Humphry Davy, Self-Made Chemist

This pioneer of electrochemistry and chemical discovery rose from humble beginnings.

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The English chemist and inventor Sir Humphry Davy was one of the first professional scientists in the world. He began his career as a humble surgeon's apprentice and ended it as one of the most famous names in European chemistry.

Humphry Davy was born on December 17, 1778, in the town of Penzance, Cornwall, England. His father, Robert, was a woodcarver descended from generations of independent yeoman farmers. Humphry was the first of Robert and his wife Grace's five children.

Robert Davy died relatively young, at the age of 48, in 1794. Humphry's mother operated a millinery shop for a few years, but the family's reduced income would not allow her or the children a leisurely existence. In 1795, 16-year-old Humphry went to work, beginning an apprenticeship with Bingham Borlase, an apothecary-surgeon in Penzance. At that time, surgeons and apothecaries were not required to have a university education, but Davy devised his own program of self-education, reading everything from theology to physics, botany to mathematics. From his earliest years, Davy expressed broad intellectual interests, which he would pursue throughout his life.

At the age of 18, Davy began his study of chemistry by reading Antoine Lavoisier's classic *Elements of Chemistry*. Already, he began to imagine a great career in science for himself. As he indicated in his notebook, Davy aspired to be the Isaac Newton of his day.

A Gaseous Phase

In 1798, Davy became friendly with Gregory Watt, son of James Watt. Through friends of the younger Watt, Davy met Thomas Beddoes, a physician and researcher at the Pneumatic Institution near Bristol. Impressed with Davy's thinking, Beddoes arranged to release him from his medical apprenticeship and hired him as an assistant at the Institution, which was devoted to the study of the medical value of various gases.

Beddoes had been experimenting with nitrous oxide, or what would come to be called "laughing gas", which was first discovered by Joseph Priestley. Davy continued these inquiries in an attempt to determine the physiological effects of the substance. He prepared impure samples of the gas and tried breathing it. Within a month, Davy obtained the gas in a pure state and determined its chemical properties and composition. He inhaled 16 quarts of the gas in 7 minutes and described its effects in detail.

Sir Humphry Davy, 1778–1829.

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Davy's observations of the anesthetic effects of nitrous oxide preceded by almost 50 years the first use of the gas on patients by dentists. Davy's experiments on himself exemplify the dangers inherent in 18th and 19th century science. Researchers like Davy took few precautions with unknown substances. Ultimately, such risk-taking would take a toll on Davy's health, but of course, rewards came with the risks. Davy was beginning to establish a reputation as a scientific star, fast gaining the respect of his fellow chemists.

After his work with nitrous oxide, Davy's next and ultimately most important investigations were in the field of electrochemistry. The 18th-century experiments of Luigi Galvani and Alessandro Volta generated widespread interest in electrochemistry. Galvani believed that nerves in animal tissues generated electricity. Volta demurred, claiming that animal tissues detected rather than generated electricity. Volta had experimented with a "pile" of disks of two different metals with damp cardboard layers between them. From this "voltaic pile" he got electricity and attributed the effects to the contact of dissimilar metals.

In 1800, William Nicholson and Anthony Carlisle in London repeated Volta's experiment. They obtained hydrogen and oxygen from water and successfully decomposed the solutions of a variety of common salts. Davy disagreed with Volta that electricity was generated simply by the contact of metals. Instead, he thought that a chemical reaction generated the current, and that in turn an electric current could stimulate a chemical reaction.

Davy initiated his own experiments and discovered that when he passed electrical current through some substances, the substances decomposed. This process was later termed electrolysis. As a result of his work, Davy determined that the actions of the voltaic pile and electrolysis were identical. He ascertained that electrical forces could generate current only when the electrolyte could oxidize one of the metals, and that the voltage generated was directly related to the reactivity of the electrolyte with the metal. Davy also discovered that metals were not necessary, as he made a pile with zinc and charcoal.

Davy proposed that electrical forces hold the elements of a chemical compound together. In June 1801, he presented a paper to the Royal Society explaining his work. Two years later, at age 24, he was elected a Fellow of the Royal Society. In the meantime, he had accepted an appointment at the Royal Institution in London. Thus, he was recognized as one of the leading lights of British science.

The Royal Institution provided Davy with significantly more resources than he had at the Pneumatic Institution. He was given a bigger voltaic battery with which to perform his experiments. With better working conditions, Davy's innovative research continued. He was able to separate pure metals by passing current through molten compounds. In 1807, he separated potassium from molten potash and sodium from common salt. When observing potassium particles in water, Davy famously exclaimed that they "skimmed about excitedly with a hissing sound and soon burned with a lovely lavender light." He presented the results of this experiment in his Bakerian Lecture of 1807.

