

**DICTIONARY
OF
ENVIRONMENTAL
CHEMISTRY**

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Edited by

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Preface

The field of environmental chemistry has been so vast in recent years, that it becomes uncertain to know how far its boundaries have been extending. An attempt has been carefully made to include terms which have been in common use and discovered in recent past. The terms have been presented in brief phrases thereby avoiding the more comprehensive treatment.

This dictionary will be of value to students of environmental chemistry and to scientists and engineers working on problems of environmental chemistry.

Finally, the editor express his sincere thank to the publisher and printer for printing this book promptly.

All comments from users on omissions or shortcomings will be highly appreciated.

THE EDITOR

A

Abatement. Reduction or lessening (of pollution) or doing away with (a nuisance).

Abiotic. Non-biological; thus an abiotic element is a physical or chemical feature of an ecosystem or environment.

Abiocoen. The non-living components of the environment.

Ablation. The removal of a surface layer, especially used for the melting and evaporation of the surface of ice, and also for the removal of loose surface material by the wind (deflation).

ABS. Abbreviation of Alkyl Benzene Sulphonate.

Absolute Humidity. The weight of the water vapour found in a unit volume of air. In the metric system it may be defined as the number of grams of water vapour in a cubic meter of air.

Absorption

- (a) The taking up usually of a liquid or gas into the body of another material (the absorbent). Thus an air pollutant may be removed by absorption in a suitable absorbent.
- (b) The taking up of radiation by a material it encounters or passes through. This can be the basis of measuring a number of substances.

Absorption Pit, Seepage P., Absorption Well, Dumb Well, Soakaway. A hole in the ground for disposal of rainwater, sullage or treated sewage effluent. It is dug in country districts where there is porous soil, a water table not less than 2 m below ground and no other danger of contaminating water supplies.

Acaricide; 'Miticide'. A preparation for killing acarids (*e.g.*, mites, such as the red spider mite). Examples are tetradifon, dicofol, and chlorobenzilate.

Accessory Mineral. A mineral occurring in small amounts in a rock and disregarded in the classification of that rock (which is based on essential minerals). Accessory minerals can provide evidence about the origin of the rock (*e.g.*, the presence of metamorphic (Metamorphism) minerals in a sandstone reveals a provenance, at least in part, from a metamorphic belt).

Accretion. A phenomenon consisting of the increase in size of particles by the process of external additions; for example water to salt particles.

Accuracy. The difference between the observed value and the true value. A statement of accuracy can only be made if the true value is known: in environmental measurements it is often very difficult to know what the true value is.

Acenaphthene. $C_{10}H_6(CH_2)_2$, a compound which is irritating to the skin and mucous membranes and ingestion of large quantities can bring about acute nausea and vomiting.

Acetamide. CH_3CONH_2 , a compound characterized by a mousy odor. Exposure to the compound can result in irritation of the tissues in contact with the substance. Acetamide has been identified as a carcinogen.

Acetanilide. B_3H_7NO . Exposure to acetanilide can bring about contact dermatitis, while skin effects such as eczematous eruptions can also take place through exposure by ingestion or inhalation. Acute poisoning in humans has occurred from the ingestion of a few grams of the chemical.

Acetone. C_3H_6O . It occurs in small amounts in the urine of normal humans and in large amounts in the urine of diabetic patients. Acetone has been found to have a relatively low toxic effect through dermal exposure, although skin irritation is a common result due to the defatting action of the ketone which can damage or destroy subcutaneous tissues.

Acid Dew Point. The dew point of flue gases having little or no SO_3 is termed as the water dew point and is usually in the region of $49^\circ C$, if SO_3 is present in any significant quantity, the dew point is raised considerably, to about $149^\circ C$. This is termed as the acid dew point. Acid condensation starts at this temperature, heavy condensation occurring when the surface temperatures fall below $121^\circ C$. Each fuel has its own acid dewpoint in given

furnace conditions, below which corrosive condensation forms in flues, chimneys, boilers, etc.

Acid Fermentation. One stage of anaerobic decomposition of sewage sludge, resulting in the biodegradation of complex organic compounds to simpler organic acids, as in anaerobic sludge digestion.

