Ethanol, a biofuel, is produced by carbohydrate fermentation processes, hydration of ethylene, and, to a lesser extent, reduction of acetaldehyde obtained from acetylene.

Ethanol is a colorless liquid with a mild and characteristic aroma and taste. It has a boiling point of 78.3°C and a melting point of -114.5°C Celsius. At 20°C Celsius it has a density of 0.7894 gram per milliliter.

Ethanol—also known as ethyl alcohol, grain alcohol, or spirits—has traditionally found many uses in the chemical industry: for the preparation of numerous esters vital to many polymer industries, for the production of diethyl ether (also called ether or ethyl ether), and as a major solvent and extractant. However, it has been best known for thousands of years as the primary alcohol component in alcoholic beverages and, since the 1970s, as a potentially significant source of transportation fuel, either as a gasoline replacement or as a blend fuel stretching available petroleum supplies.
and a refractive index of 1.3614. Its molar mass is 46.07 grams. Ethanol is completely soluble in water and most organic solvents. It has a flash point of 8° Celsius and is thus highly flammable.

**Description, Distribution, and Forms**

Alcohol obtained from fermentation processes is generally included with other fermentation products and extracts from the carbohydrate-rich grains, fruits, and so on that are the raw materials for the multitudinous alcoholic beverages produced and consumed on Earth. Alcohol produced by yeast fermentation is obtained at a maximum concentration of 14 percent; therefore, alcoholic beverages other than beer and nonfortified wines require the addition of concentrated alcohol, which is obtained by distilling dilute alcohol from the fermentation of molasses and other sugar sources. In the United States and other highly industrialized countries, the alcohol added to beverages has increasingly been produced by other methods.

Ethanol is also used in large quantities for chemical synthesis in the organic chemical industry. It is used for the preparation of numerous esters vital to many polymer industries and for the production of diethyl ether (also called ether or ethyl ether), a major solvent and extractant. Other synthetic procedures lead to the manufacture of acetaldehyde, acetic acid, ethyl halides, and acetonitrile, which are in turn employed for the preparation of drugs, explosives, adhesives, pesticides, detergents, synthetic fibers, and other substances. Ethanol itself is used in vast quantities as an extractant or solvent.

For some time, ethanol has been added to gasoline in winter to reduce air pollution, an advantage of ethanol that has been viewed as particularly valuable since the Kyoto Protocol (1997) and other international agreements obligated their signors to reduce the carbon emissions associated with internal combustion engines. Thus, the United States and other oil-importing countries have frequently explored and, to some degree, pursued the "gasohol" option of combining ethanol with varying amounts of gasoline.

**History**

The fermentation of various fruits and other products of the soil into drinking alcohol can produce pleasant tastes and, in the minds of people throughout the globe and for a very long part of history, a pleasurable effect. Based on archaeological discoveries, there is evidence of alcoholic imbibing as early as the sixth century b.c.e.

Historically, ethanol has been used as a home fuel source, albeit more recently than as a beverage. In the 1820s, for example, a blend of ethanol and turpentine was utilized as lamp fuel in the majority of American homes. Subsequently, natural gas and electricity displaced ethanol in home use in the United States and Europe, but it is still used in rural areas of the developing world for lighting and cooking. It is also widely employed as a part of everyday life in American and European homes as rubbing alcohol and as a solvent in chemical products.

Ethanol was used to power cars—especially in Western Europe—well before the Model T rolled off the first assembly line in 1908, driven by a motor based on an 1860 internal combustion engine developed in Germany to run on ethanol. However, before the first Model T was produced, the discovery of oil in the United States in the 1880s and the high tax that Congress enacted on industrial alcohol during the Civil War had combined to render the production of ethanol for transportation purposes both uneconomical and unnecessary. Both the Prohibition era in the United States (1919–33), which tainted the home production of ethanol for fuel purposes as "closet moonshining," and the discovery of deep pools of cheap oil in the Middle East during the period between World War I and World War II pushed ethanol further off the market as a source of transportation fuel until the 1973 energy crisis.

**Obtaining Ethanol**

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Beverage alcohol is produced from a great variety of sources, including grains, potatoes, and fruit, but fermentation-based industrial alcohol is almost entirely obtained by yeast fermentation of molasses. Molasses (50 percent sucrose residue from sugar processing or cornstarch) is diluted with water to approximately 15 percent and under slightly acidic conditions is fermented by yeast to give 14 percent ethanol. Fractional distillation of the solution yields the commercial product: 95 percent ethanol. Approximately 9 liters of blackstrap molasses are needed to make 3.785 liters of 190-proof ethanol.

