear sulfonates.

See alkyl sulfonate; linear molecule; detergent; sodium dodecylbenzene sulfonate.

alkyl diaryl phosphate ester. See "Santicizer 141" [Monsanto].

alkyldimethylbenzylammonium chloride.

General name for a quaternary detergent.

See benzalkonium chloride.

alkylene. A phosphated long-chain alcohol.

alkyl fluorophosphate. See diisopropyl fluorophosphate.

alkylolamine. See alkanolamine.

alkyl sulfonate. (linear alkylate sulfonate; LAS).

A straight-chain alkylbenzene sulfonate, a detergent specially tailored for biodegradability. The linear alkylates may be normal or iso (branched at the end only), but are C_{10} or longer.

See sodium dodecylbenzene sulfonate.

alkyne. See acetylene hydrocarbon.

Allan-Robinson reaction. Preparation of flavones or isoflavones by condensing *o*-hydroxyaryl ketones with anhydrides of aromatic acids and their sodium salts.

allantoin. (glyoxyldiureide; 5-ureidohydantoin), $C_4H_6N_4O_3$.

hexachlorocyclopentadiene.

(perchlorocyclopentadiene).

CAS: 77-47-4. C_5Cl_6 .**Properties:** Pale-yellow liquid; pungent odor. Bp 239C, fp 9.6C, d 1.717 (15/15C), bulk d 14.30 lb/gal (15.5C), refr index 1.563 (25C), flash p none. Nonflammable.**Grade:** Technical.**Hazard:** Toxic by ingestion, inhalation, and skin absorption. TLV: 0.01 ppm in air.**Use:** Intermediate for resins, dyes, pesticides, fungicides, pharmaceuticals.**hexachlorodiphenyl oxide.** (chlorinated diphenyl oxide).CAS: 31242-93-0. $C_{12}H_4Cl_6O$.**Properties:** Light-yellow, very viscous liquid. Bp 230–260C (8 mm Hg), d 1.60 (20/20C), bulk d 13.12 lb/gal (25C), refr index 1.621 (25C), flash p none. Soluble in methanol, ether; very slightly soluble in water. Nonflammable.**Hazard:** Toxic by ingestion. TLV: 0.5 mg/m³.**Use:** Solvent, intermediate.**1,1,1,4,4,4-hexachloro-1,4-disilabutane.** See bis(trichlorosilyl)ethane.**hexachloroendomethylene tetrahydrophthalic acid.** See chlorendic acid.**hexachloroendomethylene tetrahydrophthalic anhydride.** See chlorendic anhydride.**hexachloroethane.** (perchloroethane; carbon trichloride; carbon hexachloride).CAS: 67-72-1. Cl_3CCl_3 .**Properties:** Colorless crystals; camphorlike odor. D 2.091, mp 185C, bp sublimates at 185C. Soluble in alcohol and ether; insoluble in water.**Hazard:** Toxic by ingestion and inhalation, strong irritant, absorbed by skin. TLV: 1 ppm in air; suspected human carcinogen.**Use:** Organic synthesis, retarding agent in fermentation, camphor substitute in nitrocellulose, pyrotechnics and smoke devices, solvent, explosives.**hexachloromethylcarbonate.** (triphosgene). $(OCCl_3)_2CO$.**Properties:** White crystals; odor similar to that of phosgene. D approximately 2, bp 205–206C (partial decomposition), mp 78–79C. Decomposed by hot water and alkali hydroxides. Only slowly aceted upon by cold water. Soluble in alcohol, benzene, ether.**Derivation:** Chlorination of dimethyl carbonate exposed to direct sunlight.**Hazard:** Strong irritant to eyes and skin.**Use:** Lachrymator.**hexachloromethyl ether.** $O(CCl_3)_2$.**Properties:** Liquid; phosgenelike odor. D 1.538 (18C), bp 98C (partial decomposition).**Derivation:** Chlorination of dichloromethyl ether.**Hazard:** Strong irritant to eyes and skin.**hexachloronaphthalene.**CAS: 1335-87-1. $C_{10}H_2Cl_6$.**Properties:** White solid.**Hazard:** Toxic by inhalation, strong irritant, absorbed by skin. TLV: 0.2 mg/m³ of air.**hexachlorophene.** (2,2'-methylene-bis-(3,4,6-trichlorophenol); bis-(3,5,6-trichloro-2-hydroxyphenyl)methane).CAS: 70-30-4. $(C_6HCl_3OH)_2CH_2$.**Properties:** White, free-flowing powder; odorless. Mp 161–167C. Soluble in acetone, alcohol, ether, chloroform; insoluble in water.**Derivation:** Condensation of 3,4,5-trichlorophenol with formaldehyde in the presence of sulfuric acid.**Hazard:** FDA prohibits use unless prescribed by a physician.**Use:** Topical anti-infective (restricted), germicidal soaps, veterinary medicine.**hexachloro-2-propane.** See hexachloroacetone.**hexachloropropylene.** (hexachloropropene; perchloropropylene). $CCl_3CCl=CCl_2$.**Properties:** Water-white liquid. Bp 210C. Insoluble in water; miscible with alcohol, ether, chlorinated compounds.**Use:** Solvent, plasticizer, hydraulic fluid.**hexacontane.** $C_{60}H_{122}$. High molecular weight hydrocarbon.**Properties:** Waxy solid. Mp 101C.**Hazard:** Combustible.**hexacosanoic acid.** See cerotic acid.**n-hexadecane.** (cetane). $C_{16}H_{34}$.**Properties:** Colorless liquid. D 0.77335 (20/4C), flash p 200F (93C), bp 286.5C, mp 18.14C, refr index 1.43435 (20C). Soluble in alcohol, acetone, ether; insoluble in water, autoign temp 401F (205C).**Grade:** Technical, ASTM.**Hazard:** Combustible.**Use:** Solvent, organic intermediate, ignition standard for diesel fuels.

See cetane number.

hexadecanoic acid. See palmitic acid.**1-hexadecanol.** See cetyl alcohol.**hexadecanoyl chloride.** See palmitoyl chloride.**1-hexadecene.** (cetene; α -hexadecylene). $CH_3(CH_2)_{13}CH=CH_2$.

comirin. Exact formula undetermined. An antifungal agent produced by *Bacterium antimyceticum* composed mostly of amino acids. A gray to white powder that resists heat and acids but decomposes in the presence of alkalis; soluble in organic acids and bases; slightly soluble in water. A fungicide in paints, textile products, plant growth.

comminution. Size reduction of materials by grinding, cutting, shredding, chopping, etc. Solids can be reduced to a particle size approaching 1 micron in special fine-grinding equipment. Comminution of coal by chemical means is possible via a low molecular weight compound such as sodium hydroxide or anhydrous ethanol, which penetrates the natural fault system of the coal, causing fragmentation without mechanical crushing. This permits removal of sulfur from coal without burning or grinding. Approximately 100 lbs of chemical are needed per ton of coal.

common-ion effect. The reversal of ionization when a compound is added to a solution of another compound with which it has a common ion, the volume being kept constant.

compatibility. The ability of two or more materials to exist in close and permanent association indefinitely. Liquids (solvents) are compatible if they are miscible and do not undergo phase separation on standing. Thus, water is compatible with alcohol but not with gasoline. Liquids and solids are compatible only if the solid is soluble in the liquid. Solids are compatible if they can exist in intimate contact for long periods with no adverse effect of one on the other.