Acid Formers. A group of facultative and obligate anaerobes, capable of hydrolysis, which ferment the complex organic compounds in sewage to organic acids, including acetic acid CH_3COOH , and propionic acid, $\text{CH}_3\text{CH}_2\text{COOH}$.

Acid Hydrolysis. A method of converting the cellulose in municipal refuse into a non-polluting fuel—ethanal (ethyl alcohol).

Acidity. The capacity of wastewater to neutralize a base. Acidity of a water is expressed in hydrogen ion concentration, usually called pH. Waters with pH below 7.0 are acid. In unpolluted water, acidity comes from dissolved carbon dioxide or organic acids leached from the soil. Atmospheric pollution also may bring about acidity. Acid waters are able to corrode metal or concrete.

Acid Mine Drainage. The drainage of water having acids from active or abandoned mines. Ponds that hold mine tailings, refuse piles subject to rains, and ore or coal-washing units all make contributions to the mine drainage problem.

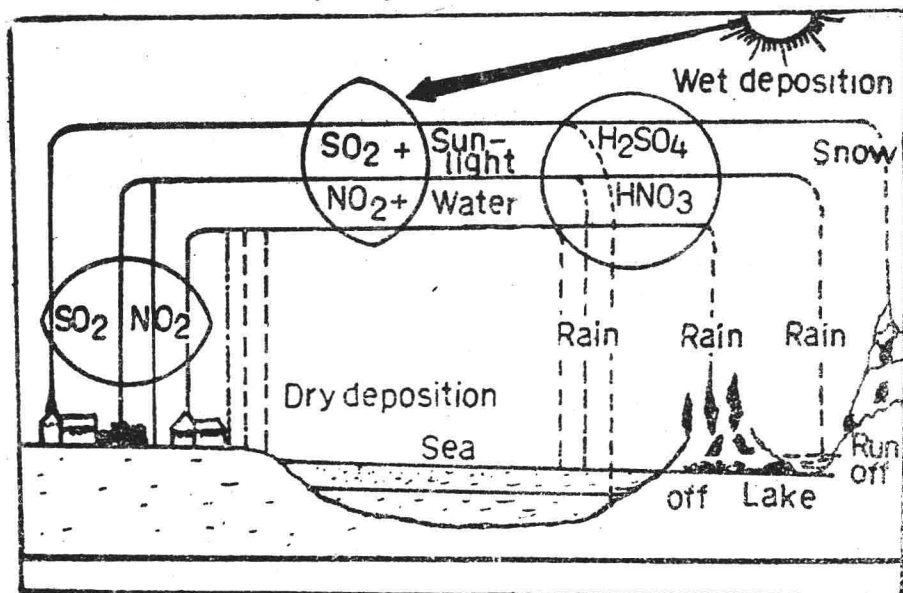
Polluted mine-drainage water is often acidic. The pyrite (iron sulphide) present in mines (especially coal or sulphide mines) is oxidised by air, water and bacteria (*Thiobacillus*) to sulphuric acid and ferrous sulphate. Consequently the water leaving the mine may contain from 100 to 6000 mg/litre of sulphuric acid, from 10 to 1500 mg/litre of ferrous sulphate FeSO_4 , from 0 to 350 mg/litre of aluminium sulphate, $\text{Al}_2(\text{SO}_4)_3$, and from 0 to 250 mg/litre of manganese sulphate, MnSO_4 .

Acid Precipitation. Acid rain.

Acid Rain (Acid Precipitation). Rain (precipitation) whose pH is less than 5.6, the normal equilibrium value for carbon dioxide and water. The pH is reduced due to the presence of acids (mainly sulphuric and nitric) produced by the combustion of fossil fuels or released by natural events such as volcanic eruptions.

Causes of Acid Rain

The most widely quoted theory is that of Likens and Bormann. According to this theory, acid rain is due to the presence of sulfuric acid and, to a lesser extent, nitric acid. The sulfuric acid comes from the combustion of sulfur-containing fossil fuels—coal and oil—which releases sulfur dioxide. Some sulfur dioxide changes to sulfur trioxide, which in humid air promptly gets converted into sulfuric acid. Precipitation washes this out of the air. The nitric acid comes from a series of chemical changes occurring to nitric oxide, another pollutant released in the combustion of any fossil fuel. Because tall smokestacks are used to carry combustion gases as far up and away from the locality of the power plant or industrial factory as possible, the sulfur and nitrogen oxides are injected into prevailing winds that carry the pollutants to distant locations.

