Fritz Haber, His Studies of Chemistry, and Biographical Info Fritz Haber, His Studies of Chemistry, and Biography

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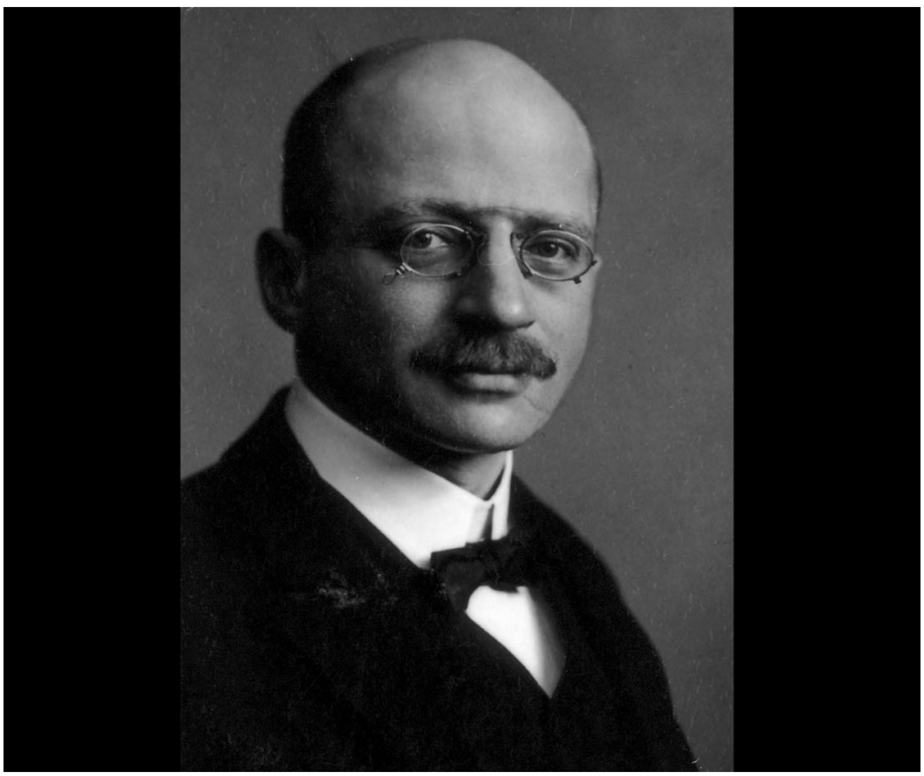

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The name Fritz Haber has long been associated with the well-known process of synthesizing ammonia from its elements. While primarily known for developing a process which ultimately relieved the world of dependence on Chilean ammonia, this twentieth century Nobel prize winner was also involved in the varying fortunes of Germany in World War I and in the rise to power of the Nazi regime.

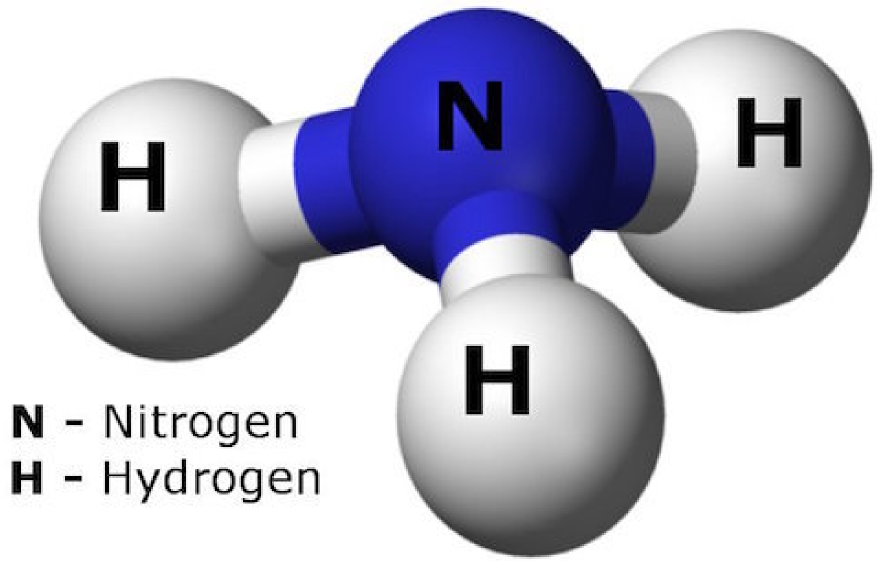

Figure 1: Ammonia molecule

Haber was born on December 9, 1868 in Prussia. He was the son of a prosperous German chemical merchant and worked for his father after being educated in Berlin, Heidelberg, and Zurich. After a short time, Haber left his father's business and took up research in organic chemistry at the University of Jena. The university's strictly orthodox methods soon led him to leave for a junior teaching position at the Technische Hochschule of Karlsruhe. At the age of 25, Haber immediately threw himself, with tremendous energy, into teaching and research in physical chemistry, a subject in which he was essentially self-taught. Quickly he gained respect and recognition for his research in electrochemistry and thermodynamics. He also authored several books arising from his research.

