



History of Chemistry in The Dow Chemical Company

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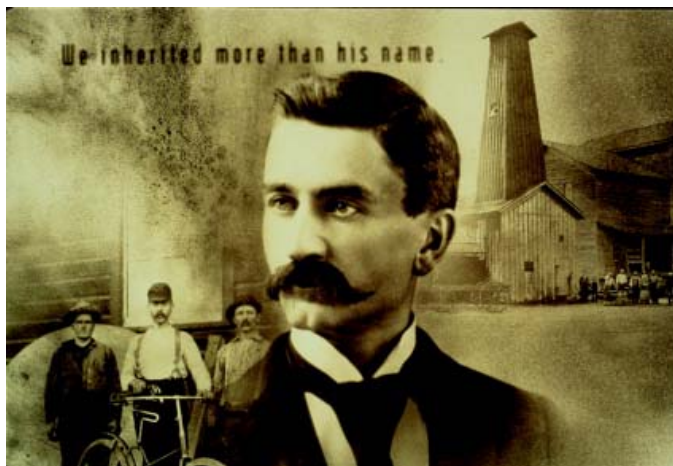
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Thank you for inviting me to be a part of this symposium. Today I would like to share with you some history of chemistry in The Dow Chemical Company in Midland, Michigan.

While I spent 35 years in Research and Development at Dow and witnessed some of the events I will be discussing today, most I know by study and from stories told by others. Dow's research and development history is long and complex. For much of my information I have relied upon Ned Brandt's book, *Growth Company - Dow Chemical's First Century*, and Robert Karpiuk's book, *Dow Research Pioneers*. The photos in today's presentation were supplied by The Post Street Archives in Midland.



Dow founder - Herbert H. Dow



Founded in 1897, The Dow Chemical Company has been a high-tech research-oriented company. The first 50 years were dominated by Herbert Henry Dow, the founder of the company, and his son Willard. Each was a strong and dynamic leader. Each had research reporting directly to him. The second 50 years witnessed the growth of research and development by a management team.

During the first 100 years of Dow's existence its research evolved through several eras. For the first 20 years Dow was primarily an inorganic chemicals company and research was concerned with chemicals from brine. Twenty years later organic chemistry was on the front burner, followed closely by polymer chemistry which today still reigns supreme.

Willard Dow – expanding Dow's research capabilities



During the Depression in 1930, Herbert H. Dow died and his son Willard became the president. Many industrial establishments were closing down their research activities at that time, but not Dow. Willard Dow made the decision to expand Dow's research. Like his father, he believed in research and innovation. Top talent was now available to Dow since other companies had greatly reduced their campus recruiting.



Development of Dow Labs

- Main Lab - 1909
- Indigo Lab - 1915
- Organic Lab - 1919
- Physical Lab - 1922
- X-Ray and Spectroscopy Lab - 1928
- Metallurgical Lab - 1932
- Biochemical Lab - 1933
- Consulting Engineering Division - 1936
- Central Research - 1980



Old Mill Lab - 1890

As manufacturing plants increased in number and in size in the Midland area, research organizations sprouted and increased until the laboratories numbered by the dozens.

Shown here are a few.

<u>Laboratories</u>	<u>Year Formed</u>
"Old Mill"	1890
Main Laboratory	1909
Indigo Laboratory	1915
Organic Research Laboratory	1919
Physical Research Laboratory	1922
X-Ray and Spectroscopy Laboratory	1928
Metallurgical Research Laboratory	1932
Biochemical Research Laboratory	1933
Consulting Engineering Division	1936
Central Research	1980

After the death of Willard Dow in 1949, all research was placed under the control of a Vice President for Research. In time, the number of laboratories decreased but the number of scientists continued to increase.



Global expansion



By the mid 1950s the company began its bold move toward global expansion, establishing manufacturing plants throughout the world. In 1965, Dow set-up “technology centers”, to insure that the newest and best technology was available at each Dow location. These were repositories of know-how. As manufacturing expanded, R&D expanded too.

Gradually R&D became more directed toward product lines and more aligned with business activities. By 1980 most of the long range basic research laboratories in Midland were consolidated into a core group called Central Research where many of them are today.

In my remarks I will examine only a fraction of the thousands of research projects involving Dow scientists. Likewise, time permits me to mention but a few of the important laboratories that have come and gone over the years. I will also recognize a small number of highly regarded Dow scientists and name a few individuals who have passed through the Dow research organizations on their way to other areas of importance.



H. H. Dow Medal Award

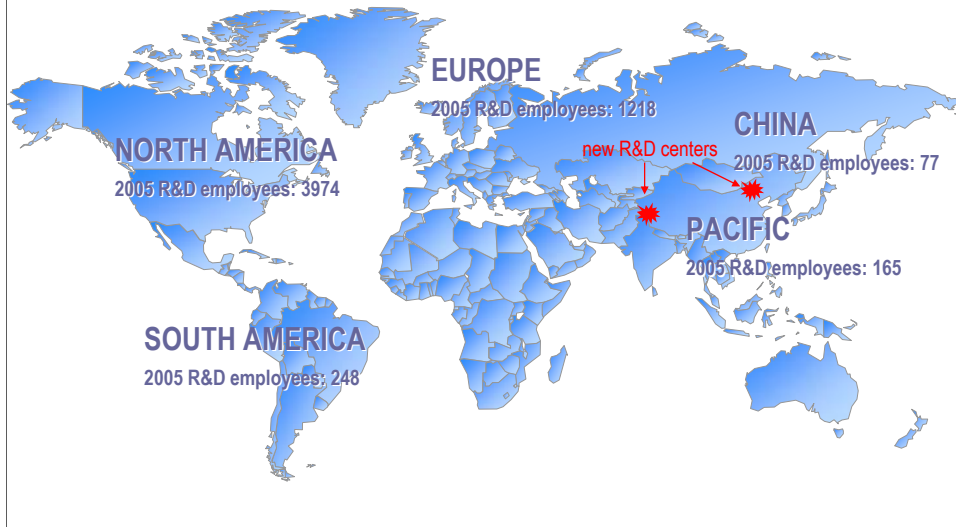


The Herbert H. Dow Gold Medal Award was established in 1979 to recognize and honor those scientists whose inventiveness and pioneering research in technology have had an outstanding impact on the growth and well-being of The Dow Chemical Company. A total of 23 awards have been presented to date with 17 scientists from the Midland area.



Dow R&D – Broad Global Resources

Over 40 Major R&D sites; ~ 5,700 employees



Dow's Research and Development organization today includes world-class, state-of-the-art facilities, staffed with over 5,700 highly talented scientists, engineers and technologists; many of whom are located in Midland.



Herbert H. Dow in the Lab



When one talks about the history of research at Dow one must start with Mr. Herbert Henry Dow. The Dow Chemical Company exists only because of Mr. Dow's research, his ideas, his foresight, his drive and his perseverance. Mr. Dow was a chemist - a most unusual, talented and determined chemist. His success is based on research first done in 1888 on an idea he had for recovering bromine from brine by electrolysis. Those early studies were done before he had finished his university studies.

