

# Environmental Engineering Glossary

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## A

**Abiotic environment** The part of an ecosystem that includes the nonliving surroundings.

**Activated sludge** An active population of microorganisms used to treat wastewater, or the process in which the organisms are employed.

**Adsorption** A surface phenomena in which a solute (soluble material) concentrates or collects at a surface (the adsorbent).

**Advanced wastewater treatment** The removal of any dissolved or suspended contaminants beyond secondary treatment, often this is the removal of the nutrients nitrogen and/or phosphorus.

**Aeration** Intimate contact of the atmosphere and water to add air (oxygen) to the water. The term is also applied to gas stripping where an undesirable gas is removed from the water. See

**Aerobes** Organisms which require molecular oxygen as an electron acceptor for energy production.

**Aerobic process** A process which requires molecular oxygen.

**Alcohol** An organic compound with one or more hydroxyl "-OH" groups.

**Aldehyde** An organic compound with a carbonyl at one end of a hydrocarbon group.

**Alkalinity** The capacity of a water to neutralize acids.

**Amine** A functional group consisting of "-NH<sub>2</sub>."

**Amino acid** A functional group which consists of a carbon with a carboxylic acid, "-COOH" and an amine, "-NH<sub>2</sub>." These compounds are the building blocks for proteins.

**Anabolism** Biosynthesis, the production of new cellular materials from other organic or inorganic chemicals.

**Anaerobes** A group of organisms that do not require *molecular* oxygen. These organisms, as well as all known life forms, require oxygen. These organisms obtain their oxygen from inorganic ions such as nitrate or sulfate or from protein.

**Anaerobic process** A process which only occurs in the absence of molecular oxygen.

**Anoxic process** A process which occurs only at very low levels of molecular oxygen or in the absence of molecular oxygen.

**Anthropogenic** Of, made, or caused by human activity or actions.

**Aromatic** A form of bonding in which ring compounds share electrons over more than two atoms. The electrons are delocalized. This leads to unusual ring stability.

**Attached growth reactor** A reactor in which the microorganisms are attached to engineered surfaces within the reactor. Examples of attached growth reactors are the trickling filter and the rotating biological contactor.

**Autotrophic** Organisms which utilize inorganic carbon for synthesis of protoplasm. Ecologists narrow the definition further by requiring that autotrophs obtain their energy from the sun. In microbiologist parlance, this would be a photoautotroph.

**Autotrophs** A group of organisms capable of obtaining carbon for synthesis from inorganic carbon sources such as carbon dioxide and its dissolved species (the carbonates). This group includes plants and algae.

## B

**Bacteria** One celled microorganisms which do not have a nuclear membrane.

**Baghouse filter** A fabric filter device used to remove particulate air pollutants.

**Biochemical oxygen demand (BOD)** The amount of oxygen required to oxidize any organic matter present in a water during a specified period of time, usually 5 days. It is an indirect measure of the amount of organic matter present in a water.

**Biofilm** A film of microorganisms attached to a surface, such as that on a trickling filter, rotating biological contactor, or rocks in natural streams.

**Biogeochemical cycle** The cycle of elements through the biotic and abiotic environment.

**Biosynthesis** Catabolism, the production of new cellular materials from other organic or inorganic chemicals.

**BOD** See biochemical oxygen demand.

## C

**Carbonaceous biochemical oxygen demand (CBOD)** The amount of oxygen required to oxidize any carbon containing matter present in a water.

**Carbonyl** A functional group with an oxygen atom double bonded to a carbon atom.

**Catabolism** The production of energy by the degradation of organic compounds.

**Cell** A unit of varying dimensions in a landfill which is isolated from the environment by 6 to 12 inches of soil cover. A cell is one day's waste or less. A cell is covered with soil at the end of each day.

**CFCs** Chlorofluorocarbons, chemicals which result in a depletion of the ozone layer in the upper atmosphere.

**Chemical fixation (or stabilization/solidification)** A term for several different methods of chemically immobilizing hazardous materials into a cement, plastic, or other matrix.

**Chemical oxygen demand (COD)** The amount of oxygen required to oxidize any organic matter in the water using harsh chemical conditions.