Although ethylene hydration was known in the early part of the nineteenth century, it did not become an industrial process until 1929; today, it is the dominant method of producing ethanol. Ethylene, obtained from the thermal cracking of petroleum fractions or from natural gas separation processes, is treated with complex phosphoric acid–based catalysts at temperatures above 300° Celsius and steam at pressures of thousands of kilograms per square centimeter. The ethanol can be fractionally distilled, and the residual ethylene can be recycled. Ethylene can also be passed into concentrated sulfuric acid, and after hydrolysis, the ethanol can be distilled from the diluted sulfuric acid.

**Uses of Ethanol**

Despite ethanol’s importance in the production of alcoholic beverages and its continued employment in various sectors of the chemical industry, its utility as a means of reducing petroleum dependency has commanded the most commentary and controversy since 1973, when Arab states embargoed oil shipments to countries supporting Israel in the Yom Kippur War.

Whether corn or sugarcane is used as ethanol's feedstock, concern exists that the expanded cultivation of both of these crops will greatly increase both air and water pollution. The indictment is especially levied against corn, because its cultivation requires the most pesticides and insecticides of any crop grown in the United States. The “pesticide cocktail”—composed of four weed killers, three insecticides, and two fungicides—produces a toxic effect known to kill wildlife, and its runoff damages subsoil streams and, hence, threatens the US supply of drinking water. Increasing the production of ethanol increases environmental costs. So too does burning it in internal combustion engines, in which—depending on the gasohol mixture of ethanol and petroleum—ethanol fuels can produce more than twice as much ground ozone as gasoline. Meanwhile, in the short term, reallocating existing corn production to meet a growing demand for ethanol inflates the cost of corn and of everything depending on it. This includes the price of corn-fed beef, milk drawn from corn-fed dairy cows, and the powdered milk that the United States exports to meet nourishment needs in poor countries of the developing world. Nonetheless, the United States, which has subsidized biofuels since 1978, is committed, under its Energy Independence and Security Act of 2007, to the goal of producing 136 billion liters of ethanol by 2022—a fourfold increase over the amount produced in 2008. In 2012 the US transport sector used about 52.2 billion liters of biofuels.

Issues also exist concerning the actual fuel savings available from an E90 (10 percent ethanol, 90 percent petroleum) gasohol mixture used in the United States. Planting and harvesting corn and processing it into ethanol involve significant use of fuel, which has to be considered in assessing overall petroleum savings through the widespread use of ethanol-petroleum solutions as gasoline. There is also the issue of kilometers-per-liter savings in ethanol versus conventional gasoline. Ethanol burns cleaner than traditional gasoline in terms of carbon gases, but it also burns faster, meaning that it requires more energy to provide the same energy output as its fossil-fuel kin. Brazil has evaded these efficiency issues by utilizing sugarcane harvested by cheap labor as its feedstock and by mandating the sale after 2007 of only flexible fuel vehicles (FFVs) capable of burning fuels containing very high levels of ethanol (up to 85 percent ethanol and beyond). Consequently, coupled with its domestic oil production, Brazil has become independent of foreign oil. For other countries, and especially those locked into E90 or even E85 mixtures, concerns over actual fuel savings as well as environmental damage from the use of corn- and sugarcane-derived ethanol continue to linger.
In the democratic world of pluralistic bargaining in public policy, these feedstocks that have nonetheless been favored over the use of switchgrass and other cellulosic sources of ethanol in the production of gasoline, despite the two to three times greater reduction in greenhouse gases possible by using cellulosic biofuels. Existing internal-combustion-engine automobiles and trucks can run, without major modifications, on E85, so the automotive industry has had reasons to support the development of the fuel, especially when alternatives have involved government mandates to retool to produce solar- or electric-powered cars. The petroleum industry, too, supports ethanol, which will maintain the demand for petroleum, as opposed to alternative energy technologies in the transportation field, in which more than one-half of all petroleum used in the United States is consumed. Above all, agricultural states with an interest in reviving their sagging agricultural communities and the large farming corporations that own most farming land in the United States have had reason to lobby diligently on behalf of the ethanol industry. Thus, whenever the focus has been on the high cost of imported fuels or reducing carbon emissions associated with automobile use, bills requiring the use of corn-based ethanol have been introduced in the US Congress and have been enacted into law.

During the 2016 presidential campaign, Democratic nominee Hillary Clinton and Republican nominee Donald J. Trump said that they supported the Renewable Fuel Standard and were in favor of ethanol mandates.

Bibliography


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