*Ecological Problems*

No direct threat to human health has been posed by acid rains. In lower Scandinavia, wildlife specialists attribute breeding failures of game fish in otherwise unpolluted Norwegian rivers to lower pH values of the water. Acid rain increases the rate at which essential nutrients such as calcium, magnesium,

and potassium are leached from both leaves and soil. Swedish scientists believe that acid rains have been reducing the net productivity of Scandinavian forests. Acid mists in smoggy air bring about deterioration of buildings, monuments, and statues made of marble or limestone, because acids attack calcium carbonate, the chief constituent of these materials.

About a third of the annual replacement costs of steel rails for England's railroads stems from the corrosive influence of acid mists.

Acid Soot (Acid Smut). Particles of carbon, held together by water that is acidic through combination with sulphur trioxide. The carbon particles are emitted during combustion, and the soot particles are roughly 1 to 3 mm in diameter.

Acid-washed Activated Carbon. Carbon which has been in contact with an acid solution with the purpose of dissolving ash in the activated carbon.

Acrylic Resins. A group of synthetic resins, which are obtained by polymerisation of acrylic acid derived monomers. They are transparent, resistant to light, weak acids, alkalis and alcohols, but are attacked by oxidising acids, chlorinated hydrocarbons, ketones and esters. They find use widely in industry and consumer products.

Acrylonitrile $\text{CH}_2=\text{CHCN}$, an explosive, flammable liquid produced by the reaction of propylene with ammonia and oxygen in the presence of a catalyst. It is used in acrylic and modacrylic fibres employed in the production of clothing, carpets, blankets, draperies, and upholstery. Animal studies with acrylonitrile indicate that it may be a tumor-inducing agent, including carcinomas.

Acrylonitrile Butadiene Styrene (ABS). A black plastic material which is used to make pipes suitable for carrying sun-heated water in solar space heating and cooling, hot water, and swimming pool installations.

Actinograph. An instrument for recording the incoming solar radiation.

Actinometer. An instrument to measure the incoming solar radiation.

Actinomycetes. Group of bacteria in which cells are arranged in fine filaments. They are important constituents of the soil, where

they assist in the decomposition of organic matter *Streptomyces griseus* produces the antibiotic streptomycin.

Activated Alumina. Granular, porous form of aluminium oxide which is capable of absorbing water oil vapour or certain other substances from gases or liquids. It is used in pollution control, chromatographic analysis, and as a catalyst.

Activated Carbon. Forms of carbon having a high adsorptive capacity for gases, vapour and colloidal solids. The property is achieved by heating to 900°C with steam or carbon dioxide, giving a porous particle structure. It is used for odor, fume and other pollution control.

Activated Carbon Processes. Japanese processes for removing sulphur dioxide from flue gases. There are three processes :

- (a) Water washing, in which the gas is absorbed on dry activated charcoal and the charcoal washed with water to give dilute sulfuric acid or gypsum.
- (b) Gas desorption, in which the gas is absorbed dry and then desorbed (desorption) to give sulfur dioxide.
- (c) Steam desorption, in which the gas is absorbed to give sulfur dioxide.

Activated Manganese Oxide Process. Japanese process which is used for removing sulfur dioxide from flue gases by dry absorption to produce ammonium sulfate.

Activated Sludge Process. An aerobic process which is utilized in the secondary treatment *e.g.* plants for sewage; organic wastes are brought into contact with biologically active micro-organisms (in returned sludge) in the presence of mechanically introduced air. The activated sludge process is in effect an artificially accelerated self-purification process.

Activated Sludge Settling Tank. A secondary sedimentation tank.

Acute Used in relation to the effects of certain concentrations of air pollutants to describe a response coming rapidly to a climax.

Acute Toxicity. A condition of polluted air or water that kills quickly. Acute toxicity can be found out by a median tolerance limit.

Adaptive Radiation. Diversification of a group of organisms into subgroups which spread in various directions and into various

environments; or, the phenomenon of distantly related organisms evolving similar ecological tolerances, and hence occupying similar niches in similar habitats.