Bromine was of interest in those days because it was the main component of many of the patent medicines, as a disinfectant, and as an ingredient in films for the emerging photographic industry. Its availability was controlled by European cartels.

Mr. Dow graduated in June 1888 from the Case Institute of Applied Science (now known as Case Western Reserve University) at the age of 22 with a solid background in chemistry and engineering. His graduating class numbered six. The school had seven faculty and 44 students. One of his professors, formerly of Harvard, was renowned for his knowledge of petroleum and electro chemistry. Another was noted for his determination of the ratio of the atomic weights of oxygen and hydrogen.

● ● ● | Albert Michelson - Nobel Prize
recipient in Physics



Dow's physics professor, Albert Michelson, was the first to measure the speed of light and in 1907 became the first American to win the Nobel Prize in Physics. Albert Einstein once stated that it was Michelson's work that opened the way for his theory of relativity.

Mr. Dow's thesis "Composition of Salt Brine in Northern Ohio with Special Reference to Bromine and Lithium Content" was presented as a paper at the American Association for the Advancement of Science in 1888. Over the years he was a strong supporter of professional societies. He was a charter member of the American Electrochemical Society in 1902, was awarded the Perkin Medal for Chemical Achievement in 1930 and was awarded 107 patents and received an honorary Doctors degree from the Case Institute in 1924.



Brines in Saginaw Valley

- Brines were rich in bromine, chlorine, sodium, calcium and magnesium



It was the composition of the brines in and around the Saginaw Valley that brought Mr. Dow to Midland. The brines were rich in bromine, chlorine, sodium, calcium and magnesium. With ample supplies of wood as a source of energy and the Tittabawassee River supplying water for cooling, processing and transportation, Mr. Dow developed his unique electrolytic process resulting in pure chlorine, bromine, elemental magnesium and derivatives which would in time, become the building blocks for a vast chemical enterprise.



Bromides being shipped to Japan



Dow's bromine process involved economy in energy by eliminating heat to evaporate water from the brine and the heating of the mother liquor to volatilize the bromine. His process was made continuous, by a controlled electrolysis of the brine and with a never before used "blowing-out" step. The "blowing-out" step used air to volatilize the liberated bromine from the brine; the bromine was then treated with wet scrap iron to form ferric bromide.

Dow's electrolytic process made him the most efficient producer in the bromine business and his bromine cell of 1892 marked the first adaptation of electrolysis to the preparation of an element in this country.



Chlorine Cell



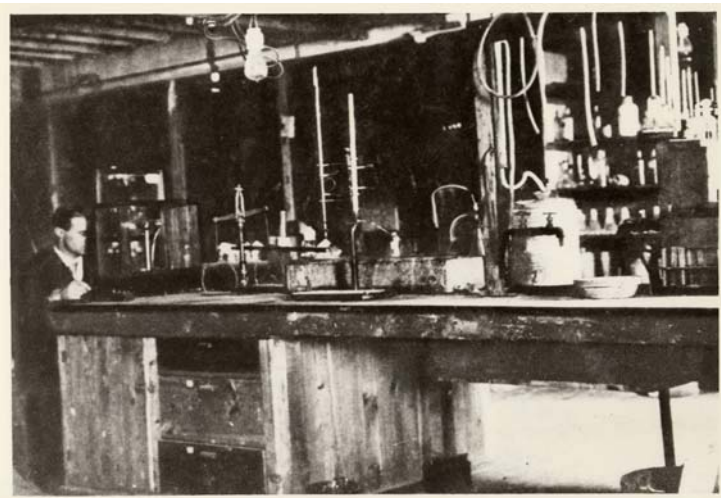
In addition to bromine, Mr. Dow was interested in testing his electrolysis technology to produce chlorine. With chlorine he could manufacture bleach, a new product, much in demand. Dow had experimented with electrolysis to produce chlorine as early as 1895. His new chlorine cell constituted the first commercially successful application in this country of electrolysis for the preparation of chlorine from salt without the use of a mechanically interposed diaphragm. Dow started selling bleach in 1899, but withdrew from the market in 1915 because of a declining market. He could produce higher-valued products with his chlorine.

The chlorine cell that Dow invented was to be the foundation of The Dow Chemical Company. When he tried to patent his cell, which was 16 feet long and had 70 anodes and 70 cathodes, he was told that it was visionary but before they would grant a patent he had to take a small cell model to Washington, D.C. and demonstrate it to them.

In 1983 Mr. Dow was inducted posthumously into the National Inventors Hall of Fame for his patent on the production of bromine by electrolysis of brine and for his “blowing-out method”. I was pleased to have been selected by the Company to make a presentation at the award ceremony in Washington D.C. on behalf of Mr. Dow’s achievements.



The Old Mill Laboratory



Mr. Dow always had a passion for research, but in the early days he did not have the money to build a laboratory, so he selected the “Old Mill”, a ramshackle building situated on the site of an 1852 log cabin, one of the first structures built in Midland.

The “Old Mill” became the center for many of the early research projects. The first work in the “Old Mill” was inorganic chemistry based on products from brine. Magnesium metal was first extracted from brine in 1916. At that time Dow employed 41 chemists and chemical engineers. The company employed 1,225 workmen.

Military needs for incendiary flares, during World War I, provided the incentive for Mr. Dow to move forward to produce magnesium metal. His first magnesium cells were constructed of welded boiler plate, lined with slabs of soapstone. Experiments with various forms of magnesium chloride as cell feed, produced only small globules of magnesium, which failed to coalesce. But with the proper uses of fluxes he was able to produce an ingot weighing 100 pounds. In 1917 Dow constructed a 3,000 pound per day production plant, without taking the process through a pilot plant.



Pouring Magnesium



Research on magnesium continued for the next 20 years. After Willard Dow became president, he realized that if magnesium was to have a future, the company must provide incentives for its use against other metals. Dow's magnesium was given the name Dowmetal and studies were undertaken in fabrication techniques and alloy compositions. Eventually new uses were found in the automobile and aircraft industries.



Piccard's Balloon



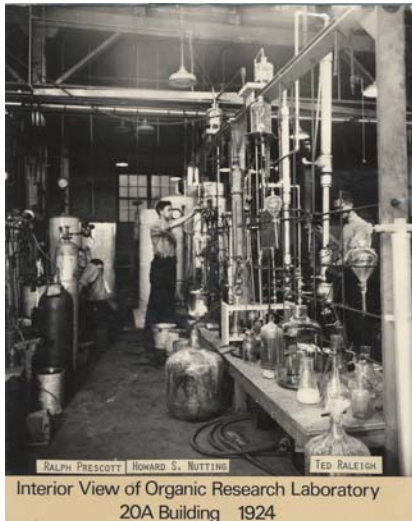
Dowmetal was used in the construction of the gondola that was displayed as a part of Jean Piccard's balloon at the 1933 World's Fair. Later, the balloon, with a Dowmetal gondola, made the stratospheric flight record of 57,579 feet.