**Chemoautotrophic** Organisms which utilize inorganic carbon (carbon dioxide or carbonates) for synthesis and inorganic chemicals for energy.

**Chemotroph** Organisms which obtain energy from the metabolism of chemicals, either organic or inorganic.

**Chlorofluorocarbons** Synthetic organic compounds used for refrigerants, aerosol propellants (prohibited in the U.S.), and blowing agents in plastic foams. CFCs migrate to the upper atmosphere destroying ozone and increasing global warming. Typical atmospheric residence times are 50 to 200 years.

**Clarifier** (sedimentation basin) A tank in which quiescent settling occurs, allowing solid particles suspended in the water to agglomerate and settle to the bottom of the tank. The solids resulting from the settling being removed as a sludge.

**Climatology** The study of the climate, how the earth's atmosphere performs over long periods of time.

**Closure** The act of preparing a landfill for long term inactivity, including placement of a cover over the landfill to prevent infiltration of surface water.

**Coagulation** Particle destabilization to enhance agglomeration.

**COD** See chemical oxygen demand.

**Colloids** Small particles which have a negligible settling velocity. These particles have a very small mass so gravitational force is low compared to surface frictional forces. Typical colloidal sizes range from  $10^{-3}$  mm to 1 mm.

**Complexation** The ionic bonding of one or more central ions or molecules by one or more surrounding ions or molecules.

**Component** A part of a mixture or solution.

**Composting** The controlled aerobic degradation of organic wastes into a material which can be used for landscaping, landfill cover, or soil conditioning.

**Compound** A substance composed of two or more elements.

**Compression settling** Settling which occurs in the lower reaches of clarifiers where particle concentrations are highest. Particles can settle only by compressing the mass of particles below.

**Consumers** Organisms which consume protoplasm produced from photosynthesis or consume organisms from higher levels which indirectly consume protoplasm from photosynthesis.

**Conversion** The fraction of a species entering a system which is converted to product.

**Corrosive waste** A waste that is outside the pH range of 2 to 12.5 or a waste that corrodes steel at a rate greater than 6.35 mm (0.25 in) per year. One of EPA's four hazardous waste properties.

**Covalent bond** A bond in which electrons are shared approximately equally by two atoms.

**Cybernetic** Systems which change in response to feedback.

## D

**Decomposers** Organisms which utilize energy from wastes or dead organisms. Decomposers complete the cycle by returning nutrients to the soil or water and carbon dioxide to the air or water.

**Denitrification** The anoxic biological conversion of nitrate to nitrogen gas. It occurs naturally in surface waters low in oxygen, and it can be engineered in wastewater treatment systems.

**Deoxygenation** The consumption of oxygen by the different aquatic organisms as they oxidized materials in the aquatic environment.

**Discrete settling** Settling in which individual particles settle independently, neither agglomerating or interfering with the settling of the other particles present. This occurs in waters with a low concentration of particles.

**Disease** Any impairment of the normal function of an organism.

**Disinfection** The destruction or inactivation of pathogenic microorganisms.

**Dispersion** A stable mixture of particles suspended in a fluid medium.

**Dissolved oxygen (DO)** The amount of molecular oxygen dissolved in water.

**Dump** An illegal and uncontrolled area where wastes have been placed on or in the ground.

## E

**Ecology** The study of living organisms and their environment or habitat.

**Ecosystem** An organism or group of organisms and their surroundings. The boundary of an ecosystem may be arbitrarily chosen to suit the area of interest or study.

**Effluent** The fluid exiting a system, process, tank, etc. An effluent from one process can be an influent to another process.

**Effluent based standards** Standards which set concentration or mass per time limits on the effluent being discharged to a receiving water.

**Electronegativity** The potential of an atom to attract electrons when the atom is bonded in a compound. The scale is 0 to 4 with 0 being the most electropositive (low attraction) and 4 being the most electronegative (high attraction).

**Electrostatic precipitator** A device which uses an electric field to trap particulate pollutants.

**Elementary reaction** A reaction in which the rate expression corresponds to the stoichiometric equation.

**Epilimnion** The top layer of a lake.

**Equivalent** The mass of the compound which will produce one mole of available reacting substance. Thus, for an acid, this would be the mass of acid which will produce one mole of  $H^+$ , for a base, one mole of  $OH^-$ .

