

chartered in January of 1907. Both National Carbon and Union Carbide had a stake in the new company.

The first Linde plant in America was built in Buffalo, New York, with a capacity of one million cubic feet of oxygen per month. Over the next several years, plants with capacities of four to five million cubic feet of oxygen per month were built in Cleveland, Detroit, Baltimore, Los Angeles, Brooklyn, Youngstown, Philadelphia, and Pittsburgh. Linde also got into the business of making tanks and apparatus for the distribution and use of oxygen.

### Prest-O-Lite Company

A lot of the calcium carbide that Union Carbide Company made went to a company in Indianapolis called the Concentrated Acetylene Company. The company had been formed in 1904 by Carl G. Fisher, James A. Allison, and P. C. Avery. Fisher had a bicycle shop and had gotten interested in acetylene by way of the lights on bicycles. Avery had developed a small portable gas tank for safely holding compressed acetylene. (Compressed acetylene—above 10 psi—was a problem because a spark or a blow could cause it to detonate.) Allison, who was in the automobile business, was the financial resource behind the deal. They set out to supply compressed acetylene in small tanks to the lighting market. Prior to that time, people bought calcium carbide and generated their own acetylene, which was not always convenient. (The acetylene was generated in the lamp itself, which was done by controlling the drip of water on dry calcium carbide in a chamber in the lamp.)

In 1906, Avery sold his share of the company to his two partners, and the name of the company was changed to the Prest-O-Lite Company. The company operated in Indianapolis for several years but the plant was beset by fires and explosions from time to time as acetylene plants in those days were inclined to do. The city required that they move out of town. They chose a rural site west of Indianapolis that became known as Speedway, because Carl Fisher had built a two-and-one-half mile oval brick track next to the plant for testing and racing automobiles. The track today, of course, is the Indianapolis Speedway, the site of the "Indy 500." Carl Fisher sold out to Union Carbide Company for \$6 million and used the money to develop the city of Miami Beach from an uninhabited, offshore sand bar in Florida. James Allison went on to form the Allison Motor Company

and produce the famed Allison aircraft engines. (The Allison Motor Company was later bought out by General Motors.)

Prest-O-Lite was very successful in providing acetylene and the necessary tanks and equipment to use it. They built a number of plants across the country. However, as electric lights came into use on cars and in houses, the acetylene lighting business declined. On the other hand, the need for acetylene for cutting and welding was growing, and Prest-O-Lite began filling that need. The safe storage of compressed acetylene in large tanks had been made possible by a discovery in France that acetylene dissolved in acetone in an inert porous filler lost its penchant to detonate, that is, decompose explosively. Inasmuch as acetone is able to dissolve large volumes of acetylene, it made for an effective system. Indeed, this system is still in use today with some modification to the porous filler.

There were natural and growing relationships among the companies involved. Union Carbide Company was making calcium carbide and selling it to the Prest-O-Lite Company, which generated acetylene and sold it. The Electro Metallurgical Company, Union Carbide Company's subsidiary, was making ferroalloys using essentially the same smelting process used by Union Carbide to make calcium carbide. National Carbon Company was making furnace electrodes and selling them to the Union Carbide Company and to the Electro Metallurgical Company. The Linde Air Products Company, owned in part by National Carbon and Union Carbide, was producing oxygen to be used with acetylene for cutting and welding. Further, Prest-O-Lite and Linde were also making and selling equipment for transporting gases and using the oxy-acetylene systems.

Prest-O-Lite was uneasy, however, with being tied to a single supplier of calcium carbide. Therefore, they decided in 1913 to try to find an alternative source of acetylene, preferably from a petroleum source. Inasmuch as they did not have the resources to make such a study, they looked about for help.