Chemical Discovery

Using electrolysis, Davy in 1808 isolated calcium, barium, strontium, and magnesium. He used a mercury cathode and was the first to create an alloy with mercury. Davy, however, was not the first to investigate the "alkaline earths". He was preceded by two Swedish scientists: Carl Wilhelm Scheele, who had distinguished baryta from lime in 1774, and J. J. Berzelius, who had prepared a calcium alloy by electrolyzing lime in mercury. Davy was the first, however, to isolate the pure metals, though many historians think that Berzelius would eventually have made similar discoveries. Davy also developed the method of separating potassium from sodium, and he used potassium to prepare boron.

Another important aspect of Davy's career was his research on chlorine. As was the case with the "alkaline earths", Scheele had anticipated his work in the 18th century. When Scheele exposed muriatic acid to manganese dioxide, a green gas resulted. Scheele did not regard the gas as an element but as "dephlogisticated marine acid." He believed that phlogiston was practically synonymous with hydrogen. Lavoisier, on the other hand, had assumed that the green gas was an oxide of an unknown "radical". Davy was suspicious of Lavoisier's theory and performed experiments to confirm the presence of oxygen.

Davy first combined the green gas, "oxymuriatic acid" as the British called it, with ammonia, but he found only muriatic acid and nitrogen. He then exposed it to heated carbon in an attempt to remove the oxygen as carbon dioxide. None of his experiments yielded any oxygen or compounds known to contain oxygen, and Davy ultimately concluded that the gas was an element. He named it "chlorine" from the Greek word *chloros*, which means yellow-green.

Additional experiments in 1810 revealed that muriatic acid was a compound of hydrogen and chlorine, and contained no oxygen. Davy's research on chlorine led to a rejection of Lavoisier's theory that oxygen was an essential constituent of acids.

The year 1810 was also an important one in British science for a less obvious reason. It was the first year a young Michael Faraday began attending Davy's lectures at the Royal Institution. In 1813, Davy hired Faraday as an assistant, the first step in a professional and personal relationship that lasted many years.

Davy was knighted by King George III in 1812; that same year, he married Jane Apreece, a wealthy widow from a prominent family. Now financially comfortable, Davy ceased lecturing at the Royal Institution, but he was granted the title Honorary Professor of Chemistry and continued to use the Institution's laboratory for his research. He also served as Secretary of the Royal Society and undertook two lecture tours of Ireland. Davy was now one of the most famous scientists in the world.

The Safety Lamp

While touring Europe in 1813 with his wife and Faraday, Davy was contacted by Sir Ralph Milbanke of the Society for Preventing Accidents in Coal Mines. This organization, founded under the auspices of the Duke of Northumberland, wanted Davy to develop a safety lamp for coal miners to wear on their helmets. Back in England in 1815, Davy agreed to work on the development of a safety lamp that would not ignite the methane-heavy air in the mines. He visited many collieries in northern England and returned from Hebburn Colliery with samples of "firedamp" taken in wine bottles.

In October 1815, Davy discovered that, in his own words, "explosive mixtures of minedamp will not pass through small apertures or tubes, and that if a lamp . . . be made air-tight on the sides and furnished with apertures to admit the air, it will not communicate flame to the outward atmosphere." A few months later, in early 1816, the first Davy lamps were tested at Hebburn Colliery. The success of Davy's safety lamp, which consisted of a candle or lamp flame surrounded by a wire sieve, revolutionized the mining industry. Although William Clanny and George Stephenson both developed similar lamps in the early 19th century, Davy is credited with inventing the first working safety lamp.

The safety lamp brought Davy even greater fame throughout Europe. In 1818 he was named a baronet, and in 1820 he was appointed President of the Royal Society, an office he held for seven years. As successful as he was, however, in the mid-1820s Davy's health began to deteriorate. He became seriously ill in 1827 and moved to Rome in 1828. Much of his ill health was later attributed to the inhalation of toxic gases over the course of a long career. In the winter of 1829 he had a stroke, and on May 29 of that year, Davy died of a heart attack in Geneva, leaving a scientific legacy that few have been able to match.

Further Reading

Knight, D. *Humphry Davy: Science & Power;* Cambridge University Press: Cambridge, U.K., 1998.

Humphry Davy; www.chemheritage.org/EducationalServices/chemach/eei/hd.html.

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