● ● ● | Dr. William Hale



Mr. Dow and his technical personnel were predominantly inorganic chemists and engineers. By 1917 Dow had become interested in organic chemistry and organized the “Carbon Club”. He asked Dr. William Hale, Professor of Chemistry at the University of Michigan to come to Midland to present a series of lectures on organic chemistry. The lectures were popular, so Mr. Dow asked Dr. Hale to join the Company and lead it into the field of organic chemistry. Dr. Hale joined the company as Dow’s first organic chemist.

● ● ● | Organic Research Laboratory



In March 1919, Dr. Hale established the Organic Research Laboratory. It was a 5 foot by 25 foot corner of the minor bromides plant. It was the first basic research laboratory in Dow. Over time the laboratory would expand to become one of Dow's most famous laboratories. Dr. Hale worked by himself for over two years.



Dr. Edgar C Britton

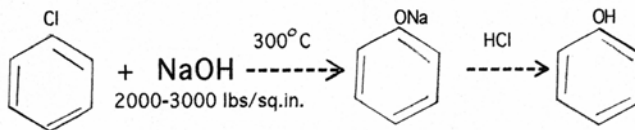


In October 1922 he recruited Dr. Edgar C. Britton, his former assistant and acting head of the chemistry department at the University of Michigan to come to Midland and assist him in building an organic research department.

Dr. Hale organized the Midland branch of the American Chemical Society. The first meeting of 20 to 30 chemists, was held December 2, 1919 with Herbert Dow as the first chairman.

In 1922 Mr. Dow became interested in producing phenol by a new process. By a "Dow process" he would say. The standard industry process was the sulfonation of benzene followed with hydrolysis, whereas Dow used the hydrolysis of bromobenzene. But with the high cost of bromine Mr. Dow wanted a new, less expensive and different process. The Organic Laboratory took up the challenge.

Chlorobenzene - Phenol The Hale-Britton Process



What was to be known as the Hale-Britton process was the high temperature/high pressure hydrolysis of chlorobenzene by a very dilute aqueous solution of alkali. The hydrolysis was conducted as a continuous process at 2000-3000 psi, by flowing the reactants through a coiled pipe line system capable of maintaining the required temperature and pressure of suitable length (about one mile) to provide the time period required for reaction (about 20 minutes).

With this unique process, Dow would dominate the phenol business for years to come. With chlorine and bromine cells producing the respective halogens and the by-product sodium hydroxide for use in the hydrolysis of chlorobenzene, Dow now had the blue print for expansion.



“What self-respecting nation would permit its fuel problem to be laid in the hand of foreigners?”

Dr. William Hale, 1936

Dr. Hale remained laboratory director until 1932. He was an early advocate of the utilization of agricultural waste products and proposed that alcohol be used for automobiles in place of gasoline. He invented the term “Chemurgy”, which is part of our language today. You might say that he was Dow’s first “green”. In 1936 he wrote, “What self-respecting nation would permit its fuel problem to be laid in the hand of foreigners?”

● ● ● | Dr. Britton in lab



As the Organic Research Laboratory reputation grew, Dr. Hale took on other responsibilities and Dr. Britton became the laboratory director in 1932. Britton worked in the Organic Research Laboratory for 42 years and became the company's most renowned organic chemist. He was always called "Doc". In 1932 he was named director of the laboratory and by the time he retired he had 366 patents - the largest number of patents by any Dow scientist to date. I'm proud to say that my name appears as a co-inventor on seven of his patents!

Over time the laboratory expanded in size to nine laboratories each staffed with eight men. Each laboratory was dedicated to a specific type of research: bio-products synthesis, organic phosphorus chemistry, bio-mechanisms, pharmaceutical chemistry, polymer and surface chemistry, phenol chemistry and catalysis, alkylene oxide chemistry, organic polymer chemistry, exploratory organic chemistry, and with an engineering department, a pilot plant and an instrument group.



Organic Laboratory Accomplishments

- Cellulose Ethers
- METHOCEL™
cellulose ethers
- ETHOCEL™
ethylcellulose
polymers



Britton's work led to an astonishing variety of products, ranging from plastics, dyes, pharmaceuticals, synthetic rubber, and silicone products to weed killers, insecticides, fungicides, and preservatives. His insecticides and herbicides opened up a new era in agricultural chemicals. The first tank car of pure butadiene shipped during World War II was manufactured by a process his scientists invented, making possible the manufacture of synthetic rubber. The foundation built on phenol and its derivatives during Britton's early years at Dow gave rise to many compounds. Thousands of organic chemicals were synthesized and evaluated. Many were sold to other companies for their studies.

CELLULOSE ETHERS went into production and became the basis of the Cellulose Products Department in 1935.

METHOCEL often called the "invisible product", used as a thickener, binder and suspension agent. It is used in adhesives, agricultural chemicals, ceramics, chemical specialties, foods, paper products, pharmaceuticals, cosmetics and latex paints.

ETHOCEL Dow's first plastic was developed just in time to be used extensively during World War II. It was used for telephone headsets and mouthpieces, control knobs, dust goggles, and airplane parts. When sprayed on tents, sleeping bags, and clothing it made them water and chemical resistant.

More Organic Lab Accomplishments. . .

- DOWICIDES
- Cliffs Dow Chemicals
- Glycols, glycol amines and ethers
- Silicones
- Butadiene
- Udex Process
- Amino Acids
- Pesticides



DOWICIDES: phenolic materials for use as preservatives and sanitizing agents.

Cliffs Dow Chemicals

By the destructive distillation of wood, obtained from Cliffs Dow Chemical, Marquette, Michigan, Organic Laboratory chemists produced acetic acid, acetic anhydride, ethanol, etc.

Glycols, glycol amines and ethers

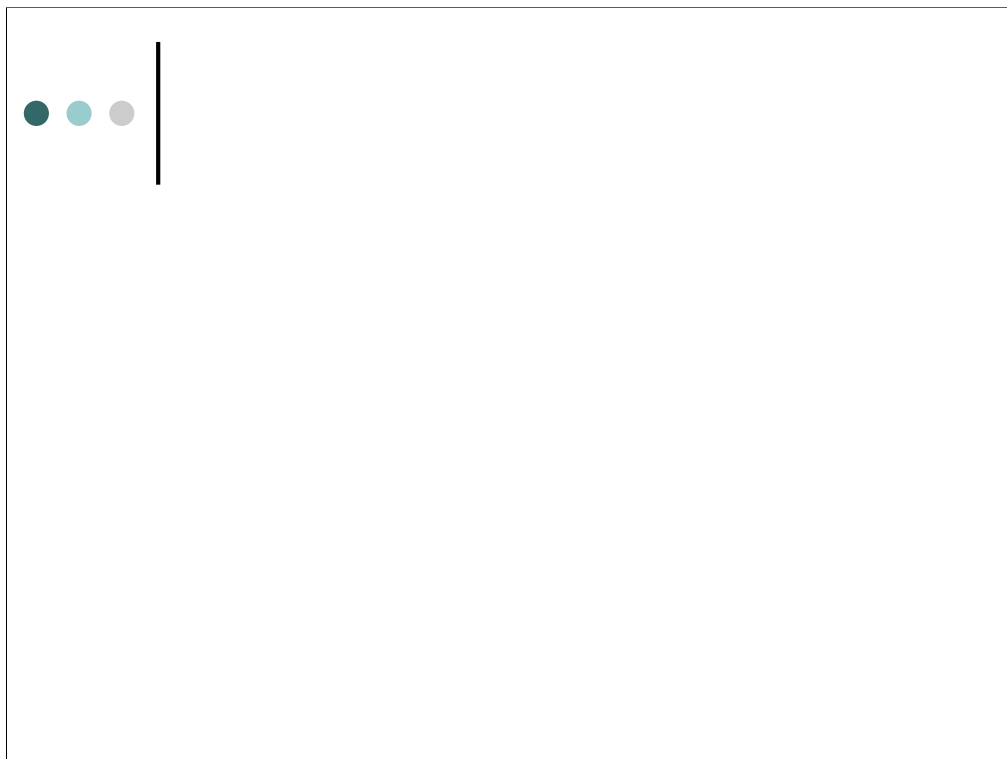
In 1931-34 processes were developed for the production of ethylene glycol, propylene glycol, ethanolamines, etc.