Adiabat. A line on a thermodynamic diagram representing a constant potential temperature.

Adiabat, Dry. A line on a thermodynamic diagram (for example Tephigram) depicting the variation of the temperature of a parcel of dry air as its pressure changes. Since in atmosphere pressure decreases with height, often in lower atmosphere a dry adiabat is taken to be a line on a height-temperature graph such that the slope is $0.98^{\circ}\text{C}/100\text{ m}$.

Adiabatic Lapse Rate. A lapse rate under adiabatic conditions, which is calculated as about 0.5°C temperature drop per 100 m of climb for air saturated with water vapour and 1°C per 100 m climb for dry air. A sub-adiabatic lapse rate (involving less cooling of the air with height) makes, for stability of the air. An atmosphere with a superadiabatic lapse rate (when the temperature drops more than adiabatically) is not stable and so disperses pollutants quickly.

Adiabatic Vaporization. The vaporization of a liquid with practically no heat exchange between the liquid and its surroundings. Normally, the vaporization of a liquid is accompanied by absorption of heat by that liquid.

Adit. In mining it refers to a horizontal or nearly horizontal opening from the surface to the ore. Adits are used for access and for draining mines.

Adsorption (verb adsorb). Adhesion of gases, vapors, liquids of solids on to a solid surface, the adsorbent (e.g. activated alumina, activated carbon). In biological treatment it is an important mechanism for sewage purification. For example, within about 30 min of entering an aeration tank the solid and liquid organics are adsorbed on the flocs of activated sludge. After this adsorption, extracellular enzymes can start to break down the organics in such a way that they get absorbed and transformed by the bacteria.

Adulterant. A chemical impurity or substance that by law does not belong in a food, plant, animal, or pesticide formulation.

Adulticide. A pesticide that is able to kill adult insects.

Advanced Wastewater Treatment, AWT, Advanced Treatment. Further action on sewage effluent that has undergone biological treatment. De-nitrification is one part of AWT, although it may have already begun in the secondary treatment. AWT may include physico-chemical treatment like ammonia stripping, activated carbon or deep-bed filters, ion exchange or membrane processes.

Advection. The process transfer of an atmospheric property (for example, heat, moisture, pollution) by horizontal motion of the air.

Aeolian Deposit (Eolian Deposit). A sediment deposited after being carried by the wind.

Aerated Lagoon. A waste stabilisation pond through which sewage flows, supplied with oxygen by floating surface aerators and sometimes also by diffusers or submerged air pipes.

Aerated Launder, A. Channel. A channel for distributing sewage at a treatment works, with air injected throughout its length along the bottom to hold the solids in suspension. Aerated launders also may be used for distributing mixed liquor to settling tanks.

Aeration. The dissolution of air in a liquid by bringing about intimate contact between air and the liquid either by bubbling air through the liquid or by spraying the liquid in air is called Aeration.

Aeration Period. The theoretical time in hours taken by mixed liquid when subjected to an aeration tank undergoing activated sludge treatment.

Aeration Surface. The absorption of air through the surface of a liquid is generally termed as Aeration surface.

Aeration Tank. A tank for mixing and aeration of sewage and activated sludge—normally 3 to 5 m deep. Tanks may be divided into square pockets three times as deep as their width. Alternatively they may be continuous rectangular channels or oxidation ditches.

Aerator. A machine or other device which is used to dissolve oxygen in sewage or water. It may also purge undesirable gases (hydrogen sulphide or carbon dioxide). Four types exist cascade or free-fall aerators, spray aerators, injection aerators and surface aerators. All types create useful turbulence at the air-water interface.

Aerobe. An organism which can live and grow only in the presence of oxygen. An organism which employs aerobic respiration.

Aerobic Conditions. Environmental conditions in which dioxygen is present.

Aerobic Biological Oxidation. Any waste treatment or process utilizing aerobic organisms, in the presence of air or oxygen, as the agent for reducing the pollution load or oxygen demand of organic substances in waste. The term is used in reference to secondary treatment of waste.

Aerobic Digester. An aeration tank that is used to treat waste activated humus or primary sludges or a mixture of them, usually in a small plant with extended aeration or contact stabilisation treatment.

