CARL BOSCH AND HIS MUSEUM

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Carl Bosch (1874-1940) (Fig. 1) was born in Cologne, studied metallurgy and mechanical engineering at the Technische Hochschule in Berlin (1894-96), then chemistry at Leipzig University, graduating in 1898. In 1899 he entered the employ of the Badische Anilin- und Sodafabrik in Ludwigshafen (Fig. 2) and participated in the development of the then new industry of synthetic indigo.

Figure 1. *Carl Bosch (1874-1940)*

When in 1908 the Badische acquired the process of high-pressure synthesis of ammonia, which had been developed by Fritz Haber (1868-1934) at the Technische Hochschule in Karlsruhe, Bosch was given the task of developing this process on an industrial scale. This involved the construction of plant and apparatus which would stand up to working at high gas pressure and high-reaction temperatures. Haber's catalysts, osmium and uranium, had to be replaced by another which would be both cheaper and more easily available.

Bosch and his collaborators solved the catalyst problem by using pure iron with certain additives. Bosch´s success was based on the cooperation of many collaborators. One of his closest co-workers was Alwin Mittasch (1869-1953) (Fig. 3), who was responsible for the development of the catalysts. Further problems which had to be solved were the construction of safe high-pressurized reactors and a cheap way of producing and cleaning the gases necessary for the synthesis of ammonia. Step by step Bosch went on to using increasingly larger manufacturing units. In order to solve the growing problems posed by materials and related safety problems, BASF set up the chemical industry's first Materials Testing Laboratory in 1912 to identify and control problems in materials for instrumentation and process engineering.

The plant in Oppau for the production of ammonia and nitrogen fertilizers was opened in 1913. Bosch wanted fertilizers to be tested thoroughly, so that customers were to be given proper instructions for their use. This meant extensive trials to determine the effect of fertilizers on soil and on plants. The result was the opening in 1914 of the Agricultural Research Station in Limburgerhof, near Ludwigshafen.

When World War I began in 1914, Germany poured its resources into the war effort. Synthetic ammonia was converted into nitric acid at the Oppau plant and then delivered to the explosives industry. Chlorine and

Figure 2*. BASF in 1881*

phosgene, important intermediates used to manufacture dyes and drugs among other things, were used as poison gas by the German army. After several expansions of the Oppau ammonia facilities, the government ordered the construction of a second major production plant. A plant in eastern Germany, away from the danger of air raids, was commissioned and started operation in 1917 at Leuna near Merseburg. At the end of the war in 1918, the situation in Germany was alarming. The Kaiser had abdicated; reparations, the dismantling of factories, a scarcity of coal, and inflation prevented economic recovery. BASF was occupied by French troops, and German dye manufacturers lost their leading position on world markets. Production facilities, subsidiaries, associated companies, and sales companies abroad were confiscated, as were the patents registered abroad. Reparations imposed by the victors hampered economic recovery.

In 1919 Bosch was appointed Managing Director. On September 21, 1921 Oppau was rocked by a huge explosion. This accident, which occurred during blasts carried out to loosen ammonium fertilizer stored in a warehouse, claimed more than 500 lives and caused considerable damage to the site and the neighboring community,

In 1923 BASF had to merge with five other companies to form Interessengemeinschaft für Farbenindustrie AG, abbreviated IG Farben. The economic crisis in Germany in the 1920s shattered the political structure of the Weimar Republic. This was accompanied by mass unemployment and economic hardship and the rise of the Nazi party. Adolf Hitler, appointed chancellor in 1933, took control of the socio-political and ideological aspects of the individual operating units of IG Farben. The national socialist ideology also shaped day-to-day operations at the Ludwigshafen and Oppau plants. The local newspaper reorganized, labor unions were banned, and IG Farben gradually became enmeshed in the Nazi system.

In 1932, Allgemein Elektrizität Gesellschaft abbreviated AEG and IG Farben collaborated in the development of a magnetic recording device. A year later, the first "magnetophones" were presented to the public at the 1935 Radio Fair in Berlin. In 1936, the Guest House in Ludwigshafen hosted a special concert, recorded on magnetic tape, with Sir Thomas Beecham conducting the London Philharmonic Orchestra. By that time Bosch had been appointed Chairman of the Board of Directors of the I.G. Farbenindustrie A.G.

Figure 3. *Alwin Mittasch (1869-1953)*

The outbreak of World War II in September 1939 forced IG Farben to switch production to the war effort. Many male employees were called up and replaced by women conscripts, prisoners of war, and forced laborers from the occupied countries of Eastern Europe. Concentration camp inmates were put to work at IG Farben's Buna factory in Auschwitz, commissioned on the orders of the German army high command in 1940. Massive air raids were launched on Ludwigshafen in 1943/44. Production dropped drastically and came to a standstill by the end of 1944. By the end of the war in 1945, the extent of the damage was