Silicones

Britton was involved very early in silicone chemistry. The relationship between him and Corning Glass Works helped bring about the formation of the Dow Corning Corporation. Some of the early chemists and managers in Dow Corning were from his laboratory. Britton served as a member of the Board of Directors of Dow Corning for 18 years.

Butadiene

Dr. Lee Horsley, one of Britton's key scientists in the 1930's and 40's, developed a critical catalyst for the production of butadiene, an important component of synthetic rubber. The first tank car of butadiene shipped from Dow was made in the Organic Laboratory pilot plant.



Udex Process

Horsley's studies of azeotropic distillation led to the development of the Udex process for purifying benzene, now used by many oil companies. Horsley's azeotropic distillation data are used throughout the world. Horsley did original work on ethanolamines and polyglycols.

Amino Acids

Britton pioneered the synthesis of eight of the essential protein building blocks but only methionine became a widely used product, as an additive to poultry feed.

Pesticides

Novel products came from the Bio-Products Synthesis Laboratory and the Organic Phosphorus Chemistry Laboratory based on chlorinated pyridines, substituted phenols and heterocyclic compounds such as Korlan and Ruelene for the systemic control of parasites in animals, Coyden coccidiostat for use in poultry and Dursban insecticide. Dursban, for many years was the world's largest used organophosphate insecticide. Ray Rigterink was awarded the H. H. Dow Gold Medal for his synthesis of Dursban.



ACS Heroes of Chemistry Award



Dow's Global Polypropylene Strategy Is on Target and on the Track

Vol. 5, No. 8
September/October 1999
Midland Headquarters
Marketing & Sales
Customer News
Hampshire Chemical

Congratulations to the Pyridine Team ACS Heroes of Chemistry Award Honors Seven Dow Ag Veterans

The 1970s and 80s were exciting times for an exciting research and engineering team at Dow Chemical Company. Back then, Dow was the only company in the world that was able to produce a full line of high-strength polypropylenes. This was a major achievement for Dow and a key to its success in the global market. The team's work resulted in the development of a new generation of polypropylenes that are now being used in a wide range of applications, from automotive parts to medical devices. The team's work has resulted in sales to Dow in excess of \$1 billion per year.

"This chemistry was developed by a dedicated, forward-thinking team that was eager to bring the new generation of agricultural chemistry to the marketplace. Their work represents the best of ongoing research in this area, and the result is a new generation of products that will improve the world of chemistry."



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Three scientists formerly of the Britton Laboratory, including me, were among seven Dow chemists and engineers who received the "Heroes of Chemistry" award at the 1999 ACS meeting in New Orleans, for our pioneering work in developing seven agricultural products based on pyridine derivatives that have resulted in sales to Dow in excess of \$1 billion per year.



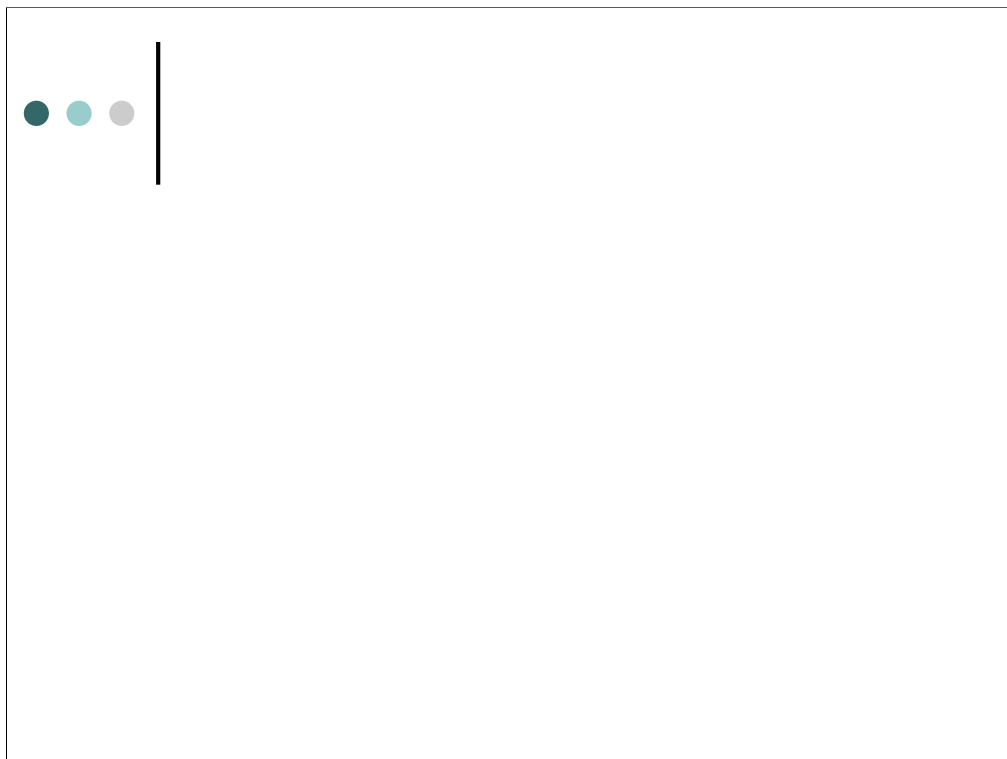
Edgar C Britton Laboratory



To acknowledge Britton's contributions to The Dow Chemical Company a new organic research laboratory was constructed and dedicated as the "Edgar C. Britton Laboratory", on May 18, 1953. Dr. Britton served as the national president of the American Chemical Society in 1952 and was awarded the Perkin Medal in 1956.

And today I am very pleased to share with you that a current Dow scientist, Dr. James Stevens, is this year's recipient of the Perkin Medal. Dr. Stevens is a Research Fellow in Performance Plastics and Chemicals and has worked in the polyolefin catalyst field since joining Dow in the 1970s in Central Research. He has been involved with the discovery and commercial implementation of Dow's INSITE™ Technology and Constrained-Geometry Catalysts, which are used in the production of approximately 2 billion pounds of polyolefins per year. He is one of the primary inventors of a number of commercial catalysts and plastic products including a variety of INSITE catalysts. Dr. Stevens will receive his award in September. Congratulations to him!