**Ethers** An organic compound which has two hydrocarbon groups bound by an interior oxygen atom. The general formula is  $R'-O-R''$ .

**Eucaryotic organisms** Organisms which possess a nuclear membrane. This includes all known organisms except viruses and bacteria.

**Evaporation** The conversion of liquid water to water vapor. It occurs on the surface of water bodies such as lakes and rivers and immediately after precipitation events in small depressions and other storage areas.

**Evapotranspiration** The sum of evaporation and transpiration. Since it is difficult to measure the two terms independently, they are often grouped as one value.

## F

**Facultative** A group of microorganisms which prefer or preferentially use molecular oxygen when available, but are capable of using other pathways for energy and synthesis if molecular oxygen is not available.

**Fermentation** Energy production without the benefit of oxygen as a terminal electron acceptor, i.e. oxidation in which the net effect is one organic compound oxidizing another.

**Fixed solids (FS)** are the solids that do not volatilize at  $550^{\circ}C$ .

**Fixed suspended solids (FSS)** is the matter remaining from the suspended solids analysis which will not burn at 550°C. It represents the non-filterable inorganic residue in a sample.

**Flash point** The lowest temperature at which sufficient vapor is produced to cause combustion if an ignition source is present.

**Flocculant settling** Settling in which particle concentrations are sufficiently high that particle agglomeration occurs. This results in a reduction in the number of particles and an increase in average particle mass. As agglomeration occurs higher settling velocities result.

**Fluidization** The suspension of particles by sufficient upward velocity of the fluid. During fluidization the gravity force is overcome by a combination of buoyancy and fluid friction.

**Flux** The movement of a mass past a surface, plane, or boundary. The units are mass per unit area per unit time or [Kg/m<sup>2</sup>-hour].

## G

**Gas stripping** Gas transfer of an undesirable gas from a water stream to the atmosphere.

**Global warming** The long-term warming of the planet due to increases in greenhouse gases which trap reflected light preventing it from exiting to space.

**Greenhouse gases** Gases which trap solar radiation. Of the solar energy entering the earth's atmosphere a portion is reflected back and a portion penetrates onto the earth's surface. The portion reflected back from the earth's surface is at a different wavelength than when it entered. Carbon dioxide and other gases, which pass solar radiation, absorb this reflected radiation, increasing the earth's temperature. This is much like a greenhouse, hence the name.

**Groundwater** Water which is contained in geologic strata. Also properly written as two words, ground water.

## H

**HAPs** Hazardous air pollutants.

**Hardness** The sum of the divalent cation concentrations expressed as meq/L or mg calcium carbonate per liter [mg CaCO<sub>3</sub>/L]. It is important because hard waters require increased amounts of soap for bathing or washing clothes and because of scale formation on piping, cooking vessels, water heaters, boilers, heat exchangers, etc.

**Heterotrophic** A group of organisms which obtain carbon for synthesis from other organic matter or proteins.

**Hindered (Zone) settling** Settling in which particle concentrations are sufficient that particles interfere with the settling of other particles. Particles settle together as a body or structure with the water required to traverse the particle interstices.

**Hydrocarbon** Any organic compound composed entirely of carbon and hydrogen. Two examples are methane gas and octane.

**Hypolimnion** The lower layer of a lake.

## I

**In situ treatment** Treatment of a waste in place, as opposed to pumping or digging the waste up and then treating it.

**Infectious disease** A disease caused by pathogenic organisms.

**Infiltration** The movement of water from the surface of the land through the unsaturated zone and into the groundwater. This occurs during and immediately after precipitation events. It can also occur at the bottom of lakes and rivers.

**Influent** The fluid entering a system, process, tank, etc. An effluent from one process can be an influent to another process.

**Ion exchange** An adsorption process in which one ion is exchanged for another ion of like charge. There is an equivalence of exchanged charge.

**Irreversible reaction** A reaction in which the reactant(s) proceed to product(s), but the products react at an appreciable rate to reform reactant(s).