"Compazine" [SmithKline]. TM for a brand of prochlorperazine, as the maleate or the edisylate.

complement. In immunochemistry, any of a number of blood proteins that act in conjunction with antibodies to cause disintegration of invading cells. They are an essential component of immune serum.

complex compound. See coordination compound.

complexing agent. See ligand; chelate; ethylenediaminetetraacetic acid.

complex ion. An ion that has a molecular structure consisting of a central atom bonded to other atoms by coordinate covalent bonds.
See coordination compound.

component. One of the minimum sets of substances required to generate the composition of all phases of a system in the absence of chemical reaction of any substances in a mixture.
See constituent.

composite. A mixture or mechanical combination on a macroscale of two or more materials that are solid in the finished state, are mutually insoluble, and differ in chemical nature. The major types are (1) Laminates of paper, fabric, or wood (veneer) and a thermosetting material (resin, rubber, or adhesive); examples are tire carcasses, plywood, and electrical insulating structures. (2) Reinforced plastics, principally of glass fiber and a thermosetting resin; other types of fibers such as boron, aluminum silicate, and silicon carbide may be used.

See whiskers. (3) Cermets, which are mixtures of ceramic and metal powders, heat treated and compressed. (4) Fabrics, e.g., woven combinations of wool or cotton and a synthetic fiber. (5) Filled composites in which a bonding material, i.e., linseed oil, resin, or asphalt, is loaded with a filler in the form of flakes or small particles; examples are linoleum, glass flake-plastic mixtures for battery cases, and asphalt-gravel road-surfacing mixtures.

composting. Aerobic bacterial decomposition of solid organic wastes, both agricultural and urban, including sewage sludge. As much as 500 tons a day can be handled in the larger installations, the waste degrading quickly without external heating. Decomposition is accelerated by adding ammonium bicarbonate. The product can be used as a soil conditioner and for landfill. The waste is piled and turned frequently to provide aeration and to maintain a high temperature in the pile to destroy pathogenic organisms. The volume of composted waste is from 20 to 60% of original volume.

compound. (1) A substance composed of atoms or ions of two or more elements in chemical combination. The constituents are united by bonds or valence forces. A compound is a homogeneous entity in which the elements have definite proportions by weight and are represented by a chemical formula. A compound has characteristic properties quite different from those of its constituent elements. It is decomposed by energy in the form of a chemical reaction, heat, or electric current. Example: water is a *liquid* formed by chemical combination of two *gases*; it can be separated into hydrogen and oxygen by an electric current (electrolysis); in certain reactions it is split into its constituent ions (H, OH) (hydrolysis); it is not chemically changed by heat or cold.

See mixture; homogeneous; chemical reaction.

(2) Loosely, a product formula (often proprietary) of various types, e.g., pharmaceuticals (a vegetable compound), rubber (a fast-curing compound), etc.

(3) Having two sets of lenses (compound microscope).

compound 1080. Use may be restricted.
See sodium fluoroacetate.

compreg. A hardwood impregnated with a phenolformaldehyde resin under heat and pressure.

tion; (3) molecular size separations which depend on the effective molecular size of sample components in solution.

Solvents, often referred to as carriers, include isooctane, methyl ethyl ketone, acetone/chloroform, tetrahydrofuran, hexane, and toluene.

Packing materials in columns of various lengths include silica gel, alumina, glass beads, polystyrene gel, and ion exchange resins.

High-performance liquid chromatography (HPLC) is the term applied to new and more effective instrumental techniques developed in recent years that have greatly increased the scope of this analytical method. It can now be applied to biological as well as chemical research. Among the separations possible are peptides (by reverse phase chromatography), proteins and enzymes (hydrophobic and size exclusion modes of chromatography), amino acids, and inorganic and organometallic compounds (neutral species, including clusters, by adsorption and size exclusion, and ionic species including coordination compounds). A comparatively recent development is the use of supercritical fluids as solvents, e.g., carbon dioxide and sulfur hexafluoride.

See supercritical fluid; gas chromatography; paper chromatography; thin-layer chromatography; instrumentation.

liquid crystal. An organic compound in an intermediate or mesomorphic state between solid and liquid. This phenomenon was first noted in 1888 in cholesteryl benzoate, a crystalline solid. It becomes a turbid liquid, or liquid crystals, when heated to 145°C; on further heating to 179°C the liquid becomes isotropic. This sequence is reversed when the substance is cooled. Color changes occur on both heating and cooling. Many organic compounds, e.g., sodium benzoate, exhibiting this behavior are known and used extensively in electric and electronic displays, thermometers, color TV tubes, electronic clocks and calculators, and similar devices dependent on temperature determination. Liquid crystals have several varieties of molecular order: nematic, smectic (nine types), and cholesteric. They indicate small temperature differences by changing color when applied to the skin and are used in medicine for this purpose. They can align with dichroic dye molecules in a thin-layer cell to produce color changes.

Available forms: Microencapsulated.

See nematic; smectic; cholesteric.

liquid dioxide. See nitrogen dioxide.

liquid-liquid extraction. The transfer of components between two liquid phases.

liquid-liquid interface. See dineric interface.

liquid, Newtonian. Characteristic of liquids is their ability to flow, a property depending largely

on their viscosity and sometimes also on the rate of shear. A Newtonian liquid is one that flows immediately on application of force and for which the rate of flow is directly proportional to the force applied. Water, gasoline, and motor oils at high temperatures are examples. Some liquids have abnormal flow response when force is applied, that is, their viscosity is dependent on the rate of shear. Such liquids are said to exhibit non-Newtonian flow properties. Some will not flow until the force exerted is greater than a definite value called the yield point. (W. A. Gruse)

liquid pitch oil. See creosote; coal tar.

liquid rosin. See tall oil.

liquid rubber. See rubber, liquid.

liquor. In chemical technology, any aqueous solution of one or more chemical compounds. In sugar manufacturing, it refers to the syrups obtained from various refining steps (mother liquors). The paper industry uses this term extensively as follows: (1) black liquor is liquid digester waste (also called spent sulfate liquor) containing sulfonated lignin, rosin acids, and other waste wood components from which tall oil is made; (2) green liquor is a solution made by dissolving chemicals recovered in the alkaline pulping process in water; (3) white liquor is made by adding caustic soda to sodium sulfide solution. In dyeing technology, red liquor is an alternate name for mordant rouge.

liter. (L, l). The volume of one kilogram of water at its temperature of maximum density (4°C) at standard atmospheric pressure. A liter is 1.05 quart, or 0.26 gallon.