Aerobic Lagoon

- (1) A maturation pond.
- (2) An aerated lagoon.
- (3) A high-rate aerobic lagoon.

Aerobic Respiration. Process whereby organisms, using gaseous or dissolved oxygen, release energy by the chemical breakdown of food substances.

Aerology. The study of the atmosphere, including the upper air as well as the more general studies understood by world meteorology; frequently used as limiting the study to the upper air.

Aerosol. Finely divided solid or liquid particles of microscopic size suspended and dispersed in a gas or in atmosphere as in the case of mist, fog, haze or smoke. The term is applied to the system of dispersed phase and dispersing medium together, while particles alone are called "aerosol particles".

Aflatoxins. A family of highly toxic chemicals which are made by the fungus *Aspergillus flavus* by growing on grains, coconuts, oil seeds, and nuts. They are among the most toxic substances known to man.

After-blow. In the Bessemer process (now rapidly becoming obsolete) for making steel, phosphorus is removed by continuing to blow air after the carbon has been consumed. It can be a cause of pollution from steel mills.

Afterburner. A device fitted after the main point of fuel combustion in a stationary plant or a vehicle to produce more nearly complete combustion of the exhaust gases. It may be a burner fitted to incinerate polluted process gas.

Agent Orange. A mixture of organochlorine herbicides consisting mainly of 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) and 2, 4-dichlorophenoxyacetic acid (2, 4-D). The Agent Orange used by U.S. military forces in Vietnam reportedly included supplies that were contaminated by dioxin. It is believed that thousands of U.S. troops in Vietnam have been exposed to the defoliant Agent Orange. Effects of exposure to Agent Orange on humans began to appear around 1977, when U.S. soldiers who had been stationed in Vietnam began to show signs of liver and gastrointestinal disorders along with skin rashes, extreme fatigue, joint pains resembling arthritis, and numbness in the hands and feet. Many Vietnam veterans exposed to the substance claimed they suffered such effect as cancer, impotence, and personality changes. Clinical reports have shown that some persons exposed to large doses of 2, 4-D experience muscular weakness, tremors, and, in severe cases, convulsions, paralysis, and even death.

Agglomeration. The clustering or adhering together of a number of small particles to form a body or structure (an agglomerate) which then acts as a larger single particle.

Agglutination. The process of uniting solid particles coated with a thin layer of adhesive material or of arresting solid particles by impact on a surface coated with an adhesive.

Aggradation. Refers to the building up of land by the deposition of material, e.g., by the deposition of detritus by streams where they flow over a surface of reduced gradient.

Agricultural Pollution. The liquid and solid wastes from farming, including runoff from pesticides, fertilizers, and feedlots; erosion and dust from plowing; animal manure and carcasses, crop residues, and debris.

Agricultural Runoff. The water that flows from cultivated land. In many countries it is the greatest single source of pesticides in water, although their content is usually below 1 μ /litre. The effects of pesticide accumulation (biomagnification) in fish or water birds may be serious.

Agricultural Wastes. Very broadly, any refuse of any form agricultural operations of any kind. In common usage, the term generally includes the following types of waste.

- (i) Manure and other wastes from farms and the operation of feedlots or poultry houses.
- (ii) Slaughterhouse wastes.
- (iii) Fertilizer runoff from cropland.
- (iv) Harvest wastes.
- (v) Pesticides that escape in the atmosphere or into the water supply.
- (vi) Salt and silt drained from irrigated land or eroded land.

Air Chemistry Model. A laboratory representation of the conditions involved in the evolution of secondary pollutants from precursor chemicals in the presence of simulated meteorological influences. The data may be based on or combined with results of studies conducted through aircraft and ground-level monitoring programs.

Air Column Separator. A vertical pipe in which an upward air current separates paper, plastics film, etc., by blowing them up away from the 'heavies, which fall to the bottom of the pipe.

Air Contaminant. Any particulate matter, gas, or combination thereof, other than water vapor or natural air.

Air Filter. A device that catches dust from air passing through it, on a mesh of textile fabric, felt, wire, paper, etc., rather than by dust arrestors. Filters are used either for measuring the amount of dust in the air or for reducing it. Their use in activated sludge plants reduces blocking of the diffusers.