**Isomers** Two or more different compounds with the same chemical formula but different structure and characteristics.

## J

## K

**Kerogen** A fossilized organic material present in oil shale and some other sedimentary rocks.

**Ketones** Organic compounds with two hydrocarbon groups bonded to a carbonyl group.

## L

**Landfill** A legal and controlled area for the placement of wastes into the ground.

**Landfilling** The placement of wastes into the land under controlled conditions to minimize their migration or effect on the surrounding environment.

**Leachate** A liquid generated in landfills. It is the result of water seeping into and through the wastes. As the water contacts the waste materials it dissolves part of the organic and inorganic matter contained in the landfill. If this leachate is allowed to exit the bottom of the landfill, it will carry contaminants to the groundwater and/or adjoining surface water.

**Leaching** The act of dissolving the soluble portion of a solid mixture by some solvent. An example is the dissolving of inorganic or organic contaminants from refuse in a landfill by infiltrating rain water.

**Ligand** The ion or molecule which surrounds or complexes with the central atom or ion.

**Limnology** The study of freshwater ecosystems.

## M

**Mass balance** An organized accounting of all inputs and outputs to an arbitrary but defined system. Stated in other terms, the rate of mass accumulation within a system is equal to the rate of mass input less the rate of mass output plus the rate of mass generation within the system.

**Maximum contaminant level (MCL)** The maximum allowable concentration of a given constituent in potable water.

**MCL** See maximum contaminant level.

**Mercaptans** See thiols.

**Metabolism** The processes which sustain an organism, including energy production, synthesis of proteins for repair and replication.

**Metalimnion** The middle layer of a lake.

**Meteorology** The study of the atmosphere and weather of the lower atmosphere, below 100 km.

**Mixed liquor suspended solids (MLSS)** The total suspended solids concentration in the activated sludge tank.

**Mixed liquor volatile suspended solids (MLVSS)** The volatile suspended solids concentration in the activated sludge tank.

**MLSS** See mixed liquor suspended solids.



**MLVSS** See mixed liquor volatile suspended solids.

## N

**Nitrification** The biological oxidation of ammonia and ammonium sequentially to nitrite and then nitrate. It occurs naturally in surface waters, and can be engineered in wastewater treatment systems. The purpose of nitrification in wastewater treatment systems is a reduction in the oxygen demand resulting from the ammonia.

**Nitrogen fixation** The conversion of atmospheric (or dissolved) nitrogen gas into nitrate by microorganisms.

**Nitrogenous oxygen demand (NOD)** The amount of oxygen required to oxidize any ammonia present in a water.

**Nonpoint source pollution (NPSP)** Any pollution from a source which cannot be attributed to a particular discharge point, e.g. from agricultural crops, city streets, construction sites, etc.

**NPDES** The National Pollutant Discharge Elimination System. The discharge criteria and permitting system established by the U.S. EPA as a result of the Clean Water Act and its subsequent amendments or the permit required by each discharger as a result of the Clean Water Act.

**NPSP** See nonpoint source pollution.

## O

**Organic compound** Any compound containing carbon except for the carbonates (carbon dioxide, the carbonates and bicarbonates), the cyanides, and cyanates.

**Organic nitrogen** Nitrogen contained as amines in organic compounds such as amino acids and proteins.

**Oxidative phosphorylation** The synthesis of the energy storage compound adenosine triphosphate (ATP) from adenosine diphosphate (ADP) using a chemical substrate and molecular oxygen.

**Packed tower** See trickling filter.

**Pathogenic organism** An organism capable of causing infection.

**Phenol** An aromatic benzene ring with a hydroxyl substituted for one hydrogen.

**Phenyl-** A benzene ring named as a constituent group, C<sub>6</sub>H<sub>5</sub>-.

**Phosphorylation** The synthesis of the energy storage compound adenosine triphosphate (ATP) from adenosine diphosphate (ADP).

**Photoautotrophic** Organisms which utilize inorganic carbon dioxide for protoplasm synthesis and light for an energy source.

**Photochemical pollutants** Chemicals which react photochemically (in the presence of sunlight) to destroy ozone in the stratosphere.