"Lithafrax" [Carborundum]. TM for a ceramic material made from β -spodumene.

litharge. (lead oxide, yellow; plumbous oxide; lead monoxide).

CAS: 1317-36-8. PbO. An oxide of lead made by controlled heating of metallic lead.

Properties: Yellow crystals. D 9.53, mp 888°C. Insoluble in water; soluble in acids and alkalis. A strong base. Commercial grades are yellow to reddish, depending on treatment and purity.

See massicot.

Derivation: By oxidizing metallic lead in air. Various forms of lead and various temperatures from 500–1000°C are used.

Grade: CP, fused, powdered.

Hazard: Toxic by ingestion and inhalation. TLV (Pb): 0.15 mg/m³ of air.

Use: Storage batteries, ceramic cements and fluxes, pottery and glazes, glass, chromium pigments, oil refining, varnishes, paints, enamels; assay of precious metal ores, manufacture of red lead, cement

Properties: Colorless oil. D 0.8886 (18/4C), fp -35°C , bp 212°C (16 mm Hg), refr index 1.4593 (25C). Insoluble in water; soluble in alcohol and ether. Combustible.

Derivation: Urea fractionation and vacuum distillation of methyl esters of safflower oil.

Grade: Technical, purified (99 + %).

Use: Intermediate for detergents, emulsifiers, wetting agents, stabilizers, resins, lubricants, plasticizers, textiles, reference standard in gas chromatography, biochemical research.

methyl lithium. CH_3Li . Commercially available as a 5% solution in ether.

Hazard: Flammable, dangerous fire and explosion risk, self-ignites in air.

Use: In Grignard-type reactions.

methylmagnesium bromide. CH_3MgBr . Available in solution in ether.

Derivation: Reaction of magnesium and methylbromide.

Hazard: Flammable, dangerous fire and explosion risk.

Use: Alkylating agent in organic synthesis, Grignard reagent.

methylmagnesium chloride. CH_3MgCl . Available as a solution in tetrahydrofuran.

Hazard: Flammable, dangerous fire and explosion risk.

Use: Alkylating agent in organic synthesis, Grignard reagent.

methylmagnesium iodide. CH_3MgI . Available as solution in ether.

Derivation: Reaction of magnesium and methyl iodide.

Hazard: Flammable, dangerous fire and explosion risk.

Use: Alkylating agent in organic synthesis, Grignard reagent.

methylmaleic anhydride. See citraconic anhydride.

methyl margarate. See methyl heptadecanoate.

methyl mercaptan. Legal label name for methanethiol.

methylmercury acetate. $\text{CH}_3\text{HgOOCCH}_3$.

Hazard: Toxic by ingestion, absorbed by skin. TLV: 0.01 mg/m^3 of air.

Use: Seed disinfectant.

methylmercury cyanide. (methylmercury nitrile). CH_3HgCN .

Properties: Crystals. Mp 95°C . Soluble in water and organic solvents.

Hazard: Toxic by ingestion, absorbed by skin. TLV: 0.01 mg/m^3 of air.

Use: Fungicide, seed disinfectant.

methylmercury dicyandiamide.

See cyano(methylmercury)guanidine.

methylmercury-2,3-dihydroxypropylmercaptide. $\text{CH}_3\text{HgSCH}_2\text{CH}_2\text{OCH}_2\text{OH}$.

Hazard: Toxic by ingestion, absorbed by skin. TLV: 0.01 mg/m^3 of air.

Use: Seed disinfectant.

methylmercury-8-hydroxyquinolate. See methylmercury quinolinolate.

methylmercury quinolinolate.

(methylmercury-8-hydroxyquinolate; methylmercury oxyquinolate).

CAS: 86-85-1. $\text{C}_9\text{H}_6\text{NOHgCH}_3$.

Properties: Yellow crystals. Mp $133\text{--}137^{\circ}\text{C}$.

Hazard: Toxic material. TLV: 0.01 mg/m^3 of air.

Use: Seed disinfectant.

methyl methacrylate.

CAS: 80-62-6. $\text{CH}_2\text{:C}(\text{CH}_3)\text{COOCH}_3$. Acrylic resin monomer.

Properties: Colorless, volatile liquid. Bp 101°C , fp -48.2°C , d 0.940 (25/25C), flash p (OC) 50F (10C), autoign temp 790F (421C). Slightly soluble in water; soluble in most organic solvents. Readily polymerized by light, heat, ionizing radiation and catalysts. Can be copolymerized with other methacrylate esters and many other monomers.

Derivation: (1) Acetone cyanohydrin, methanol, and dilute sulfuric acid; (2) oxidation of *tert*-butyl alcohol to methacrolein and then to methacrylic acid, followed by reaction with methanol.

Grade: Technical (inhibited).

Hazard: Flammable, dangerous fire risk, explosive limits in air 2.1–12.5%. TLV: 100 ppm in air.

Use: Monomer for polymethacrylate resins, impregnation of concrete.

See acrylic resin.

methylmethane. See ethane.

N-methyl methyl anthranilate.

See dimethyl anthranilate.

7-methyl-3-methylene-1,6-octadiene.

See myrcene.

methylmorphine. See codeine.

N-methyl morpholine.

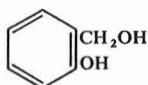
CAS: 109-02-4.



Properties: Water-white liquid; ammonia odor. D 0.921 (20/20C), bp 115.4°C , fp -66°C , flash p 75F (23.9C) (TOC). Forms constant-boiling mixture with 25% water and boiling at 97°C . Miscible with benzene, water.

in 1926. It has yielded a better understanding of the electron and its critical part in chemical bonding than is possible with Newtonian mechanics. In simple language, the orbital theory considers the electron not as a particle but as a three-dimensional wave that can exist at several energy levels; its exact location and position in the "shell" (which in most elements is a group of orbitals) cannot be precisely determined but only predicted by the laws of mathematical probability. The orbital levels and the movement of electrons within them are expressed by wave functions and quantum numbers. The probability that an electron will be found in a given volume (i.e., the square of the one-electron wave function) is called the orbital of that electron, and the shape of the orbital is defined by surfaces of constant probability (i.e., spheres and elliptically shaped doughnuts). The electron orbital, described in terms of probability, is like a cloud, with indefinite boundaries. The energy state of each electron is given by four quantum numbers that describe its principal level, its angular momentum, its magnetic moment, and its spin. This concept has exerted a profound effect on modern ideas about chemical bonding, transition metal complexes, semiconductors, and solid-state physics.

orcin. (dihydroxytoluene; methylresorcinol; orcinol).
CAS: 504-15-4. $\text{CH}_3\text{C}_6\text{H}_3(\text{OH})_2$.



