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THE HISTORY OF hydrogen

Hydrogen has received increased attention as an environmentally friendly option to help meet today's energy needs. The road leading to an understanding of hydrogen's energy potential presents a fascinating tour through scientific discovery and industrial ingenuity.

History of Hydrogen Timeline

1766 - Hydrogen was first identified as a distinct element by British scientist Henry Cavendish after he separated hydrogen gas by reacting zinc metal with hydrochloric acid. In a demonstration to the Royal Society of London, Cavendish applied a spark to hydrogen gas yielding water. This discovery led to his later finding that water (H₂O) is made of hydrogen and oxygen.



Hydrogen balloon

1783 – Jacques Alexander Cesar Charles, a French physicist, launched the first hydrogen balloon flight. Known as "Charliere," the unmanned balloon flew to an altitude of three kilometers. Only three months later, Charles himself flew the first manned hydrogen balloon.

1788 – Building on the discoveries of Cavendish, French chemist Antoine Lavoisier gave hydrogen its name, which was derived from the Greek words - "hydro" and "genes," meaning "water" and "born of."

1800 – English scientists William Nicholson and Sir Anthony Carlisle discovered that applying electric current to water produced hydrogen and oxygen gases. This process was later termed "electrolysis."

1839 – The fuel cell effect, combining hydrogen and oxygen gases to produce water and an electric current, was discovered by Swiss chemist Christian Friedrich Schönbein.

1845 – English scientist and judge Sir William Grove demonstrated Schönbein's discovery on a practical scale by creating a "gas battery." For his achievement he earned the title "Father of the Fuel Cell."



"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable."

~ Jules Verne, *The Mysterious Island* (1874)

1920s – German engineer Rudolf Erren converted the internal combustion engines of trucks, buses and submarines to use hydrogen or hydrogen mixtures. British scientist and Marxist writer J.B.S. Haldane introduced the concept of renewable hydrogen in his paper, *Science and the Future*, by proposing that "there will be great power stations where during windy weather the surplus power will be used for the electrolytic decomposition of water into oxygen and hydrogen."

1937 – After ten successful trans-Atlantic flights from Germany to the United States, the *Hindenburg*, a dirigible inflated with hydrogen gas, erupted into flames while landing in Lakewood, New Jersey. See 1997.

1958 – The United States formed the National Aeronautics and Space Administration (NASA). NASA's space program currently uses the most liquid hydrogen worldwide, primarily for rocket propulsion and as a fuel for fuel cells.

1959 – Francis T. Bacon of Cambridge University in England built the first practical hydrogen-air fuel cell. The 5-kilowatt (kW) system powered a welding machine. He named his fuel cell design the "Bacon Cell." Later that year, Harry Karl Ihrig, an engineer for the Allis-Chalmers Manufacturing Company, demonstrated the first fuel cell vehicle: a 20-horsepower tractor. Hydrogen fuel cells, based upon Bacon's design, have been used to generate on-board electricity, heat and water for astronauts aboard the famous Apollo spacecraft and all subsequent space shuttle missions.

1970 – Electrochemist John O'M. Bockris coined the term "hydrogen economy." He later published *Energy: The Solar-Hydrogen Alternative*, describing his envisioned hydrogen economy where cities in the United States could be supplied with solar energy.

1972 – A 1972 Gremlin, modified by The University of California at Los Angeles, entered the 1972 Urban Vehicle Design Competition and won first prize for the lowest tailpipe emissions. Students converted the Gremlin's internal combustion engine to run on hydrogen supplied from an onboard tank.

1973 – The OPEC oil embargo and the resulting supply shock suggested that the era of cheap petroleum had ended and that the world needed alternative fuels. The development of hydrogen fuel cells for conventional commercial applications began.

1974 – Professor T. Nejat Veziroglu of the University of Miami, FL, organized The Hydrogen Economy Miami Energy Conference (THEME), the first international conference held to discuss hydrogen energy. Following the conference, the scientists and engineers who attended the THEME conference formed the International Association for Hydrogen Energy (IAHE).

1977 – International Energy Agency (IEA) was established in response to global oil market disruptions. IEA activities included the research and development of hydrogen energy technologies. The U.S. Department of Energy (DOE) was also created.

1978 – National Science Foundation transferred the Federal Hydrogen R&D Program to the U.S. DOE.