A scientist who got his start in the Organic Laboratory was Dr. Don Tomalia, the father of Starburst Polymers. He joined the lab in 1962. After various assignments, he left Dow and formed Dendritic Nanotechnologies.



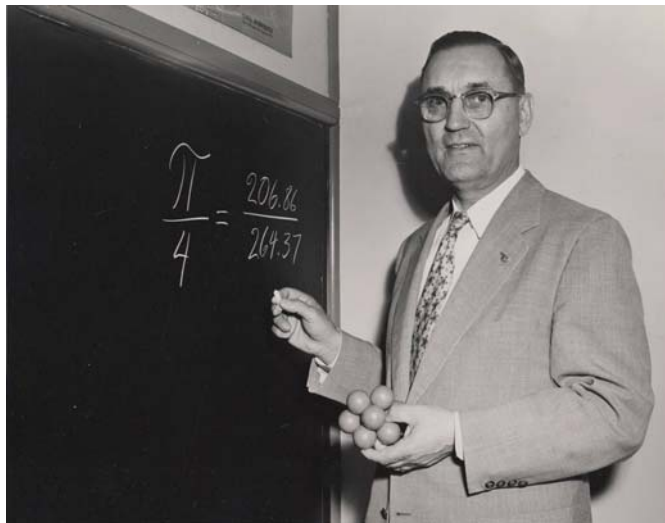
Another person I want to acknowledge today is Harold Moll. He joined Dow in 1937 and spent most of his time in the Organic Lab. If any of you have questions concerning the early activities in the Organic Lab, I suggest that you visit with Harold. Harold is 92 years old and is here today. Harold, please stand and be recognized.

Harold has two sons, Norman, who is a retired Scientist from Dow, and David who is currently a chemist at Dow. Had the event planners known of Harold's history and availability, they could have asked him to speak today. The Moll family could have spoken on their 70 year's of service with the company. I have only 35 years! Thank you, Harold.

The success of the Organic Research Lab prompted Herbert Dow to establish a number of independent laboratories based on disciplines.



John Grebe



Just as Edgar C. Britton's name was linked to the Organic Laboratory, John Grebe's name was linked to the Physics Laboratory. Upon graduating from Case with a degree in Physics in 1924 he caught the eye of H.H. Dow who was at Case to receive an Honorary Doctorate. Dow hired Grebe on the spot. Dr. Dow was always on the lookout for the top students. .

● ● ● | Physics Laboratory



Grebe's first assignment at Dow was to examine "Applications of Automatic Control to Chemical Reactions". John Grebe became the Company's idea man and Dr. Dow gave him free rein from the beginning. Grebe soon set about developing a multidisciplinary laboratory and for the next 20 years products poured out from the Physics Laboratory.



Physics Lab Accomplishments



Ethylene Cracker

Ethylene

The first ethylene produced in the company was by the dehydration of ethyl alcohol. This was not a cost effective method and by the early 1930's the Physics Lab had developed a cracking process for the production of ethylene from hydrocarbons. Frank Ford was the first scientist in the petrochemical industry to produce ethylene commercially from crude oil.



Styrene Plants

- STYRON™ Polystyrene – Dow's second plastic product and the company's #1 sales item for half a century



Styrene monomer

Prior to 1930 styrene and its polymers were laboratory curiosities.

In the mid 1930's, Driesbach and coworkers invented the Dow styrene process by passing ethylbenzene vapors into superheated steam to bring about partial dehydrogenation of ethylbenzene, using special low inventory stills.

During World War II, Dow designed plants produced over 90% of the styrene monomer that was used to manufacture GR-S rubber which was considered critical, when natural rubber supplies were cut off by the Japanese

STYRON--polystyrene plastic

STYRON, developed by the Physics Laboratory, was to become Dow's second plastic product and the company's number one sales item for half a century. Dow's high impact polystyrene, also was a great success and was the first commercially successful tough polystyrene on the market.

Later acrylonitrile/ butadiene/ styrene and other co and terpolymers were developed.



More Physics Lab Accomplishments

- Butadiene
- Styrene/Butadiene Latex
- STYROFOAM™
- Monomers

Butadiene

While the Organic Laboratory developed the process for making butadiene, the Physics Laboratory developed the sulfur dioxide process for purifying butadiene. It would become the purest butadiene available.

Styrene/Butadiene Latex

The styrene/butadiene latex plant for the manufacture of Styaloy was idle after World War II, when Dr. L.L. (Zip) Ryden conceived the idea to replace the binders, starch in paper coating and casein in water based paints with a modified latex. The research solved the difficult compatibility problem with the paper and paint emulsions, as well as determining the optimum styrene/butadiene ratio for effective binder. The resulting commercial S/B latex revolutionized the water base paint industry, paper coating industry and later the carpet backing industry and is still one of Dow's greatest businesses worldwide.

In time Dr. Ryden was known as the "father of latex." After he had polio he continued directing laboratory experiments from his iron lung. His laboratory was renamed "The Zip Ryden Laboratory."



STYROFOAM - expanded polystyrene

Ray McIntire and colleagues attempted to copolymerize styrene with isobutylene to make a flexible, low loss dielectric for early radar applications. However, the styrene polymerized to a high molecular weight solid and the isobutylene remained as an unreacted, low boiling solvent. When the reactor pressure was released, the isobutylene vaporized inside the gelled mass of polystyrene causing rapid expansion into a rigid cellular product. This was the beginning of Styrofoam.

Monomers

Divinyl benzene, methyl styrene, and chlorostyrene were monomers used to manufacture special rubbers, considered critical to the war effort in World War II by the War Production Board.