Properties: White, crystalline prisms becoming red in air; intensely sweet, unpleasant taste. D 1.2895, mp (anhydrous) 107°C, (hydrated) 56°C; bp 287–290°C. Soluble in water, alcohol, and ether.

Derivation: By fermentation of various species of lichens (rocella) and extraction.

Use: Reagent for certain carbohydrates (beet sugar, lignin, pentoses, etc.).

order of magnitude. A range of values applied to numbers, distances, dimensions, etc., that begins at any value and extends to 10 times that value; e.g., 2 is of the same order of magnitude as any number between itself and 20; and 5 miles is of the same order of magnitude as any distance between 5 and 50 miles. The expression usually applies to extremely large or extremely small units, i.e., the size ranges of atoms, molecules, colloidal particles, etc., or astronomical distances.

ore. An aggregate of valuable minerals and gangue from which one or more metals can be extracted at a profit.

ore flotation. See flotation.

organelle. A portion of a cell having specific functions, distinctive chemical constituents, and characteristic morphology; it is a unit subsystem of a cell. Examples are mitochondria and chromosomes. Organelles are often closely associated with enzymes. The lysosome (an enzyme-bearing organelle) has been synthesized.

organic chemistry. A major branch of chemistry that embraces all compounds of carbon except such binary compounds as the carbon oxides, carbides, carbon disulfide, etc.; such ternary compounds as the metallic cyanides, metallic carbonyls, phosgene (COCl_2), carbonyl sulfide (COS), etc.; and the metallic carbonates, such as calcium carbonate and sodium carbonate. The total number of organic compounds is indeterminate, but some 6,000,000 have been identified and named. These fall into several structural groups as follows:

I. Aliphatic (straight chain)

1. Hydrocarbons (petroleum and coal derived)
 - (a) Paraffins or alkanes (saturated) ($\text{C}_n\text{H}_{2n+2}$)
methane and homologs; halogen-substituted derivatives, e.g., fluorocarbons
 - (b) Olefins (unsaturated)
 - (1) Alkenes (one double bond) (C_nH_{2n})
ethylene and homologs
 - (2) Alkadienes (two double bonds) ($\text{C}_n\text{H}_{2n-2}$)
butadiene, allene
 - (c) Acetylenes or alkynes (triple bond)
2. Alcohols (ROH): methanol and homologs
3. Ethers (ROR): methyl ether and homologs
4. Aldehydes (RCHO): formaldehyde, acetaldehyde
5. Ketones (RCOR): acetone, methyl ethyl ketone
6. Carboxylic acids (RCOOH)
7. Carbohydrates ($\text{C}_n\text{H}_{2n}\text{O}_n$)
 - (a) Sugars: glucose, fructose, sucrose, gums
 - (b) Starches: wheat, corn, potato
 - (c) Cellulose: cotton, plant fibers

II. Cyclic (closed ring)

1. Alicyclic hydrocarbons (properties similar to aliphatics)
 - (a) Cycloparaffins (naphthenes) (saturated): cyclohexane, cyclopentane, etc.
 - (b) Cycloolefins (unsaturated): cyclopentadiene, cyclooctatetraene
 - (c) Cycloacetylenes (triple bond)
2. Aromatic hydrocarbons (arenes): unsaturated compounds; hexagonal ring structure; single and multiple fused rings
 - (a) Benzene group (1 ring)
 - (b) Naphthalene group (2 rings)
 - (c) Anthracene group (3 rings)
 - (d) Polycyclic group (steroids, sterols)
3. Heterocyclic: unsaturated; usually pentagonal rings containing at least one other element besides carbon
 - (a) Pyrroles
 - (b) Furans
 - (c) Thiazoles

- (d) Porphyrins
- III. Combinations of aliphatic and cyclic structures
 - 1. Terpene hydrocarbons
 - 2. Amino acids (some are aliphatic and others combinations)
 - 3. Proteins and nucleic acids (coiled or helical formations)
- IV. Organometallic compounds
- V. Synthetic high polymers, including silicones

Important areas of organic chemistry include polymerization, hydrogenation, isomerization, fermentation, photochemistry, and stereochemistry. There is no sharp dividing line between organic and inorganic chemistry; the two often tend to overlap. See inorganic chemistry.

"Organiclear" [*Standard*]. (methylene bis-thiocyanate).

CAS: 6317-18-6. TM for wood preservative.

Use: To stop wood rot, termite attack, mildew, and decay.

organoborane. A compound composed of an unsaturated organic group and a borane obtained by the hydroboration reaction. Such compounds are useful catalytic reagents in organic syntheses of some complexity, e.g., *cis*- or *trans*-olefins, optically pure alcohols, alkanes, and ketones. Prostaglandins and insect pheromones have been synthesized by this means. A particularly versatile example is triphenylboron, $B(C_6H_5)_3$. See hydroboration; carborane; borane.

organoclay. (organopolysilicate). A clay such as kaolin or montmorillonite, to which organic structures have been chemically bonded; since the surfaces of the clay particles, which have a latticelike arrangement, are negatively charged, they are capable of binding organic radicals. When this type of structure is in turn reacted with a monomer such as styrene, a complex known as a polyorganosilicate graft polymer results.

organoleptic. A term widely used to describe consumer testing procedures for food products, perfumes, wines, and the like in which samples of various products, flavors, etc. are submitted to groups or panels. Such tests are a valuable aid in determining the acceptance of the products and thus may be viewed as a marketing technique. They also serve psychological purposes and are an important means of evaluating the subjective aspects of taste, odor, color, and related factors. The physical and chemical characteristics of foods are stimuli for the eye, ear, skin, nose, and mouth, whose receptors initiate impulses that travel to the brain, where perception occurs.

organometallic compound. An organic compound composed of a metal attached directly to carbon (RM); such compounds have been prepared of

practically all the metals, as well as with such non-metals as silicon and phosphorus. Metallic salts (soaps) of organic acids are excluded. Examples are diethylzinc (the first known organometallic), Grignard compounds such as methyl magnesium iodide (CH_3MgI), and metallic alkyls such as butyllithium (C_4H_9Li), tetraethyllead, triethyl aluminum, tetrabutyl titanate, sodium methylate, copper phthalocyanine, and metallocenes. Some are highly toxic or flammable; others are coordination compounds.