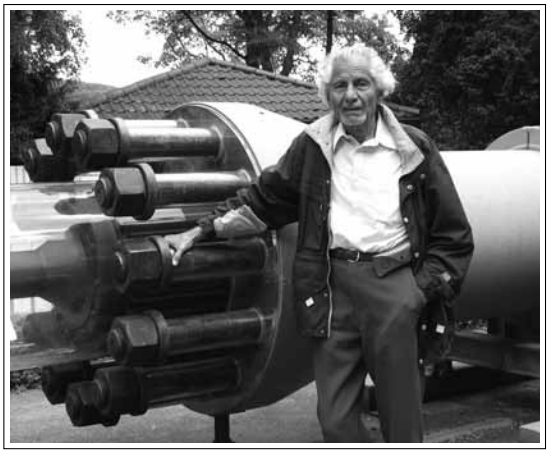

Figure 4. *Example of high-pressure reactors (with author); photo by Nadia Habashi*

enormous. Economic recovery was hindered by continuous political unrest, reparations obligations, the dismantling of factories, lack of coal, transportation problems, and the French occupation of the west bank of the Rhine. In November, 1945 the Allied Control Council ordered the dissolution of IG Farben. Little by little, a starving, freezing, and war-weary population began to rebuild the site, and production was resumed.

Among Bosch's many honors, he was awarded the Nobel Prize for Chemistry, jointly with Friedrich Bergius, in 1931 for their contributions to the invention and development of chemical high-pressure methods. Bosch received this honor for converting a laboratory procedure into a large-scale industrial process. He became President of the Kaiser Wilhelm Gesellschaft in 1937.

Carl Bosch Museum

The Carl Bosch Museum was inaugurated in May, 1998. It is located in Heidelberg near the castle in a villa built by BASF as a residence for its Chief Executive Officer, at 46 Schloβ-Wolfsbrunnenweg. The museum shows the most interesting highlights of the life of Bosch. The display covers IG Farben's role during the Third Reich and the development of high-pressure technology from its beginnings in the laboratory to the creation of gigantic industrial complexes. The Museum portrays both Bosch's private life and his professional career. Even as a boy he gained some technical experience in his father's plumbing workshop. Because of his studies in mechanical engineering he was rather skilled in being a process technician. Another section is dedicated to Bosch's activities as founder of the ammonia synthesis plants at Oppau and at Leuna-Merseburg. The original incentive for ammonia synthesis was the enhancement of crop yields, but this changed during World War I.

Additional features in the Museum include the knowledge of materials, safety standards at work, a competent process control, and the advent of a new profession: the chemical technician. The "high-pressure workshop," equipped with a lathe, tools, fittings, and high-pressure pipes, illustrates the new dimension an industrial technician was confronted with in those days.

The devastating explosion of the Oppau plant in 1921 did not deter industry from going ahead with the technology. The construction and manipulation of high-pressure reactors required new empirical and theoretical knowledge, as well as new approaches to education and training. The construction of the most important elements of an ammonia producing plant, like the inner part of the reactor, the ammonia separator, and the mole-pump gives the visitor an impressive idea of this new industrial technology.

Figure 5. *Example of high-pressure reactors (with author); photo by Nadia Habashi*

Bosch's technical and scientific achievements are well documented by his honors and distinctions and by his 1931 Nobel Prize. Documents of his active struggle against National Socialist anti-Semitic policy are preserved there. Bosch devoted much spare time to various scientific hobbies. His crystal and insect collections became so large that he bought a nearby house and converted it into the "House of Collections." As an amateur astronomer, he built a small observatory in his house. A unique part of the museum is the large high-pressure equipment displayed in the open air outside the building (Fig. 4 and 5).

Figure 6. *Some equipment on display at the* German Chemistry Museum *in Merseburg*

German Chemistry Museum

Closely related to the Bosch Museum is the Deutsches Chemie-Museum in Merseburg not far from Leipzig, located on the campus of the University of Applied Science. This Museum contains a unique collection of original chemical plants and apparatus used in the chemical industry of the 20th century. Set up in 1993, it has been developing ever since. It is composed of two parts: The Technical Park displaying the high-pressure equipment used in ammonia synthesis in 1925; and The Pupils' Lab, meant to acquaint the young generation with science. About 500 experiments related to chemistry and the physical sciences are set up for the young people to carry out. A view of some of the equipment on display is shown in Fig. 6.

ABOUT THE AUTHOR

Fathi Habashi is Professor Emeritus of Extractive Metallurgy at Laval University in Quebec City. He holds a B.Sc. in Chemical Engineering from the University of Cairo (1949), a Dr. techn. degree in Inorganic Chemical Technology from the University of Technology in Vienna (1959), and Dr. Sc. *honorus causa* from the Saint Petersburg Mining Institute in Russia (1993). He held the Canadian Government Scholarship at the Mines Branch in Ottawa (1960–1962), taught at Montana College of Mineral Science & Technology (1964–1967), and then worked at the Extractive Metallurgical Research Department of Anaconda Company in Tucson, AZ before joining Laval in 1970. His research was mainly directed towards organizing the unit operations in extractive metallurgy and putting them into a historical perspective. He authored a number of metallurgy textbooks. Fathi.Habashi@arul.ulaval.ca.