Saran™ Resins and Films

- SARAN Wrap
- Vinyl Chloride/Vinylidene Chloride monomers



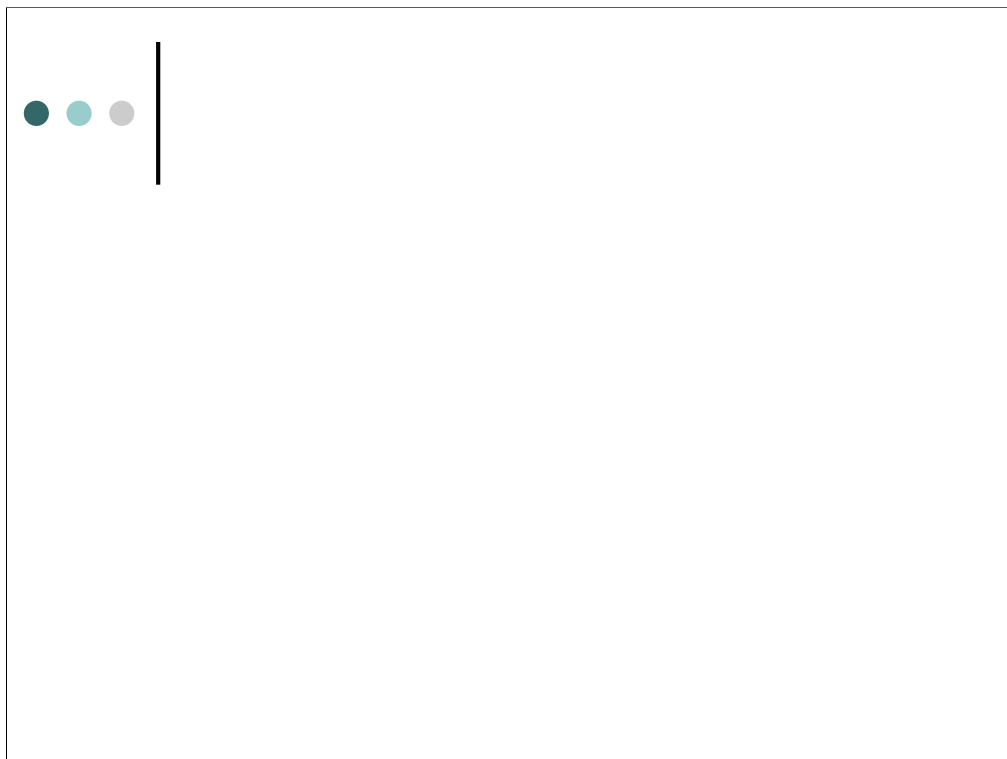
SARAN - vinylidene chloride/vinyl chloride copolymer

In 1933 while working on perchloroethylene for use by the dry cleaning industry, Dr. Ralph Wiley and co-workers noticed a white substance had formed on the inside of a distillation flask. Curious about the material, some was scraped off for analysis. Subsequent research showed it to be a vinylidene chloride/vinyl chloride copolymer.

It should be noted that this was in the early 1930's and only wet chemical analysis techniques were available. Mass spectrometric and chromatographic analyses were not known and infrared spectroscopy was just being tested. Polymer chemistry was in its infancy and there were no polymer experts at Dow.

In time these copolymers became known as Saran resins. Saran resins have found many uses in pipes, tubing, belts, handbags, seat covers films, filaments, etc.

Ralph Wiley became known as the "father of Saran".



Saran Wrap

The company developed an air balloon expansion technique for making Saran Wrap from a hot Saran resin. Saran Wrap was Dow's first consumer product.

Vinyl Chloride/ Vinylidene Chloride monomers

The Physics Lab developed methods for making these two monomers for marketing to those manufacturing polyvinyl chloride (PVC) plastics and for its internal use. Dow became a major world supplier of vinyl chloride monomer. Methods were also developed for vinylidene chloride.



More Physics Lab Accomplishments

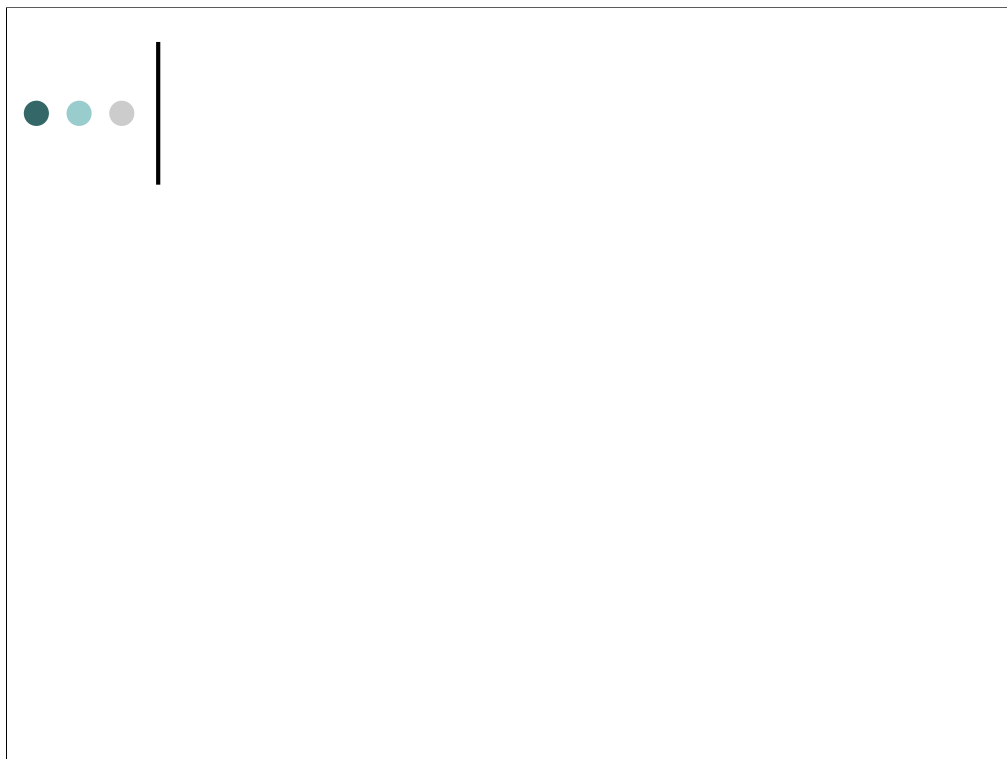
- Ethafoam
- Dowex exchange resins
- Polyacrylamides
- Chlorinated solvents
- Dowtherm products
- Bromine from seawater

ETHAFOAM is an expanded cellular polyethylene, used extensively in furniture cushions, mattresses, as a floatation material in the buoyancy field and for shock mitigation packaging to prevent damage of high value fragile equipment such as electronic devices. Louis “Bud” Rubens, the “father of Ethafoam”, was awarded the H. H. Dow Gold Medal in 1979.

DOWEX-exchange resins

Dr. William “Bill” Bauman (1937) is the father of the Dow ion-exchange resins (DOWEX-30). Dowex-30 and related resins are used to purify water, liquid foods and other materials. Dr. Bauman received the H. H. Dow Gold Medal in 1979.

Polyacrylamides are used in the development of absorbent beads, in diapers and in electro conductive paper. Much of the original research was done by Dr. Griffen “Giff” Jones.



Chlorinated solvents

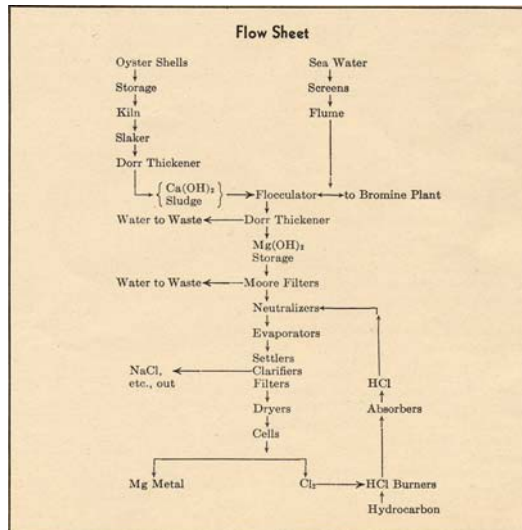
By the direct chlorination of hydrocarbons Dow was able to make carbon tetrachloride, trichloroethylene, perchloroethylene, for use as metal cleaning solvents, for dry cleaning of clothes, as paint removers, etc.