Reactive and moderately reactive organometallic compounds will react with all functional groups; two major types of reaction in which they are involved are oxidation and cleavage by acids. Probably the most important organometallic reactions are those involving addition to an unsaturated linkage. Many of them are powerful catalysts and form useful coordination complexes.

See catalysis; metallocene; coordination compound.

organophosphorus compound. Any organic compound containing phosphorus as a constituent. These fall into several groups, chief of which are the following: (1) phospholipids, or phosphatides, which are widely distributed in nature in the form of lecithin, certain proteins, and nucleic acids; (2) esters of phosphinic and phosphonic acids, used as plasticizers, insecticides, resin modifiers, and flame-retardants; (3) pyrophosphates, e.g., tetraethyl pyrophosphate, which are the basis for a broad group of cholinesterase inhibitors used as insecticides; (4) phosphoric esters of glycerol, glycol, sorbitol, etc., which are components of fertilizers. While many of these compounds play an important part in animal metabolism, those in group (3) are toxic and should be handled with extreme care.

organopolysilicate. See organoclay.

organosilane. See organosilicon.

organosilicon. An organic compound in which silicon is bonded to carbon (organosilane). Such compounds were first made by Friedel and Crafts in 1863. Silicon was found to have a remarkable chemical similarity to carbon, which it can replace in organic compounds. The silicon-carbon bond is about as strong as the carbon-carbon bond, and compounds containing them are similar in properties to all-carbon compounds. Organosilicon oxides (organosiloxanes or silicones) were discovered by F. S. Kipping in England in 1900; he found that Grignard reagents would react with silicon tetrachloride to form silicon-carbon-bonded polymers of both ring and chain types. These were named silicones because of the similarity of their empirical formula (R_2SiO) to that of ketones (R_2CO).

An organosilicon compound (tetramesityldisilene) containing a silicon to silicon double bond has been synthesized. It is a crystalline solid, mp 176°C, and

drocarbon, mineral and vegetable oils and animal fats and oils, and are particularly resistant to petroleum products. "Paracril" is also used as a plasticizer for vinyls and other thermoplastic and thermosetting resins.

"Paradene" [Neville]. TM for low-priced, dark, thermoplastic, coal tar resins (coumarone-indene) available in low to high softening-point ranges.
Use: Rubber compounding.

paraffin. (1) Also called alkane. A class of aliphatic hydrocarbons characterized by a straight or branched carbon chain; generic formula C_nH_{2n+2} . Their physical form varies with increasing molecular weight from gases (methane) to waxy solids. They occur principally in Pennsylvania and mid-continent petroleum. (2) Paraffin wax.

paraffin, chlorinated. A paraffin oil or wax in which some of the hydrogen atoms have been replaced by chlorine atoms. Nonflammable.

Use: High-pressure lubricants, as flame-retardants in plastics and textiles, as plasticizer for polyvinyl chloride in polyethylene sealants, and in detergents.

paraffin distillate. A distilled petroleum fraction that when cooled consists of a mixture of crystalline wax and oil.

paraffin oil. An oil either pressed or dry-distilled from paraffin distillate. Liquid petrolatum is also known as paraffin oil. Combustible.

Grade: By viscosity and color.

Use: Floor treatment, lubricant.

paraffin wax. (paraffin scale; paraffin).

CAS: 8002-74-2.

Properties: White, translucent solid; tasteless; odorless. Consisting of a mixture of solid hydrocarbons of high molecular weight, e.g., $C_{36}H_{74}$. D 0.880–0.915, mp 47–65°C, flash p 390°F (198°C), autoign temp 473°F (245°C). Soluble in benzene, ligroin, warm alcohol, chloroform, turpentine, carbon disulfide, and olive oil; insoluble in water and acids. Combustible.

Grade: Yellow crude scale, white scale, refined wax, ASTM, NF. Also graded by melting point in F and color. The higher-melting grades are more expensive.

Hazard: Many waxes contain carcinogens. TLV: 2 mg/m³ of air.

Use: Candles; paper coating; protective sealant for food products, beverages, etc.; glass-cleaning preparations; hot-melt carpet backing; biodegradable mulch (hot melt-coated paper); impregnating matches; lubricants; crayons; surgery; stoppers for acid bottles; electrical insulation; floor polishes; cosmetics; photography; antifrothing agent in sugar refining; packing tobacco products; protecting rubber products from sun-cracking; chewing-gum base (to ASTM specifications).

"Parafint." TM for a polymethylene wax. It is white, odorless, and has congealing point of 96°C. Available in flaked form. Approved by FDA.

"Para-Flux" [Hall]. TM for a series of petroleum-based plasticizers for natural and synthetic rubbers.

paraformaldehyde. (paraform).

CAS: 30525-89-4. $HO(CH_2O)_nH$. A polymer of formaldehyde in which n equals 8 to 100. Not to be confused with the trimer, symtrioxane.

Properties: White solid; slight odor of formaldehyde. Melting range 120–170°C, flash p 160°F (71°C) (CC), autoign temp 572°F (300°C). Insoluble in alcohol and ether; soluble in strong alkali solution. The higher polymers are insoluble in water. Combustible.

Derivation: By evaporating an aqueous solution of formaldehyde.

Available forms: Flake, powder.

Grade: Bags, carlots.

Hazard: Toxic by ingestion.

Use: Fungicides; bactericides; disinfectants; adhesives; hardener and waterproofing agent for gelatin; contraceptive creams.

paraldehyde. (2,4,6-trimethyl-1,3,5-trioxane).

CAS: 123-63-7. $C_6H_{12}O_3$. A cyclic polymer (trimer) of acetaldehyde. A depressant drug; may be addictive.

Properties: Colorless liquid; disagreeable taste; agreeable odor. D 0.9960 (20/20°C), bp 124.5°C, mp 12.6°C, vap press 25.3 mm Hg (20°C), flash p 96°F (35.5°C) (TOC), sp heat 0.434, refr index 1.40–1.42 (20°C), bulk d 8.27 lb/gal (20°C), autoign temp 460°F (237°C). Decomposes on standing; stable toward alkalis but slowly decomposed to acetaldehyde when treated with a trace of mineral acid; miscible with most organic solvents and volatile oils; soluble in water.

Derivation: Action of hydrochloric acid and sulfuric acid upon acetaldehyde.

Grade: Technical, USP.

Hazard: Flammable, moderate fire risk. Toxic by ingestion.

Use: Substitute for acetaldehyde; rubber accelerators; rubber antioxidants; synthetic organic chemicals; dyestuff intermediates; solvent for fats, oils, waxes, gums, resins; leather; solvent mixture for cellulose derivatives; sedative (hypnotic).

paralytic shellfish poisoning. See red tide.

paramagnetic analytical methods. Analysis of fluid mixtures by measurement of the paramagnetic susceptibilities of materials when exposed to a magnetic field.