Figure 2: Location of Prussia

During the first decade of the twentieth century, the world-wide demand for nitrogen based fertilizers exceeded the existing supply. The largest source of the chemicals necessary for fertilizer production was found in a huge guano deposit (essentially sea bird droppings) that was 220 miles in length and five feet thick, located along the coast of Chile.

Scientists had long desired to solve the problem of the world's dependence on this fast disappearing natural source of ammonia and nitrogenous compounds. It was Haber, along with Carl Bosch, who finally solved this problem. Haber invented a large-scale catalytic synthesis of ammonia from elemental hydrogen and nitrogen gas, reactants which are abundant and inexpensive. By using high temperature (around 500 degrees Celsius), high pressure (approximately 3000 psi), and an iron catalyst, Haber could force relatively nonreactive gaseous nitrogen and hydrogen to combine into ammonia. This furnished the essential precursor for many important substances, particularly fertilizers and explosives used in mining and warfare.

Figure 3: A source of guano

Although ammonia and its exploitation ultimately have the ability both to sustain life and destroy it, Haber did not have either reason specifically in mind when performing his research. His dedication to science and the search for solutions to a chemical problem inspired his work. He said later of his work: "The interest of a wider circle has its source in the recognition that ammonia synthesis on a large scale represents a useful...way to satisfy an economic need. This practical usefulness was not the preconceived goal of my experiments. I was not in doubt that my laboratory work could furnish no more than a scientific statement of the foundations and a knowledge of the experimental equipment, and that much had to be added to this result in order to attain economic success on an industrial scale."

In 1911, Haber was appointed director of the Kaiser Wilhelm Institute for Physical Chemistry in Berlin. This new research facility was to become more famous than the school he had built up at Karlsruhe. With the outbreak of World War I in 1914, Haber was in charge of forming a center for cross-disciplinary research in chemistry and physics and as such, he immediately placed himself and his laboratory at the service of the German government. He became a behind-the-scenes consultant on industrial mobilization.

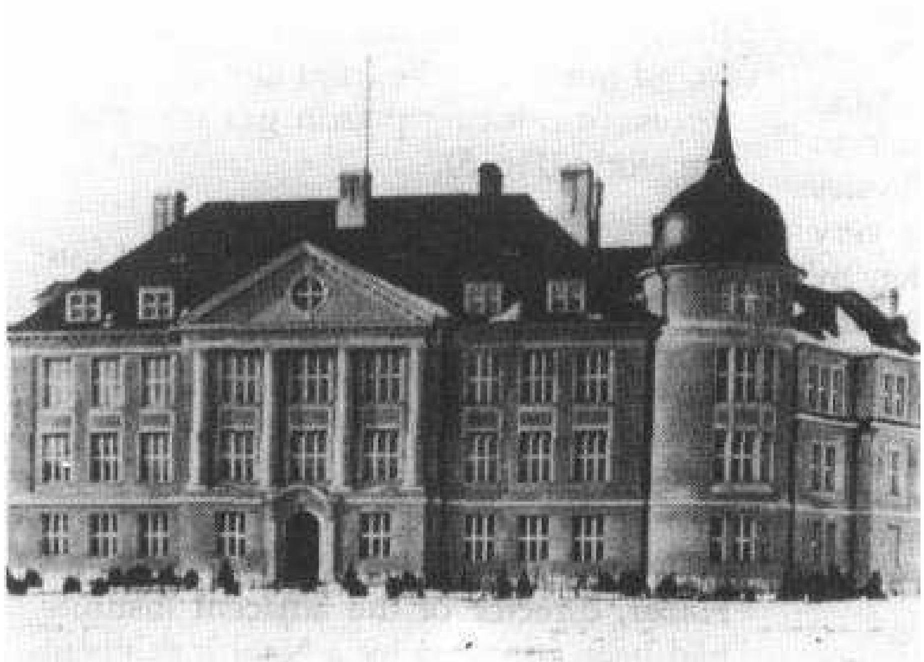

Figure 4: Kaiser Wilhelm Institute for Physical Chemistry

During the war, Haber, the embodiment of Prussian pride, unquestionably and uncritically accepted the State's wisdom. He served his beloved country in many ways. For example, because Germany was essentially landlocked for the duration of the war, the supply of necessary materials was a serious problem. Haber's institute worked on numerous wartime concerns including the problem of keeping motors running. He showed that xylene and the solvent naptha were good substitutes for toluene as an antifreeze in benzene motor fuel. Since xylene and naptha were available in Germany and toluene was not, Haber's contributions helped to keep German machinery running and aided in sustaining their war effort for four years.