Dowtherm products are eutectic mixtures of diphenyl and diphenyloxide, used as heat exchangers for high-temperature heat transfer.

Bromine from seawater

By 1924 Mr. Dow begins to think of mining the ocean as a source for bromine and for magnesium. With Ethyl gasoline under development, there was a need for bromine to make ethylene dibromide. The quantities needed were far more than Dow was capable of making. Dow at that time was producing 90% of the nation's bromine. By 1929 Dow was actively planning to extract bromine from seawater and set about to design plants. Shortly after Mr. Dow's death in 1930, Willard Dow, the new president, moved rapidly to complete his father's dream and in 1931 the Ethyl-Dow Company was formed and in 1940 a large ethylene dibromide plant was built in Freeport, Texas using bromine from seawater.

Magnesium from the Sea



Magnesium from seawater

For Willard Dow, one of the high points of his presidency occurred January 21, 1941 when the first ingot of magnesium made from seawater was poured in Freeport, Texas. It was one of the greatest chemical engineering feats of all time and after many years of preparation, much of it in Midland, The Dow Chemical Company under Willard Dow's leadership had finally pulled it off. For the first time man was mining the ocean. It was a historic event and with war looming the need for magnesium was about to multiply. His father's dream was becoming a reality, for since 1924 Herbert Dow was always thinking about using the ocean as a mine.

● ● ● | Dr. Sylvia Stoesser – Dow's first
women researcher



DOWELL, Inc.

In 1929, the year of the stock market crash, Dr. Sylvia Stoesser became Dow's first woman researcher. Her first assignment was to study the stability of high-temperature lubricants from fractions of diphenyl oxide. She also did research on styrene monomer and chlorinated solvents. Before long she was involved in inhibitor studies which played an important role in the formation of DOWELL.

In 1932 the Pure Oil Company was operating oil wells in the Midland area and had heard that scientists in the Physics Laboratory were experimenting with acidizing brinewells to improve their productivity. By such a system Dow could extract chemicals from the underground brine and later return what was left back to the well. New and better inhibitors were needed which would prevent acid from eating away the iron well casings.



Dowell Truck



Arsenic acid and copper salts were originally used as inhibitors, but Dr. Stoesser directed her research towards organic compounds, in an effort to develop a substance that would form an organic film on the surface of the metal pipe with which the acid came in contact. Organic inhibitors, particularly mercaptans were found to be far more effective than the inorganic inhibitors used. Dr. Stoesser was the co-inventor listed in five key Dowell patents.

Such procedures were tried on oil wells with spectacular success. Overnight the demand for oil well servicing skyrocketed. Dowell was incorporated in 1932 as a service company to increase the productivity of gas, oil, and brine wells. Later it was headquartered in Tulsa, Oklahoma.



Dow helps to fluoridize water

- 1944: Midland was the first city in the USA to fluoridize public drinking water



In 1944, Midland became the first city in the United States and fourth in the world to fluoridize its public drinking water. This came about because of the development of an electron microscope in the Physics Lab and their working with the Dental School at the University of Michigan, the Midland County Dental Association, the State Health Department and the U.S. Public Health Service.

If you have questions about the Physics Laboratory, I refer you to Eldon Graham. He joined the Lab in 1947 and is here today. In 1970, Eldon left Dow to set up the Engineering Department at Saginaw Valley State University which was just being formed.



Analytical Lab (circa 1940)



ANALYTICAL LABORATORY

The analytical laboratory grew out of the control labs in the various production departments, which ran quality checks on the products being made. Water and air pollution studies were initiated in the lab. The glass fabrication lab came from the main lab and grew to 35 artisans in glass. The X-ray and spectroscopy group were first located in the main laboratory as was the Indigo lab. The Indigo section operated from 1915 until 1930.

The analytical laboratory was also the springboard for many who moved into other areas of Dow such as sales, business, and manufacturing or into other areas of research and development.



Analytical Lab - Today



In 1987 the new \$15 million Analytical Sciences Laboratory was built. It brought together under one roof the Main Laboratory, the X-Ray Spectroscopy Lab, the Radiochem Lab, the Chem-Physics Laboratory and the Instrument Applications Laboratory. The facility accommodates over \$30 million of highly sophisticated equipment and 200 analytical scientists.



Measurements of dioxins

<u>Year</u>	<u>dioxins</u>
1950	parts per thousand
1964	parts per million
1976	parts per billion
1980	parts per trillion
1983	parts per quadrillion 1 in 1,000,000,000,000,000

In the early 1950's, chemists were able to measure accurately to parts per thousand. By 1964, Dr. Warren Crummett and his associates in the Analytical Laboratory were measuring dioxins in parts per million. Dioxins were just coming to national importance resulting from the Love Canal incident, a plant explosion in Seveso, Italy and with the spraying of Agent Orange in Vietnam. By 1976 measurements of dioxins were parts per billion, in 1980 in parts per trillion and in 1983 in parts per quadrillion.

<u>Year</u>	<u>dioxins</u>
1950	parts per thousand
1964	parts per million
1976	parts per billion
1980	parts per trillion
1983	parts per quadrillion 1 in 1,000,000,000,000,000



Measurements of dioxins

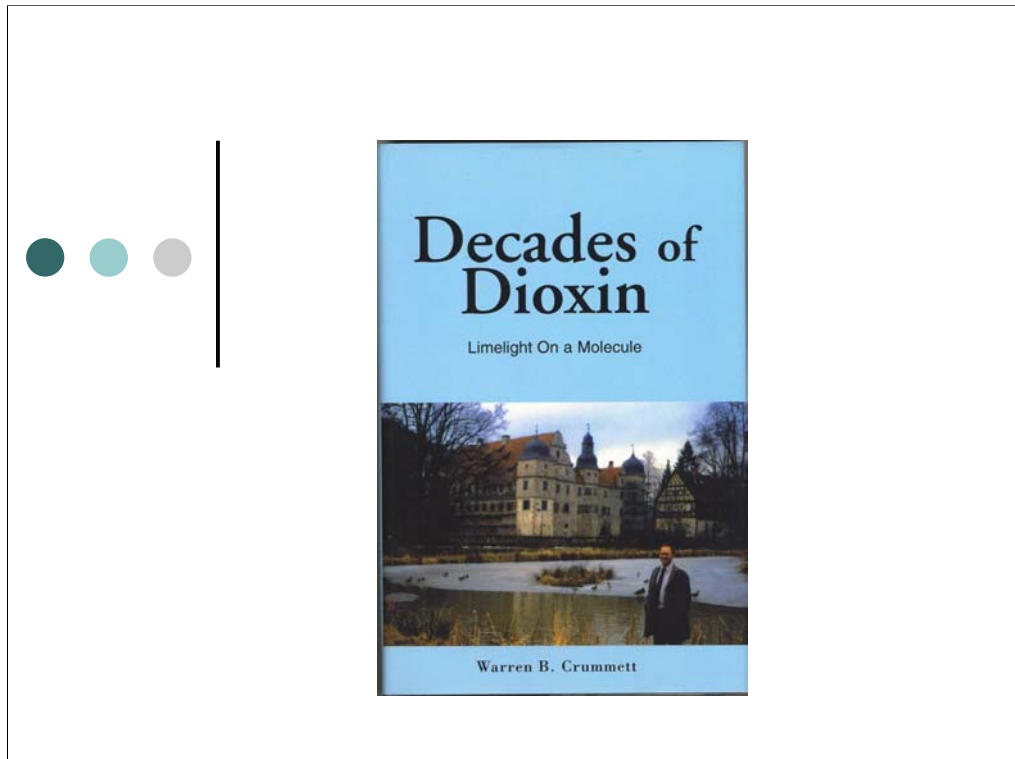
- One part per quadrillion is the length of 1 inch in 100 round trips around the sun



For example, one part per quadrillion is the length of 1 inch in 100 round trips around the sun.

