

Chemical of the Week

METHANE – CH₄

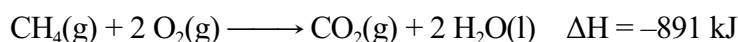
Methane is a colorless, odorless gas with a wide distribution in nature. It is the principal component of natural gas, a mixture containing about 75% CH₄, 15% ethane (C₂H₆), and 5% other hydrocarbons, such as propane (C₃H₈) and butane (C₄H₁₀). The “firedamp” of coal mines is chiefly methane. Anaerobic bacterial decomposition of plant and animal matter, such as occurs under water, produces marsh gas, with is another name for methane.

At room temperature, methane is a gas less dense than air. It melts at –183 °C and boils at –164 °C. It is not very soluble in water. Methane is combustible, and mixtures of about 5 to 15 percent in air are explosive. Methane is nontoxic when inhaled, but it can produce suffocation by reducing the concentration of oxygen inhaled. A tiny amount of smelly organic sulfur compounds (tertiary butyl mercaptan, (CH₃)₃CSH, and dimethyl sulfide, CH₃SCH₃) is added to give commercial natural gas a detectable odor. This is done to make gas leaks readily detectible. An undetected gas leak could result in an explosion or asphyxiation.

Methane is synthesized commercially by the distillation of bituminous coal and by heating a mixture of carbon and hydrogen. It can be produced in the laboratory by heating sodium acetate with sodium hydroxide and by the reaction of aluminum carbide (Al₄C₃) with water.

In the chemical industry, methane is a raw material for the manufacture of methanol (CH₃OH), formaldehyde (CH₂O), nitromethane (CH₃NO₂), chloroform (CH₃Cl), carbon tetrachloride (CCl₄), and some freons (compounds containing carbon and fluorine, and perhaps chlorine and hydrogen). The reactions of methane with chlorine and fluorine are triggered by light. When exposed to bright visible light, mixtures of methane with chlorine or fluorine react explosively.

The principal use of methane is as a fuel. The combustion of methane is highly exothermic.



The energy released by the combustion of methane, in the form of natural gas, is used directly to heat homes and commercial buildings. It is also used in the generation of electric power. During the past decade natural gas accounted for about 1/5 of the total energy consumption worldwide, and about 1/3 in the United States. The cost of natural gas to Wisconsin consumers is regulated by the State Public Service Commission. Madison Gas & Electric Company currently charges its residential customers about \$0.76 per 100 cubic feet.

Natural gas occurs in reservoirs beneath the surface of the earth. It is often found in conjunction with petroleum deposits. Before it is distributed, natural gas usually undergoes some sort of processing. Usually, heavier hydrocarbons (propane and butane) are removed and marketed separately. Non-hydrocarbon gases, such as hydrogen sulfide, must also be removed. The cleaned gas is then distributed throughout the country through thousands of miles of pipeline. Local utility companies add an odorant before delivering the gas to their customers.

Some methane is manufactured by the distillation of coal. Coal is a combustible rock formed from the remains of decayed vegetation. It is the only rock containing significant amounts of carbon. The elemental composition of coal varies between 60% and 95% carbon. Coal also contains hydrogen and oxygen, with small concentrations of nitrogen, chlorine, sulfur, and several metals. Coals are classified by the amount of volatile material they contain; that is, by how much of the mass is vaporized when the coal is heated to about 900 °C in the absence of air. Coal that contains more than 15% volatile material is called

bituminous coal. Substances released from bituminous coal when it is distilled, in addition to methane, include water, carbon dioxide, ammonia, benzene, toluene, naphthalene, and anthracene. In addition, the distillation also yields oils, tars, and sulfur-containing products. The non-volatile component of coal, which remains after distillation, is coke. Coke is almost pure carbon and is an excellent fuel. However, it may contain metals, such as arsenic and lead, that can be serious pollutants if the combustible products are released into the atmosphere.