#### Mellon Institute

The secretary of Prest-O-Lite, Frank E. Sweet, was directed to the Mellon Institute in Pittsburgh, which had just been established by Richard B. Mellon and Andrew W. Mellon, Pittsburgh bankers. The purpose of the Mellon Institute was to do research for the sole benefit of industrial sponsors. It filled a need when most industry did not have in-house research and development activities of any note. It

utilized a fellowship system for individual studies and operated in loose association with the University of Pittsburgh. In practice, the industrial sponsor defined the objectives and paid the bills. Mellon provided professional guidance, laboratory facilities, and—with the sponsor's approval—key personnel who would be wholly devoted to the sponsor's program. One key policy of the Institute was that there was to be no competition between fellowships.

In 1913, Mellon established Institute Fellowship 37 for Prest-O-Lite. Its objective was to explore alternative methods for the commercial generation of acetylene. The senior fellow assigned to lead the work was Dr. George Oliver Curme, Jr. Dr. Curme had been born in 1888 in Mount Vernon, Iowa, where his father was a university professor. Curme, the younger, had an undergraduate degree in chemistry from Northwestern University and a doctorate in chemistry from the University of Chicago. He had just recently returned from a year of study in Germany at the University of Berlin and at the Kaiser Wilhelm Institute. Work on the study started in 1914 and lasted three years. In that time, Curme and his associates developed an electrothermic process for generating a mixture of hydrocarbon gases rich in acetylene by subjecting gas oil, a petroleum fraction between kerosene and diesel fuel, to a submerged high-frequency electric arc. The gas produced contained about 25-percent acetylene and about half that much ethylene. It appeared that acetylene produced by this technology could be competitive with acetylene from calcium carbide.

Dr. Curme, being an organic chemist, was also much interested in chemical derivatives of acetylene. However, he had not been permitted to pursue work in this area because Union Carbide Company had sponsored a Mellon fellowship (No. 64) in 1914 to find diversified uses for calcium carbide and acetylene. In fact, they had demonstrated the practicality of the hydration of acetylene to acetaldehyde and processes for the conversion of acetaldehyde to aldol, to acetic acid, and to vinyl acetate. Linde had also sponsored a Mellon fellowship, in 1915, to explore uses for nitrogen, a byproduct of the production of oxygen.

Dr. Curme then turned his attention to ethylene, which also had been made in some quantity in the submerged arc process. There was no conflict here insofar as usage and derivatives were concerned. Furthermore, ethylene in all likelihood could be made cheaper than acetylene. There was also the prospect of using ethylene for a greater number of aliphatic chemicals than had been proposed for acetylene. The most obvious potential derivative was ethanol, ordinary ethyl alcohol,

which at the time was made only by fermentation. And up to Curme's time, the little ethylene that was made was produced by the dehydration of fermentation alcohol. (Some ethylene was also found in an impure state in water gas and as an unwanted byproduct in petroleum refining.)

Ethylene had been discovered in 1795 by four Dutch chemists—Deimann, van Troostwyk, Bondt, and Louwvenburgh—who had prepared it by dehydrating ethanol. From the ethylene, they made ethylene dichloride, which is a heavy liquid insoluble in water. They called the ethylene “olefiant” or “oil forming gas” on the strength of that property. The name survives today as “olefins,” which describes a whole series of homologous compounds. In the 1820s, Henry Hennell, working with Michael Faraday's laboratory, reversed the process and made ethanol from ethylene by combining it with sulfuric acid to produce ethyl hydrogen sulfate and then hydrolyzing that with water to yield ethanol. Berthelot conducted the same reaction with propylene to make isopropanol in 1855.

Work on ethylene derivatives at Mellon started in 1917 with Dr. Curme, his brother Henry, plus John N. Compton and Glenn B. Bagley. The area that they chose to explore first was the manufacture of benzoic acid by way of ethylene, ethylene dichloride, and dibenzyl. The experimenters used the Claude process for the separation and purification of ethylene rather than the Linde cryogenic process, because they felt that their work was in conflict with Union Carbide's objectives and in turn with Linde.