Haber also served his country in the most basic sense with his process of ammonia synthesis. Not only was ammonia used as a raw material in the production of fertilizers, it was also (and still is, for that matter) absolutely essential in the production of nitric acid. Nitric acid is a raw material for the production of chemical high explosives and other ammunition necessary for the war. Having helped to make Germany independent of Chile and other countries for necessary materials, Haber perhaps served his country in the greatest capacity. Without his process, Germany would never have had a chance to win the war.

Another contribution Haber made to Germany's war effort was in the development of chemical warfare. With strong purpose and great energy he became involved in the production of protective chemical devices for troops, but more infamously, directed the first gas attacks against enemy troops. Haber is often referred to as the father of modern chemical warfare as he organized and directed the first large scale release of chlorine gas at Ypres, France on April 22, 1915. Although figures reported vary, somewhere between 5,000 to 15,000 Allied troops were wounded or killed that day, with loses among German troops due to the gas, in the hundreds. Gas warfare, while a psychological weapon, never was a decisive factor in the war. The allied forces immediately improved their protective devices and retaliated with attacks of their own.

At the end of the War, Haber's life took an unhappy turn. Overwhelmed by the outcome of the war and feeling some responsibility for his country's failure, he was near nervous exhaustion. The Swedish Academy of Science had passed him over for a Nobel Prize for his ammonia synthesis discovery, but later decided to give him the award in 1918. Despite the great honor, his role in chemical warfare had left him isolated from the foreign scientific community. He strongly felt some responsibility for the enormous war debt of the German state and attempted to make a contribution to reduce the burden by formulating a process to extract gold from sea water. After some concentrated labor on this project, he had to conclude that the huge amount of gold in the ocean was present at too low a concentration for the process to be profitable. He spent most of the remaining fifteen years of his career at the Kaiser Wilhelm Institute, which under his direction became a center for academic brilliance in physical chemistry.

When Hitler became Chancellor and Jewish academics were purged, Haber realized that the time had come when his strong patriotism and his service to his native land could not overcome the reality of his Jewish heritage. Because of his distinguished service to his country in World War I, his life was not actually threatened, but he realized that it was time to emigrate. It is known that he would have preferred to go to Switzerland, but no invitation was offered. He was offered a position at Cambridge; thus, he left Germany for good in 1933. He did not stay long in England, as ill health and the climate depressed him. On route to visit Switzerland, he died suddenly at Basle on January 30, 1935, at the age of 65.

Figure 5: Cambridge University

Fritz Haber was an extremely dedicated and talented scientist. He is primarily known for his ammonia synthesis and poison gas involvement, but to focus on only these aspects of his life is an injustice to him. Haber and the Institute worked on many different projects and made a variety of important chemical findings. He studied the nature of the quinone-quinol system. He devised a glass electrode to measure hydrogen ion concentration by means of the electric potential across a thin piece of glass. Other electrochemical subjects investigated by Haber include: studies of fuel cells, the electrolysis of crystalline salts, and the measurement of the free energy of oxidation of hydrogen, carbon monoxide, and carbon. Even his failure at obtaining gold from sea water actually paved the way for the extraction of bromine from the ocean.

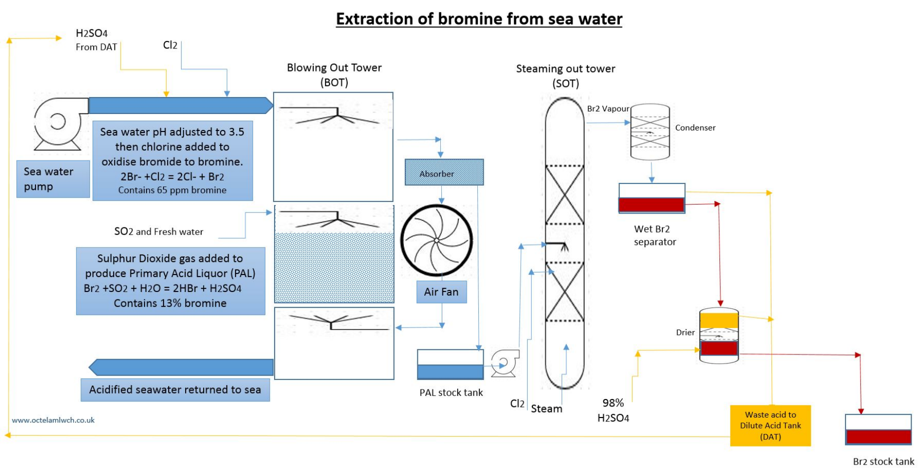

Figure 6: Extracton of bromine from sea water

Haber deserves a place in chemical history for his important discoveries. Perhaps of equal importance is the story of his political involvement in World War I and the later discrimination toward him by the country to whose service he had devoted his life, an appropriate illustration that science is a world-wide activity, not necessarily a geo-political one.

References

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Notes

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