See electron paramagnetic resonance; magnetochemistry.

paranitraniline. See *p*-nitroaniline.

by (1) direct esterification and (2) transesterification reactions. Combustible.

Some examples of (1): decaglycerol monostearate, semisolid, d 1.04, mp 51.9C; decaglycerol monooleate, viscous liquid, d 1.13, mp around 0C; decaglycerol hexaoleate, liquid, d 0.97, mp -17.7C.

Examples of (2): triglycerol monolinoleate, viscosity 322 cP (75.5C); triglycerol trilinoleate, viscosity 30.1 cP (75.5C).

Use: Lubricants, plasticizers, paint and varnish vehicles, gelling agents, urethane intermediates, adhesives, cross-linking agents, humectants, textile fiber finishes, functional fluids, surface-active agents, dispersants and emulsifiers in foods, pharmaceuticals, cosmetic preparations.

polyglycol. See polyethylene glycol.

polyglycol amine H-163.

$\text{HO}[\text{C}_2\text{H}_4\text{O}]_2\text{C}_3\text{H}_6\text{NH}_2$.

Properties: Colorless liquid. D 1.0556, bp (decomposes), fp 14.5C, bulk d 8.8 lb/gal, flash p 295F (146C). Soluble in water. Combustible.

polyglycol distearate. (polyethylene glycol distearate).

CAS: 9005-08-7.

$\text{C}_{17}\text{H}_{35}\text{COO}(\text{CH}_2\text{CH}_2\text{O})_n\text{OCC}_{17}\text{H}_{35}$. Distearate ester of polyglycol.

Properties: A soft, off-white solid. D 1.04 (50C), mp 43C, pH of 10% dispersion 7.26, saponification number variable. Soluble in chlorinated solvents, light esters, and acetone; slightly soluble in alcohols; insoluble in glycols, hydrocarbons, and vegetable oils. Combustible.

Use: Plasticizer for various resins, component of grinding and polishing pastes to promote easy removal in water.

"Polygriptex." TM for an adhesive especially designed for bonding polyethylene sheeting to porous surfaces, used in making polyethylene-lined bags and multiwall kraft bags. Has good adhesion to waxed surfaces. Available in viscosities from 300 to 20,000 cP.

polyhalite. $2\text{CaSO}_4 \cdot \text{MgSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$. A naturally occurring potash salt found in Germany, Texas, and New Mexico.

Use: Source of potash for fertilizer.

polyhexamethylenedipamide. Same as nylon 66.

polyhexamethylene sebacamide. Same as nylon 610.

polyhydric alcohol. See polyol.

polyimide. Any of a group of high polymers that have an imide group ($-\text{CONHCO}-$) in the polymer chain.

Properties: Tensile strength 13,500 psi, d 1.42, water absorption 0.3% (24 h at 77K), heat distortion point above 260C, dielectric constant at 2000 mc 3.2, and coefficient of linear expansion 28.4×10^{-6} inch/inch/foot. High-temperature stability (up to 370C), excellent frictional characteristics, good wear resistance at high temperatures, resists radiation, exhibits low outgassing in high vacuum, resistant to organic materials at quite high temperatures, not resistant to strong alkalis and to long exposure to steam. Flame retardant.

Use: High-temperature coatings, laminates and composites for aerospace vehicles, ablative materials, oil sealants and retainers, adhesives, semiconductors, valve seats, bearings, insulation for cables, printed circuits, magnetic tapes (high- and low-temperature-resistant), flame-resistant fibers, binders in abrasive wheels.

polyindene resin. See coumarone-indene resin.

polyisobutene. See polybutylene.

polyisobutylene. See polybutylene.

polyisocyanurate. See isocyanurate.

polyisoprene. $(\text{C}_5\text{H}_8)_n$. The major component of natural rubber, also made synthetically. Forms are stereospecific *cis*-1,4- and *trans*-1,4-polyisoprene. Both can be produced synthetically by the effect of heat and pressure on isoprene in the presence of stereospecific catalysts. Natural rubber is *cis*-1,4-; synthetic *cis*-1,4- is sometimes called synthetic natural rubber. *trans*-1,4-Polyisoprene resembles gutta-percha. Polyisoprene is thermoplastic until mixed with sulfur and vulcanized. Supports combustion.

See rubber, natural; rubber, synthetic; catalyst, stereospecific.

"Polylite" [Reichhold]. TM for a group of 100% reactive alkyd resins, dissolved in styrene and other monomers. Highly diversified applications both alone and in combination with such materials as fibrous glass. This group also includes resins for use with diisocyanate to form rigid or flexible polyurethane foams.

"POLYMEKON" [Petroli]. TM for a dispersion.

polymer. A macromolecule formed by the chemical union of five or more identical combining units called monomers. In most cases the number of monomers is quite large (3500 for pure cellulose) and often is not precisely known. In synthetic polymers this number can be controlled to a predetermined extent, e.g., by short-stopping agents. (Combinations of two, three, or four monomers are called, respectively, dimers, trimers, and tetramers and are known collectively as oligomers.) A partial list of polymers by type is as follows:

- I. Inorganic: siloxane, sulfur chains, black phosphorus, boron-nitrogen, silicones
- II. Organic
 1. Natural
 - (a) Polysaccharides: starch, cellulose, pectin, seaweed gums (agar, etc.), vegetable gums (arabic, etc.)
 - (b) Polypeptides (proteins): casein, albumin, globulin, keratin, insulin, DNA
 - (c) Hydrocarbons: rubber and gutta-percha (polyisoprene)
 2. Synthetic
 - (a) Thermoplastic: elastomers (unvulcanized), nylon, polyvinyl chloride, polyethylene (linear), polystyrene, polypropylene, fluorocarbon resins, polyurethane, acrylate resins
 - (b) Thermosetting: elastomers (vulcanized), polyethylene (cross-linked), phenolics, alkyds, polyesters
 3. Semisynthetic: cellulose (rayon, methylcellulose, cellulose acetate), modified starches (starch acetate, etc.)

polymer, addition. See addition polymer.

polymer, atactic. See atactic.

polymer, block. See block polymer.

polymer, condensation. A polymer formed by a condensation reaction.

polymer, coordination. A polymer made by organic addition, neither free radical nor ionic, using an organometallic catalyst.

polymer, electroconductive. A polymer or elastomer made electrically conductive by incorporation of a substantial percentage of a suitable metal powder (e.g., aluminum) or acetylene carbon black; the proportion used must be high enough to permit the particles to be in contact with one another in the mixture. Polyelectrolytes such as ion-exchange resins, salts of polyacrylic acid, and sulfonated polystyrene are electroconductive in the presence of water. Pyrolysis of polyacrylonitrile makes it electrically conductive without impairment of its structure. Polyacetylene and a few related polymers are made conductive by various doping agents such as arsenic pentafluoride and iodine.