#### Union Carbide and Carbon Corporation

In the meantime, the heavy demands of World War I for steel and alloys had caused growing pains in Union Carbide, Electro Metallurgical, National Carbon, Presto-O-Lite, and Linde. The interrelationships were so tight that any upset in one of the group translated quickly to the rest. As a result, National Carbon proposed a merger. There was already some interlocking ownership, anyway. (Union Carbide owned 40 percent of Prest-O-Lite's stock and 30 percent of Linde's stock.) It was generally felt that a merger would be beneficial all around. Union Carbide had furnaces and strategic materials, top notch management, and capital. Some of the directors of National Carbon were looking to retire, and Carl Fisher of Prest-O-Lite wanted to get on with his development of Miami Beach. Linde needed help in the form of capital and technical management. A merger was deemed natural,

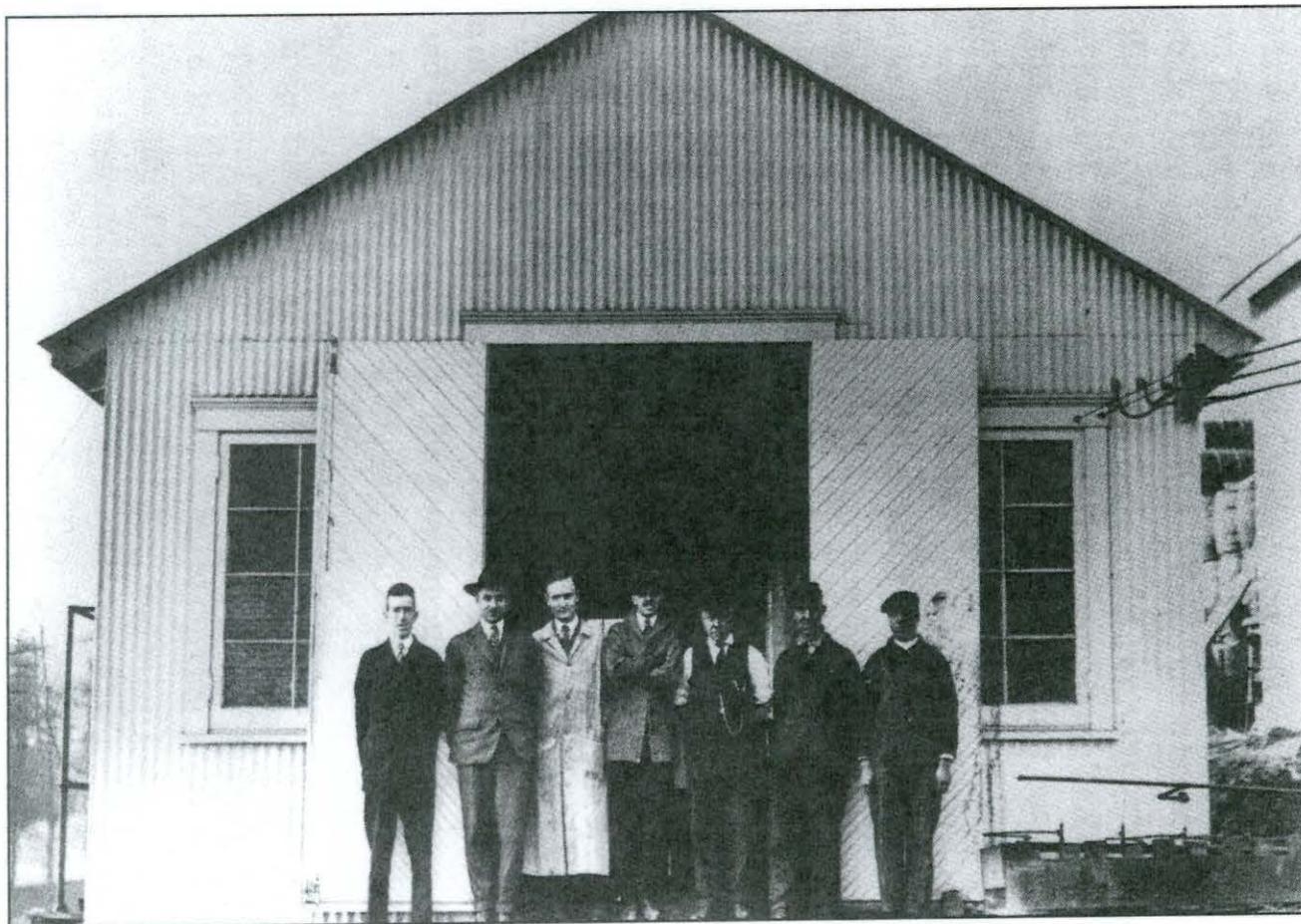


Figure VIII - Laboratory Known as the "Shack" at the Mellon Institute in 1917  
Individuals left to right: Glenn D. Bagley, George O. Curme, Jr., Henry R. Curme, John  
N. Compton. Others unidentified.

functional, and logical. So, on November 1, 1917, Union Carbide and Carbon Corporation came into being.

The new entity was formed as a holding company capitalized at \$79 million with Myron T. Herrick of National Carbon as chairman and George O. Knapp of Union Carbide Company as president. Among those on the board of directors were C. K. G. Billings of the Peoples Gas Light and Coke Company, Jesse Ricks, a lawyer, and Edgar F. Price, the former farm boy from Spray. Ricks had represented Union Carbide Company interests for some years and had put the deal together without any underwriting fees being involved. (The story goes that some of the principals were parishioners of the same church in Chicago and had struck the agreement to form the Company on the church steps after Sunday services.) The financial men behind the merger were Cornelius Kingsley Garrison Billings and his associate, Anthony N. Brady. They held large blocks of stock in Union Carbide Company and controlled the action. However, the largest block of stock was taken by John Motley Morehead. Headquarters for the new company were established in New York City with other offices in Chicago.

