Topic Page: Carbon

Definition: **carbon (C)** from *Processing Water, Wastewater, Residuals, and Excreta for Health and Environmental Protection: An Encyclopedic Dictionary*

(1) An element present in all materials of biological origin. Atomic weight = 12.011. Atomic number = 6. Specific gravity varies from 1.8 (amorphous carbon) to 3.5 (diamond). Valence = 4. It forms innumerable compounds, particularly the carbohydrates and chains containing carbon and other atoms close to it in the periodic table. It is the primary element of organic matter, but carbon dioxide (CO_2) and its compounds are inorganic. It occurs in a pure state as diamond or graphite or in an impure state as charcoal. (2) Same as activated carbon.

Image from:
Powdered activated carbon. in *Water Encyclopedia: Water Quality and Resource Development*

Summary Article: **carbon**
From *The Columbia Encyclopedia*

[Lat.,=charcoal], nonmetallic chemical element; symbol C; at. no. 6; interval in which at. wt. ranges 12.0096–12.0116; m.p. about 3,550 degrees Celsius; graphite sublimes about 3,375 degrees Celsius; b.p. 4,827 degrees Celsius; sp. gr. 1.8–2.1 (amorphous), 1.9–2.3 (graphite), 3.15–3.53 (diamond); valence +2, +3, +4, or −4.

Properties and Isotopes

Carbon is found free in nature in at least four distinct forms (see allotropy). One form, graphite, is a very soft, dark gray or black, lustrous material with either a hexagonal or rhombohedral crystalline structure. Diamond, a second crystalline form, is the hardest substance known. In a third form, the so-called amorphous carbon, the element occurs partly free and partly combined with other elements; charcoal, coal, coke, lampblack, peat, and lignite are some sources of amorphous carbon. A fourth form contains the fullerenes, stable molecules consisting of carbon atoms that arrange themselves into 12 pentagonal faces and any number greater than 1 of hexagonal faces. The most prominent of the fullerenes is buckminsterfullerene, a spheroidal molecule, resembling a soccer ball, consisting of 60 carbon atoms. A fifth form, “white” carbon, is believed to exist. Carbon has the capacity to act chemically both as a metal and as a nonmetal. It is a constituent of all organic matter.

Carbon has 13 known isotopes, which have from 2 to 14 neutrons in the nucleus and mass numbers from 8 to 20. Carbon-12 was chosen by IUPAC in 1961 as the basis for atomic weights; it is assigned an atomic mass of exactly 12 atomic mass units. Carbon-13 absorbs radio waves and is used in nuclear magnetic resonance spectrometry to study organic compounds. Carbon-14, which has a half-life of 5,730 years, is a naturally occurring isotope that can also be produced in a nuclear reactor. It is used extensively as a research tool in tracer studies; a compound synthesized with carbon-14 is said to be “tagged” and can be traced through a chemical or biochemical reaction. Carbon-14 has been used in the study of such problems as utilization of foods in animal nutrition, catalytic petroleum processes, photosynthesis, and the mechanism of aging in steel. It is also used for determining the age of archaeological specimens (see dating).

Compounds

There are more carbon compounds than there are compounds of all other elements combined. The

study of carbon compounds, both natural and synthetic, is called organic chemistry. Plastics, foods, textiles, and many other common substances contain carbon. Hydrocarbon fuels (e.g., natural gas), marsh gas, and the gases resulting from the combustion of fuels (e.g., carbon monoxide and carbon dioxide) are compounds of carbon. With oxygen and a metallic element, carbon forms many important carbonates, such as calcium carbonate (limestone) and sodium carbonate (soda). Certain active metals react with it to make industrially important carbides, such as silicon carbide (an abrasive known as carborundum), calcium carbide, used for producing acetylene gas, and tungsten carbide, an extremely hard substance used for rock drills and metalworking tools.

Natural Occurrence and Uses

Carbon has been known to humans in its various forms since ancient times. Although carbon makes up only .032% of the earth's crust, it is very widely distributed and forms a vast number of compounds. Carbon exists in the stars; a series of thermonuclear reactions called the carbon cycle (see nucleosynthesis) is a source of energy for some stars. Carbon in the form of diamonds has been found in meteorites. Coke is used as a fuel in the production of iron. Carbon electrodes are widely used in electrical apparatus. The “lead” of the ordinary pencil is graphite mixed with clay. The successful linking in the 1940s of carbon with silicon has led to the development of a vast number of new substances known collectively as the silicones.

Biological Importance

All living organisms contain carbon; the human body is about 18% carbon by weight. In green plants carbon dioxide and water are combined to form simple sugars (carbohydrates); light from the sun provides the energy for this process (photosynthesis). The energy from the sun is stored in the chemical bonds of the sugar molecule. Anabolism, the synthesis of complex compounds (such as fats, proteins, and nucleic acids) from simpler substances, involves the utilization of energy stored by photosynthesis. Catabolism is the release of stored energy by the oxidative destruction of organic compounds; water and carbon dioxide are two byproducts of catabolism. This continuing synthesis and degradation involving carbon dioxide is known as the biological carbon cycle.

Bibliography

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