See polyacetylene.

polymer, eutactic. A tactic polymer completely devoid of any structural disorder along its chain.

polymer, graft. See graft polymer.

polymer, high. An organic macromolecule composed of a large number of monomers. The molecular weight may range from 5000 into the millions

(for some polypeptides). Natural high polymers are exemplified by cellulose $(C_6H_{10}O)_n$ and rubber $(C_5H_8)_n$. Proteins are natural high-polymer combinations of amino acid monomers. The dividing line between low and high polymers is considered to be in the neighborhood of 5000 to 6000 mw.

Synthetic high polymers (or "synthetic resins") include a wide variety of materials having properties ranging from hard and brittle to soft and elastic. Addition of such modifying agents as fillers, colorants, etc. yields an almost infinite number of products collectively called plastics. High polymers are the primary constituents of synthetic fibers, coating materials (paints and varnishes), adhesives, sealants, etc. Polymers having special elastic properties are called rubbers, or elastomers.

Synthetic polymers in general can be classified: (1) by thermal behavior, i.e., thermoplastic and thermosetting; (2) by chemical nature, i.e., amino, alkyd, acrylic, vinyl, phenolic, cellulosic, epoxy, urethane, siloxane, etc.; and (3) by molecular structure, i.e., atactic, stereospecific, linear, cross-linked, block, graft, ladder, etc. Copolymers are products made by combining two or more polymers in one reaction (styrene-butadiene).

See cross-linking; block polymer; epitaxy; homopolymer; plastics.

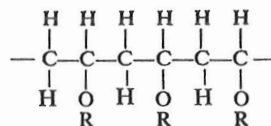
polymer, homo- A polymer consisting of only one repeated monomer.

polymer, inorganic. A polymer in which the main chain contains no carbon atoms and in which behavior similar to that of an organic polymer can be developed, i.e., covalent bonding and cross-linking, as in silicone polymers. Here the element silicon replaces carbon in the straight chain; substituent groups are often present, forming highly useful polymers. Other inorganic high polymers are black phosphorus, boron, and sulfur, all of which can form polymeric structures under special conditions. At present these have little or no commercial significance.

Note: Some authorities consider silicone resins to be semiorganic, since their substituent groups are composed of methyl groups.

polymer, isotactic. A type of polymer structure in which groups of atoms that are not part of the backbone structure are located either all above or all below the atoms in the backbone chain, when the latter are all in one plane.

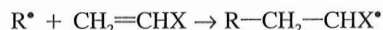
See polymer, stereospecific.



polymerization. A chemical reaction, usually carried out with a catalyst, heat, or light, and often

under high pressure, in which a large number of relatively simple molecules combine to form a chainlike macromolecule. The combining units are called monomers, e.g., styrene is the monomer for polystyrene. The linear chains can be combined (cross-linked) by addition of appropriate chemicals.

The polymerization reaction occurs spontaneously in nature; industrially it is performed by subjecting unsaturated or otherwise reactive substances to conditions that will bring about combination. This may occur by *addition*, in which free radicals are the initiating agents that react with the double bond of the monomer by adding to it on one side, at the same time producing a new free electron on the other.



By this mechanism the chain becomes self-propagating. Polymerization may also occur by condensation, involving the splitting out of water molecules by two reacting monomers, and by so-called oxidative coupling. The degree of polymerization (DP) is the number of monomer units in an average polymer unit of a given sample.

Polymerization techniques may be (1) in the gas phase at high pressures and temperatures (200C), (2) in solution at normal pressure and temperatures from -70 to +70C, (3) bulk or batch polymerization at normal pressure at 150C, (4) in suspension at normal pressure at 60-80C, (5) in emulsion form at normal pressure at -20 to +60C (used for copolymers). Catalysts of the peroxide type are necessary with some of these methods.

Note: Polymerization, like its handmaiden, catalysis, has long been one of the most complex and productive areas of chemical research; from year to year new materials and reaction mechanisms are constantly being explored, sometimes with only marginal success. But it need only be recalled that such now commonplace materials as polyethylene, polycarbonate, nylon, neoprene, epoxies, acrylics, to mention only a few, as well as block, graft, and stereospecific polymers, have resulted from continuous and intensive research by many brilliant chemists over the last 60 years, and this research continues undiminished.

See free radical; cross-linking.

polymer, ladder. See ladder polymer.

polymer, low. A polymer composed of comparatively few monomer units and having a molecular weight from 300 to 5000.

polymer, natural. See polymer.

polymer, stereoblock. See stereoblock polymer.

polymer, stereospecific. (stereoregular). A polymer whose molecular structure has a definite spatial arrangement, i.e., a fixed position in geometrical

space for the constituent atoms and atomic groups comprising the molecular chain, rather than the random and varying arrangement that characterizes an amorphous polymer. Achievement of this specific steric (three-dimensional) structure (also called tacticity) requires use of special catalysts such as those developed by Ziegler and Natta about 1950. Such polymers are wholly or partially crystalline. Synthetic natural rubber, *cis*-polyisoprene, is an example of a stereospecific polymer made possible by this means. There are five types of stereospecific (or stereoregular) structures: *cis*, *trans*, isotactic, syndiotactic, and tritactic.

See catalyst; stereospecific.

polymer, syndiotactic. See syndiotactic polymer.

polymer, synthetic. See polymer.

polymer, water-soluble. Any substance of high molecular weight that swells or dissolves in water at normal temperature. These fall into several groups, including natural, semisynthetic, and synthetic products. Their common property of water solubility makes them valuable for a wide variety of applications as thickeners, adhesives, coatings, food additives, textile sizing, etc.

See specific entries.

(1) *Natural.* This type is principally composed of gums, which are complex carbohydrates of the sugar group. They occur as exudations of hardened sap on the bark of various tropical species of trees. All are strongly hydrophilic. Examples are arabic, tragacanth, karaya.

(2) *Semisynthetic.* This group (sometimes called water-soluble resins) includes such chemically treated natural polymers as carboxymethylcellulose, methylcellulose, and other cellulose ethers, as well as various kinds of modified starches (ethers and acetates).

(3) *Synthetic.* The principal members of this class are polyvinyl alcohol, ethylene oxide polymers, polyvinyl pyrrolidone, polyethyleneimine.

polymethacrylate resin. See acrylic resin; methyl methacrylate.

polymethylbenzene. See durene; pseudocumene. Durene and pseudocumene are two members of this group with some commercial production and use.

polymethylene polyphenylisocyanate.