The merger appeared to signal the end of the Prest-O-Lite fellowship at Mellon, because now Presto-O-Lite and Union Carbide were tied together and Presto-O-Lite no longer needed an alternate source of acetylene. However, a demonstration of the submerged arc process had been scheduled for Prest-O-Lite management and it proceeded anyway. The demonstration was also attended by representatives from Union Carbide Company, and included John Motley Morehead. The reaction was favorable but noncommittal.

At about this same time, Dr. R. F. Bacon, the Director of the Mellon Institute, was appointed as technical head of the United States Army's Chemical Warfare Service. In this position, he was seeking to develop a new source of ethylene for the manufacture of dichloroethyl sulfide in support of the war effort in Europe. Ethylene for its manufacture was being made by the dehydration of ethanol, which was in short supply. Bacon was aware of Curme's work, and he approached him about the possibility of making ethylene from gas oil by the electrothermal process. Dr. Curme, however, suggested using ethane instead, a gas in abundant supply, inasmuch as it required less power to crack, and electrical energy was in short supply. As a result, at the instigation of the Chemical Warfare Service, the Mellon Prest-O-Lite fellowship took on a program to explore the manufacture of dichlo-

roethyl sulfide from ethylene dichloride derived from ethylene.

The first efforts were devoted to the ethylene chlorhydrin process, and work was also started to convert propylene to isopropanol. The fellowship now had the advantage that it had the resources of the Linde Company with its low-temperature separations technology as a partner. A small scale model of the proposed unit was set up at the Linde laboratory in Buffalo, New York. It consisted of an electrically heated silicon tube to crack ethane and a low temperature liquefaction and separation unit. Suitable conditions and yields for the manufacture of ethylene were demonstrated. In the summer of 1918, work was started on a small "commercial" ethylene plant at Buffalo. The job was nearly complete in November when the war ended and the demand for dichloroethyl sulfide evaporated.