Using GC Mass Spectroscopy, Crummett's group was the first to find dioxins in urban dust, automobile mufflers, cigarette smoke, wood fires, sewage sludge and many other places. They were the first to determine the 2,3,7,8-TCDD specifically and the first to separate the 22 isomers of TCDD. They were the first to prove de novo syntheses of the chlorinated dioxin in fire and published their "Trace Chemistry of Fire" hypothesis.

Dr. Crummett has been recognized throughout the country for his work in analytical methodology near the limits of detection and as the result of his management of Dow's analytical studies of "dioxins", was awarded the H.H. Dow Gold Medal in 1980.



A most interesting book by Dr. Warren Crummett, “Decades of Dioxin: Limelight On a Molecule” discusses the difficulties of the scientist as he attempts to explain his findings to the public, to the environmentalist, to the media and to regulators.

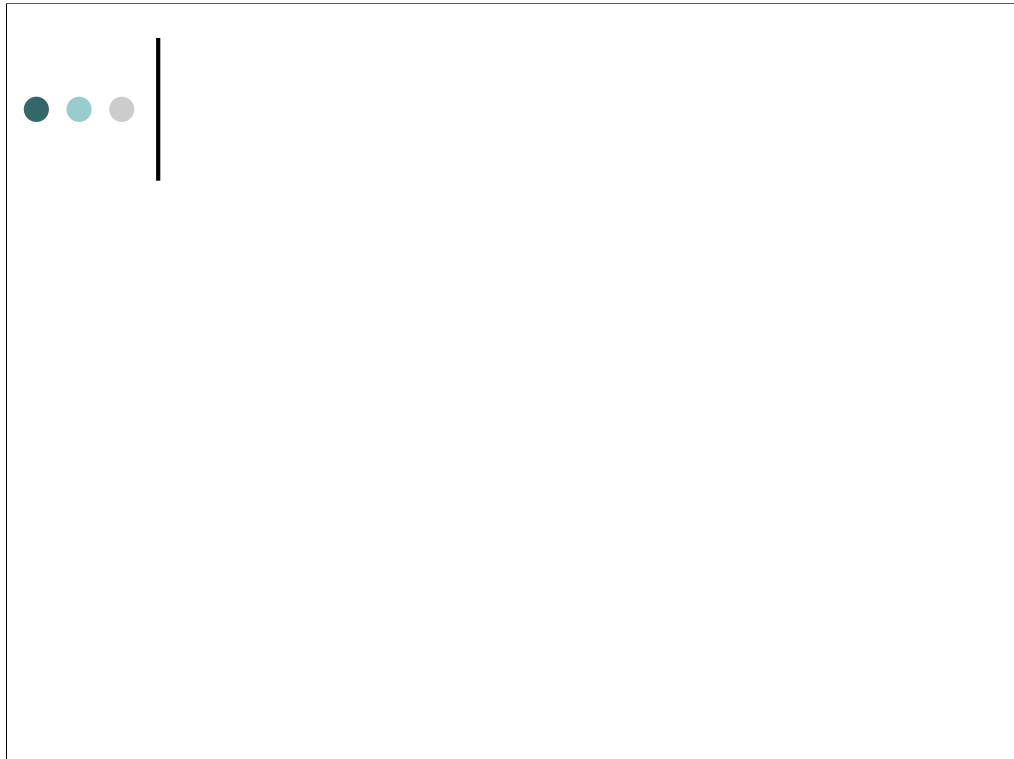
● ● ● | Dow labs and people - Today



TOWARD THE NEW CENTURY

Dow continues to innovate in the Chemical Sciences. Dow scientists developed metallocene homogeneous catalysts for the solution polymerization of olefin polymers, and launched the new technology, INSITE, which I referenced earlier. Products from these new polymers are globally used by Dow and other manufacturers to make light weight athletic shoes, medical tubing, swimming equipment, automobile bumpers, truck bed liners, electrical wire insulation, soft foams and other items for commerce. With INSITE, Dow has been able to develop polymers that meet customers' specific needs. As one of the largest global suppliers of plastics in the industry, Dow is committed to expanding markets and transforming technologies to help customers innovate, differentiate and create value.

These new polymers were so outstanding that the board of intellectual property owners selected the Dow's inventors to receive the 1994 Inventor of the Year Award. The award was presented by the chairman of the Senate Judiciary Subcommittee on patents, copyrights and trademarks in Washington, D.C. And in recognition for Dow's innovations, the Company was awarded the prestigious National Medal of Technology by President Bush in 2002.



Today, Dow continues to apply its science and technology acumen to the development of a range of other products. To name a few:

- New adhesives for bonding automotive body panels, enabling more crash-durable and more rigid vehicles.
- The use of soy bean oil as feedstock for the production of polyol, which is used in polyurethane foams for bedding, furniture, car seats, and other applications. The soy oil is renewable, and production of polyol from soy is performed with half the energy of the traditional scheme and there is no CO₂ net emission.
- Advanced ceramic materials for the removal of soot from diesel exhaust, enabling cleaner vehicles.
- To ensure quality water for life, Dow's FILMTEC membranes are used to produce billions of liters of water per day in industrial, municipal, and residential systems around the world. Desalination is one way FILMTEC membranes are helping to turn oceans into fresh water. At the same time, Dow recently introduced ADSORBSIA media to address new legislation in the United States targeted at removing naturally occurring Arsenic from drinking water.



Dow is a Knowledge Industry

- *Science launched this enterprise.*
- *Science has led us to greatness.*
- *Science will lead us to further heights.*

Robert Lundeen, Dow Chairman of the Board, 1983

Dow scientists and researchers continue to work toward developing new products, processes and technologies that meet the needs of customers in a variety of markets while reducing the impact on human health and the environment. I am confident that the Dow R&D organization will continue to provide innovative products that will make a lasting and positive impact on the world.

So, that is a brief history of chemistry at The Dow Chemical Company in Midland and I am proud to have been a part of such an exciting time at the Company. In closing I would like to quote Robert Lundeen, a former chairman of the board of The Dow Chemical Company, who in 1983, when speaking at a luncheon ceremony honoring Dow scientists called the chemical industry a "knowledge industry." He stated:

"Science launched this enterprise."

"Science has led us to greatness."

"Science will lead us to further heights."

Thank you.