A polymer of diphenylmethane-4,4'-diisocyanate.

polymethylene wax. See wax, polymethylene.

poly-4-methylpentene-1.

Properties: High resistance to all chemicals except carbon tetrachloride and cyclohexane. Excellent

ends to increase with

$(\text{C}_2\text{H}_3\text{Cl}-)_n$. A vinyl polymer that is more stable. The copolymer with vinyl chloride. It generally uses as polyvinyl

(C). A chlorinated polymer with high strength and superior thermal temperature range.

corrosive materials up to direct attack by hydrocarbons, and al-

yl methyl ether; polyvinyl methyl ether; polyvinylidene chloride.

; polyvinyl ether).

very solid, dependent on when pure. D (2). Insoluble in water; stable to alkalies and dilute acids; limited number of rosin derivatives and

vinyl ethyl ether. Improve adhesion to cellulose acetate, and

$(\text{HF}-)_n$. Polymer of this is characterized by high strength, high stability to air and water, and stain resis-

r food packaging;

oor use, packaging,

nyl acetal.

ran). A stereoregu-

abrasion resistant, permeable to flavor. Softened by chloroform in cyclohexanone. Self-extinguishing. Polyvinylidene chloride. Polyvinylidene chloride with substituted compounds.

Available forms: Extruded and molded products, oriented fibers, films.

Use: Packaging of food products, especially meats and poultry; insecticide-impregnated multiwall paper bags; pipes for chemical processing equipment; seat covers; upholstery; fibers; bristles; latex coatings.

See saran fiber; "Cryovac."

polyvinylidene fluoride. $(-\text{H}_2\text{C}=\text{CF}_2-)_n$. A thermoplastic fluorocarbon polymer suitable for compression and injection molding and extrusion.

Properties: Crystals. Mp 171°C, thermally stable from -62 to +148°C. Combustible, self-extinguishing, and nondripping. Tensile strength 7000 psi at 25°C, yield stress 5500 psi, elongation 300%, compression strength 10,000 psi, thermal conductivity 1.05 Btu/hr/sq ft/F/in, water absorption 0.04% in 24 hr, d 1.76, refr index 1.42. Resistant to oxidative degradation, electricity, acids, alkalies, oxidizers, halogens; somewhat soluble in dimethylacetamide; attacked by hot concentrated sulfuric acid or *n*-butylamine.

Available forms: Powder, pellets, solution, and dispersion.

Use: Insulation for high-temperature wire; tank linings; chemical tanks and tubing; protective paints and coatings with exceptional resistance (30 years) to weathering and UV; valve and impeller parts; shrinkage tubing to encapsulate resistors, diodes, and soldered joints; sealant.

See fluorocarbon polymer.

polyvinyl isobutyl ether. (PVI; polyvinyl ether). $[-\text{CH}(\text{OCH}_2\text{CH}(\text{CH}_3)_2\text{CH}_2-)]_n$.

Properties: White, opaque elastomer or viscous liquid depending on molecular weight; almost odorless. D 0.91-0.93 (20°C), refr index 1.45-1.46 (25°C). Insoluble in water, ethanol, and acetone; soluble in most other organic solvents; stable toward dilute and concentrated alkalies and dilute acids. Compatible with a limited number of commercial resins, including rosin derivatives and some phenolics. Combustible.

Derivation: Polymerization of vinyl isobutyl ether by peroxides or acid catalysts.

Grade: As 100% material in three molecular weight ranges.

Use: Adhesives, waxes, tackifiers, plasticizers, surface coatings, laminating agents, cable filling compositions, lubricating oils.

polyvinyl methyl ether. (PVM).

$(-\text{CH}_2\text{CHOCH}_3-)_n$. A nonionic polymer of high molecular weight.

Properties: Colorless (when pure), tacky liquid. D 1.05, refr index 1.47, solidifies near 0°C. Soluble in water at 32°C, above which it precipitates from water but redissolves on cooling; soluble in most organic solvents except aliphatic hydrocarbons. Compatible with rubber latexes, rosin derivatives, and some phenolics. Combustible.

Derivation: Polymerization of vinyl methyl ether with peroxides or acid catalysts.

Use: Pressure-sensitive and hot-melt adhesives, bonding of paper to polyethylene, laminating adhesive, tackifier and plasticizer for coatings, heat sensitizer for rubber latex, pigment binder in textile finishing and printing inks, protective colloid in emulsions.

polyvinyl methyl ether-maleic anhydride.

(PVM/MA). $[-\text{CH}_2\text{CHOCH}_2\text{CHCOOCOCH-}]_n$. Water-soluble copolymer of vinyl methyl ether and maleic anhydride.

Use: Protective colloid, dispersing agent, thickener, binder, adhesive and size in coatings, detergents, emulsions, paper, textiles, leather, latex, rust preventive, foam stabilizer.

poly-2-vinylpyridine.

$(-\text{CH}(\text{C}_4\text{H}_4\text{N})-\text{CH}_2-)_n$. A vinyl-type polymer suggested for use as a photographic dye mordant, tablet coating material, antistatic for textiles and paper, and textile dye receptor.

polyvinylpyrrolidone. (PVP).

CAS: 9003-39-8. $(\text{C}_5\text{H}_9\text{NO})_n$.

Properties: White, free-flowing, amorphous powder or aqueous solution. D 1.23-1.29, bulk d 15lb/ft³, hygroscopic. Soluble in water and organic solvents; compatible with wide range of hydrophilic and hydrophobic resins.

Grade: Various molecular weight: 10,000, 40,000, 160,000, 360,000.

Use: Pharmaceuticals; blood plasma expander; cast films adherent to glass, metals, and plastics; complexing agent; detoxification of chemicals such as dyes, iodine, phenol, and poisonous drugs. Tabletting, photographic emulsions, cosmetics (hair sprays, shampoos, hand creams, skin lotions), dentifrices, dye-stripping, textile finishes, protective colloid, detergents, adhesives, beer and wine clarification.

polyvinyl resin. (vinyl plastic). Any of a series of polymers (resins) derived by polymerization or copolymerization of vinyl monomers $(\text{CH}_2=\text{CH}-)$ including vinyl chloride and acetate, vinylidene chloride, methyl acrylate and methacrylate, acrylonitrile, styrene, the vinyl ethers, and numerous others. Specifically, polyvinyl chloride, acetate, alcohol, etc. and copolymers or closely related materials.

See vinyl; polyvinyl.

"POLYWAX" [Petrolite]. TM for polyethylene.

Pomeranz-Fritsch reaction. Formation of isoquinolines by the acid-catalyzed cyclization of benzalaminoacetals prepared from aromatic aldehydes and aminoacetal.