**Photophosphorylation** The synthesis of the energy storage compound adenosine triphosphate (ATP) from adenosine diphosphate (ADP) using solar energy.

**Phototroph** Organisms which obtain energy from light using photooxidation.

**Pollution** Any man made condition which adversely affects the quality of the environment.

**Potable water** Water that has does not contain harmful or objectionable impurities and is aesthetically pleasing to drink.

**POTW** or Publicly Owned Treatment Works Any municipally owned wastewater treatment facility.

**Precipitation** The falling to earth of condensed water vapor in the form of rain, snow, sleet or hail.

**Primary standards** Required drinking water quality standards related directly to human health. These standards are required and enforceable by the U.S. EPA.

**Primary treatment** Treatment which includes all operation prior to and including primary treatment, e.g., bar screening, grit removal, comminution, and primary sedimentation.

**Procarvotic organisms** Organisms which do not have a cellular membrane.

**Producers** Autotrophic organisms which produce protoplasm using inorganic carbon and energy from the sun.

**Publicly owned treatment works (POTW)** A municipal or domestic wastewater treatment facility.

## Q

## R

**Reactive waste** A waste which; 1) reacts violently with water, 2) forms potentially explosive mixtures with water, 3) is normally unstable, 4) contains cyanide or sulfide in sufficient quantity to evolve toxic fumes at high or low pH, 5) is capable of exploding if heated under pressure, or 6) is an explosive compound listed in Department of Transportation (DoT) regulations. One of EPA's four hazardous waste properties.

**Reaeration** The dissolving of molecular oxygen from the atmosphere into the water.

**Receiving water** A water which receives wastewater (treated or otherwise) discharges.

**Receiving water quality standards** Standards which require a discharger to maintain a certain quality level in the receiving water.

**Recycling** The recovery and reuse of a product which would otherwise be thrown away.

**Refuse** All forms of solid waste.

**Refuse derived fuel (RDF)** A fuel derived from the combustible portion of municipal solid waste. The fuel is often processed into small briquettes, similar in size to charcoal.

**Respiration** Energy production in which oxygen is the terminal electron acceptor, i.e. oxidation to produce energy where oxygen is the oxidizing agent.

**Reversible reaction** A reaction in which the reactant(s) proceed to product(s), but the products react at an appreciable rate to reform reactant(s).

**Runoff** The water that flows overland to lakes or streams during and shortly after a precipitation event.

## S

**Saltwater intrusion** The gradual replacement of freshwater by saltwater in coastal areas where excessive pumping of groundwater occurs.

**Secondary standards** Recommended drinking water quality standards which relate to aesthetics and/or health. These standards are recommended, not required.

**Secondary treatment** In wastewater treatment, the conversion of the suspended, colloidal and dissolved organics remaining after primary treatment into a microbial mass which is then removed in a second sedimentation process. Secondary treatment included **both** the biological process and the associated sedimentation process.

**Secured landfill** A landfill which has containment measures such as liners and a leachate collection system so that materials placed in the landfill will not migrate into the surrounding soil, air and water.

**Sedimentation** The gravity settling, and thus removal, of materials more dense than the suspending fluid.

**Sedimentation basin.** See clarifier.

**Shock load** Influent wastewater entering the plant which has an unusually high organic content and/or high flow rate.

**Site remediation** The process of cleaning up a hazardous waste disposal site that has either been abandoned or that those responsible either refuse to cleanup or are financially unable to cleanup.

**Siting** Obtaining government (federal, state, and local) permission to construct an environmental processing, treatment, or disposal facility at a given site.

**Sludge** A mixture of solid waste material and water. Sludges result from the concentration of contaminants in water and wastewater treatment processes. Typical wastewater sludges contain from 0.5 to 10 percent solid matter. Typical water treatment sludges contain 8 to 10 percent solids.

**Softening** The removal of divalent cations by precipitation or ion exchange.

**Solidification** See chemical fixation.

**Solids flux** See flux.

**Source reduction** The elimination or reduction of the waste at the source by modification of the actual process which produces the waste.