#### Carbide and Carbon Chemicals Corporation

During the year following the Armistice (November 11, 1917), the program hung in the balance. The post-war uncertainty and confusion contributed to the situation. Also, no one in the organization other than Dr. Curme seemed to know anything about manufacturing chemicals. However, studies had indicated that there were promising markets for ethylene dichloride, ethanol, ethylene glycol, isopropanol, and acetone. Earlier, Dr. Curme had proposed to the new corporation that:

"Starting with a plentiful supply of ethylene and acetylene, and the necessary by-products obtained in the manufacture of these substances, a huge chemical industry can be built up capable of absorbing thousands of tons of products annually. The Union Carbide and Carbon Corporation with control of the Linde process, the Carbide process, and with its knowledge and control of electric power projects, is in an exceptional position to exploit this field."

Toward the end of 1918, it was decided that a thorough review should be made of the program, its prospects evaluated, and a decision made to either continue or not. A week of intensive figuring was spent by Dr. Curme and John N. Compton. They put together a set of estimates and presented them in New York. The decision was made to continue. The estimates proved to be faulty, in part, because they were based heavily on the sale of diethyl sulfate at \$1.00 per pound—



Figure IX  
Union Carbide Corporate Offices 1917 - 1959  
42nd Street and Madison Avenue, New York, NY

which was a product that didn't sell until 1957. What really was bought, however, was Dr. Curme's vision of an aliphatic chemicals industry. The ultimate sponsor at the Corporate level was Edgar F. Price, a vice president of the Corporation and one of the original employees at Spray. Without him, Curme's vision would have died.

As a result, it was decided that work should continue on ethylene and derivatives for both commercial uses and possible national defense needs. The new project was to function as a division of Linde with W. F. Barrett, then a vice president of Linde, at its head. James A. Rafferty, an assistant works manager at Linde, was made the full-time manager of the project. H. Earle Thompson was brought in from Linde and made the principal technical adviser with the overall responsibility for engineering. Dr. Curme and his associates were still part of the Mellon Institute.

The acetylene studies were put on the shelf, and work was started at Mellon to build ethylene facilities and a unit to make diethyl sulfate, a precursor to ethanol and ethylene chlorhydrin. A small unit to make isopropanol was also set up at Linde in Buffalo and fifteen gallons made. The first ethylene from the new system was made in January of 1920. There was some trepidation about compressing ethylene because it never had been done before and its counterpart, acetylene, was prone to detonate. Therefore, the first ethylene compressor was tested in an open field at a safe distance from all concerned. Fortunately, ethylene proved safe to compress. Operations were carried out in a combined continuous and batch manner between Mellon in Pittsburgh and Linde in Buffalo.

Fire destroyed the pilot plant at Buffalo in May of 1920. Its reconstruction was deemed inadvisable, and a new site was sought. Rafferty was given the responsibility for finding it, and he explored locations in West Virginia, because of the quantity and quality of natural gas there. One of the sites was at Clendenin, a hamlet on the Elk River about twenty miles above Charleston, which was the location of the Clendenin Gasoline Company. The company was a small gas processing plant that had contracts to take natural gas collected from wells, process it to remove the accompanying gasoline by absorption, and return the stripped gas, methane, to a public utility. It operated on a self supporting basis by selling the gasoline. However, the gasoline produced was "wild," that is, it contained dissolved volatile gasses—ethane, propane, and butane. These were partly removed before the gasoline was sold by letting them "weather off" to the atmosphere from open storage tanks. The wasted ethane and propane, however, were just the mate-

rial that was needed as feedstocks for the manufacture of ethylene and propylene. In effect, they could be had for free from the Clendenin plant. Accordingly, the plant and some adjacent land were purchased. The plant continued to be held under the name Clendenin Gasoline Company to avoid the need to establish new contracts with sellers and buyers. (The Clendenin Gasoline Company continued in existence until 1938.)

In mid-1920, Carbide and Carbon Chemicals Corporation was formed to take over the project. The petrochemical industry had been born. Rafferty was named general manager and Curme chief chemist.