1988 – The Soviet Union Tupolev Design Bureau successfully converted a 164-passenger TU-154 commercial jet to operate one of the jet's three engines on liquid hydrogen. The maiden flight lasted 21 minutes.

1989 – The National Hydrogen Association (NHA) formed in the United States with ten members. Today, the NHA has nearly 100 members, including representatives from the automobile and aerospace industries, federal, state and local governments, universities, researchers, utilities and energy providers. The International Organization for Standardization's Technical Committee for Hydrogen Technologies was also created.

1990 – The world's first solar powered hydrogen production plant at Solar-Wasserstoff-Bayern, a research and testing facility in southern Germany, became operational. The U.S. Congress passed the Spark M. Matsunaga Hydrogen, Research, Development and Demonstration Act (PL 101-566), which prescribed the formulation of a 5-year management and implementation plan for hydrogen research and development in the United States. The Hydrogen Technical Advisory Panel (HTAP) was mandated by the Matsunaga Act to ensure consultation on and coordination of hydrogen research.

1991 – Georgetown University in Washington, D.C. begins development of three 30-foot Fuel Cell Test Bed Buses (TBB) as part of their Generation I Bus Program. In 2001, Georgetown finished their second Generation II bus, which uses hydrogen from methanol to power a 100kW fuel cell "engine."

1992 – The Partnership for a New Generation of Vehicles (PNGV), a cooperative R&D program, was established by the Clinton Administration as a joint effort between the government and automobile manufacturers for the research and development of new vehicles technologies and alternative fuels, including hydrogen.

1994 – Daimler Benz demonstrated the NECAR I (New Electric CAR), its first hydrogen fuel cell vehicle, at a press conference in Ulm, Germany.

1995 – The Chicago Transit Authority unveiled the first of their three hydrogen fuel cell buses. The small pilot fleet began operation the following year.

1997 – Retired NASA engineer Addison Bain challenged the belief that hydrogen caused the *Hindenburg* accident. The hydrogen, Bain demonstrated, did not cause the catastrophic fire but rather it was the combination of static electricity and highly flammable material on the skin of the airship. For more information, view the *Hydrogen Safety* fact sheet.

1998 – Iceland unveiled a plan to create the first hydrogen economy by 2030.

1999 – Europe's first hydrogen fueling stations were opened in the German cities of Hamburg and Munich. The Royal Dutch/Shell Company committed to a hydrogen future by forming a hydrogen division. Also, a consortium of Icelandic institutions, headed by the financial group New Business Venture Fund, partnered with Royal Dutch/Shell Group, Daimler Chrysler (a merger of Daimler Benz and Chrysler) Norsk Hydro to form the Icelandic Hydrogen and Fuel Cell Company, Ltd. to further the hydrogen economy in Iceland.

2001 – Ballard Power Systems launched the world's first volume produced proton exchange membrane (PEM) fuel cell system designed for integration into a wide variety of industrial and consumer end-product applications.

2002 – Executives from Daimler Chrysler Corporation, Ford Motor Company and General Motors Corporation, along with Secretary of Energy Spencer Abraham, announced a new cooperative automotive research (CAR) partnership between the U.S. Department of Energy and the U.S. Council for Automotive Research (USCAR). The program, Freedom CAR, focuses on developing enabling technologies, such as hydrogen fuel cells, for petroleum-free cars and light trucks.

2003 – President George W. Bush announced in his 2003 State of the Union Address a \$1.2 billion hydrogen fuel initiative to develop the technology for commercially viable hydrogen powered fuel cells, such that "the first car driven by a child born today could be powered by hydrogen and pollution free." U.S. Secretary of Energy Spencer Abraham launched the International Partnership for the Hydrogen Economy (IPHE) to foster global cooperation in the development of hydrogen technology.

2004 – U.S. Energy Secretary Spencer Abraham announced over \$350-million devoted to hydrogen research and vehicle demonstration projects, nearly one-third of President Bush's commitment. The funding encompasses over 30 lead organizations and more than 100 partners selected through a competitive review process.



NASA uses hydrogen both as a fuel for its rockets and for fuel cells to generate electricity.



For more information on hydrogen and to view the electronic version of this fact sheet, please visit www.HydrogenAssociation.org or www.eere.energy.gov/hydrogenandfuelcells/