Air-Gap Protection. A way of preventing contamination of water by back siphonage in a main.

Air Injection Oxygen I

- (1) Air is injected into sewers to keep the sewage aerobic, especially in pumped rising mains and in the rising limbs of siphons, both of which run full and may become anaerobic. Pure oxygen has at times been used because the volume to be blown in to provide a given dissolved oxygen level is only one-fifth of the corresponding volume of air.
- (2) Diffused-air system.

Air Pollutants. The bulk of air pollutants produced by human activity come from furnaces, the internal combustion engine and the smelting of metals, mainly flyash; sulfur dioxide, SO_2 ; carbon monoxide, CO ; and hydrocarbons. CO_2 , carbon dioxide, although produced in very large quantities, is not regarded as a pollutant. In industrial areas of Britain that produce metalplating wastes, toxic metals, especially cadmium, found in lettuce leaves, are believed to have been brought by polluted rain.

Air Pollution. The contamination of the atmosphere with undesirable solids, liquids and gases. In a strict sense, air may be regarded as polluted when there is added to it any substance foreign or additional to its normal composition. This definition of pollution is much too wide, however, for the purposes of practical air pollution control, and the term 'air pollution' is usually restricted to those conditions in which the general atmosphere contains substances in concentrations which are harmful, or likely to be harmful, to man or to his environment (Table 1)

TABLE 1

Substances with known effects on health (acute or chronic)	Substances thought to have long-term effects per se	Potential long-term effects of combinations
Arsenic	Arsenic (arsenical dermatitis)	
Asbestos	Asbestos (asbestosis, mesothelioma)	
Beryllium	Beryllium (berylliosis)	Be+F (fluorides potentiate pulmonary changes in berylliosis)
Carbon monoxide		Synergistic in pO_2 depression
Carcinogens		Carcinogens produce tumors in presence of promoters
Fluoride	Fluoride (fluorosis)	Fluoride (promoters or accelerates lung disease)
Hydrocarbons		$\text{HC} + \text{O}_3 \rightarrow$ tumorigen + influenza \rightarrow cancer
Hydrogen sulfide (possibly with mercaptans)		Antagonizes pollutants (strictly speaking not detrimental to health)
Inorganic particulates	Inorganic particulates (pulmonary sclerosis)	

Lead Nitric Oxide. Nitrogen dioxide	Nitrogen dioxide (mild accelerator of lung tumors,	NO_2 + micro- organisms (pneu- monia) + HNO_2 (bronch- iolitis, fibrosa obliterans) + tars (smoker's lung cancer)
Organic oxidants (peroxyacetyl nitrates) Organic particulates (asthmagenic agents) Ozone	Asthmagenic agents (asthma) Ozone (chronic lung changes, accelerated aging)	O_3 + micro- organisms (lung- tumor accelera- tor) SO_2 , SO_3 + partic- ulates aggravate lung disease
Sulfur dioxide, sulfur trioxide		

Air Pollution Control. Measures which are taken to maintain a degree of purity of air resources consistent with the promotion of public health and welfare, the protection of plant and animal life, the protection of property and other sources, the visibility requirements for safe ground and air transportation, and continued economic development and growth.

Air Pollution Control (Mists, Dusts, and Gaseous Constituents). Determining gas density involves questions of whether moisture is present or whether the gas molecular weight is other than that of standard air. The basic technique for sampling aerosol mists can be done with an apparatus which is required to collect SO_2 , P_2O_5 , and monoethanolamine (MEA). Filter funnels, three in series, are filled with a 1-in. layer of glass fibre. The gas should have a pressure drop of approximately 10 in. Hg across the funnels for good mist collection. In the presence of water vapor the funnels are mounted in a wooden box fitted with light bulbs to prevent vapor condensation. From the box, impingers remove gaseous constituents such as SO_2 . Gases moved by means of a vacuum pump or an ejector are then metered and their pressure and temperature recorded.

Air Pollution Control (Smith-Greenberg Impinger). Similar to a thimble holder, but used if other contaminants such as SO_2 are present. Since condensation causes an increase in the liquid value in the impinger, this amount is measured, calculated back to gaseous volume, and added to the metered air volume. The