### People

What happened to the major players along the way? Thomas Leopold Willson went back to Canada where he made calcium carbide, promoted fertilizer and hydroelectric projects, and made and lost a fortune. He died on a business trip to New York in 1915 at the age of 55.

Major James Turner Morehead paid off his debts, regained a small fortune, and died in 1908 at age 66.

John Motley Morehead served as a construction engineer and consultant to the calcium carbide industry for several years. In 1902, he joined Peoples Gas Light and Coke of Chicago as chief chemist. He subsequently became affiliated first with Union Carbide Company and then with Union Carbide and Carbon Corporation. Along the way he acquired a considerable fortune. He was the largest single stockholder in the Corporation when it was formed. He distinguished himself early on in the field of gas analysis, and continued to serve as a consultant in Union Carbide Corporation. In the 1940s, he experimented successfully with making synthetic gemstones in the Linde laboratories at Tonawanda, New York, which he funded out of his own pocket. The gemstones were marketed first as instrument bearings and then as Linde "Stars." Morehead went to the office daily in New York and never retired. He died in 1965 at age 94. He was a major benefactor of the University of North Carolina, donating about \$30 million to the school during his lifetime. He also served as mayor of Rye, New York, from 1925 to 1930, and as the United States Envoy Extraordinary and Minister Plenipotentiary of Sweden from 1930 to 1933.

Guillaume de Chalmot, the developer of the calcium carbide process and

the ferroalloy processes, died in 1899 at the age of 29, possibly of tuberculosis. He was manager of the Willson Aluminum Company Holcomb Rock plant at the time.

Edgar F. Price, hired in 1891 by Major Morehead at Spray, became president of Union Carbide Company and then a vice president and director of Union Carbide and Carbon Corporation. He was consistently supportive of the chemicals programs. He retired in 1925.

Cornelius Kingsley Garrison Billings, the financial strength behind the new corporation, was a noted horseman and had a 4000-acre horse farm in Virginia. He also had an estate in New York City (The Cloisters, which was sold in 1925 to John D. Rockefeller, Jr. who donated it to The Metropolitan Museum of Art), and estates on Long Island and at Santa Barbara, California. He became a member of the board of directors of Union Carbide and Carbon Corporation when it was formed in 1917 and served until his death in 1937 at age 76. He was chairman of the board from 1929 to 1937.

James A Rafferty, whose roots were in Peoples Gas Light and Coke Company, had joined Linde in 1917 and moved over to Carbide and Carbon Chemicals Corporation in 1920. He was elected president of the Chemicals group in 1929 and became a director of the parent corporation in 1941. Although he was a mechanical engineer and a chemist, he was not directly involved in the front line of the Company's technology. Nonetheless, his was the guiding hand behind the selection of people and the support of programs that made the chemicals show go. He was recognized as a prime mover in the petrochemicals industry in 1948 when he was presented the Chemical Industry Medal by the Society of Chemical Industry. He died in 1951 while still active with the Company.

George Oliver Curme, Jr. joined Carbide and Carbon Chemicals Corporation from the Mellon Fellowship in 1920 and went on to be vice president-research and a director of Union Carbide Corporation. He provided active direction of the Company's technical programs. He held numerous patents, including those for the manufacture and purification of ethylene, the manufacture of ethylene dichloride, the manufacture of acetaldehyde, the manufacture of acetic acid, the manufacture of ethylene glycol, the manufacture of ethylene chlorhydrin, and the manufacture of acetylene from organic liquids. Along the way, he received the Chandler Medal from Columbia University in 1933, the Perkin Medal from the Society of Chemical Industry in 1935, the Elliot Creeson Medal from the Franklin Institute in 1936, the National Modern Pioneer Award from the National Association of Manufac-

turers in 1940, the Willard Gibbs Medal from the American Chemical Society in 1944, and the National Medal of Science in 1976. Curme retired in 1955, although he continued as a director of the Company until 1961. He died in 1976 at the age of 87.



Figure X  
George Oliver Curme, Jr. 1888 - 1976