**Species** In chemistry, an ion or molecule in solution.

**Stabilization** See chemical fixation.

**Sterilization** The destruction or inactivation of all microorganisms.

**Storage** The short term retention of water after a precipitation event.

**Stratosphere** The atmosphere from approximately 12 km to 70 km. The temperature of the atmosphere increases in this region.

**Stream based standards** See receiving water quality standards.

**Strong acid** An acid that, for practical purposes, ionizes completely under the conditions of interest. Common strong acids are hydrochloric, nitric, and sulfuric. See weak acid.

**Substrate level phosphorylation** The synthesis of the energy storage compound adenosine triphosphate (ATP) from adenosine diphosphate (ADP) using organic substrates without molecular oxygen.

**Surface water** Water which is contained in lakes, rivers, and oceans.

**Suspended growth reactor** A reactor in which the microorganisms are suspended in the wastewater. Examples of suspended growth reactors are activated sludge reactors and anaerobic digesters. See attached growth reactor.

**Synergism** is the act of working together. Two chemicals which are synergistic have a greater effect together than the sum of their individual effects. The effect can be either positive or negative.

**System** An arbitrarily defined area or volume surrounded by a boundary and possessing specific inputs, outputs, and reactions.

**T**

**Thermocline** The depth at which an inflection point occurs in a lake temperature profile.

**Thiols** Organic compounds which contain the "-SH" functional group. Also called mercaptans.

**Total dissolved solids** (TDS) is the amount of dissolved matter in the water.

**Total solids** (TS) is the amount of organic and inorganic matter which is contained in a water.

**Total suspended solids** (TSS) is the amount of suspended (filterable) matter in a water.

**Toxicity** A U.S. EPA hazardous waste characteristic defined with a rigorous test procedure, the TCLP (for Toxicity Characteristic Leaching Procedure). In the procedure, a waste is extracted for 24 hours with an acetic acid solution. The acid extract is then analyzed for the presence of any of the contaminants listed in the procedure.

**Trace contaminants** Contamination found in trace (very low) levels.

**Transpiration** The loss of water from plants through leaves and other parts. This loss can be a significant amount of water during very dry periods.

**Trickling filter** An attached growth biological process in which the microbial film is attached to non-moving rock or plastic media.

**Trophic level** A level in the food chain. The first trophic level consists of the primary producers, autotrophs. The second trophic level is vegetarians which consume autotrophic organisms.

**Troposphere** The lower atmosphere, from the earth's surface to approximately 12 km. This portion of the earth's atmosphere contains about 95 percent of the atmospheric gases. The temperature gradually declines through this region.

## U

**Ultimate biochemical oxygen demand (BOD<sub>u</sub>)** The total amount of oxygen required to oxidize any organic matter present in a water, i.e. after an extended period, such as 20 or 30 days.

**Ultimate disposal** The process of returning residuals back to the environment in a form which will have the minimal or reduced negative environmental impacts.

## V

**Virion** A virus particle. Viral DNA or RNA enclosed in an organic capsule. See virus.

**Virus** A submicroscopic genetic constituent which can alternate between two distinct phases. As a virus particle, or virion, it is DNA or RNA enveloped in an organic capsule. As an intracellular virus, it is viral DNA or RNA inserted into the host organisms DNA or RNA.

**Volatile** A material which will vaporize easily.

**Volatile solids** (VS) is the amount of matter which volatilizes (or burns) when a water sample is heated to 550EC.

**Volatile suspended solids** (VSS) is the non-filterable residue remaining after firing the total suspended solids at 550EC. See total suspended solids and fixed suspended solids.

## W

**Waste minimization** The elimination or reduction of a waste prior to its generation. This is accomplished by process changes rather than waste treatment methods.

**Wastewater** Consumed or used water from a municipality or industry that contains dissolved and/or suspended matter.

**Weak acid** An acid that does not ionize completely under the conditions of interest. Examples include acetic acid, carbonic acid, and hypochlorous acid. See strong acid.

**Wetland** Semi-aquatic land, that is land that is either inundated or saturated by water for varying periods of time during each year, and that supports aquatic vegetation which is specifically adapted for saturated soil conditions.

## X

## Y

## Z

**Zone settling** See hindered settling.