F.I.: Messrs. R. K. Scales
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E T H Y L   C O R P O R A T I O N

July 21, 1958

MEMORANDUM TO DEPARTMENT HEADS:

Messrs. A. C. Burdick
J. A. Costello
G. O. Hayes
R. A. Kehoe
G. F. Kirby
M. P. Murdock
W. R. Perdue, Jr.
H. A. Savage
F. P. Warne

Gentlemen:

Attached for your information is a copy of the latest revision of the "Brief History of Ethyl Corporation."

This material is used in handling requests from appropriate publications or individuals from time to time.

Sincerely,

James E. Boudreau

James E. Boudreau

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ETHYL CORPORATION: A Brief History

Ethyl Corporation has been formally in existence since 1924--but its real beginnings go back to the days before World War I. The Company came into being as a result of a scientist's curiosity as to what was causing knock in automobile engines. There were many interesting theories about the problem in those early days, but little factual knowledge. But the knock that was beginning to appear in automobile engines of the World War I era was a major barrier to automotive progress.

The man who first recognized the problem of knock was Charles F. Kettering. He was to become Ethyl Corporation's first president (1924-25) and is today its senior board member.

Mr. Kettering had just perfected his electric self-starter and battery ignition, and they were introduced for the first time on the 1912 Cadillac. As it happened, the Cadillac engine was advanced for its day and it knocked on the gasoline then available. That noisy ping was so bothersome, in fact, that it was called "the knock heard 'round the world." We know today that it was due to the fact that the temperatures and pressures exerted upon the gasoline, during combustion, were too great for the fuel to withstand. But lacking such knowledge, people in those times freely held Mr. Kettering's new inventions to blame. Little did they realize that knock was a fuel, and not a mechanical, problem.

Another invention of "Boss Ket," his Delco farm lighting unit, figured in the mystery. When operated on gasoline, the Delco unit gave satisfactory performance and efficiency. But when it was run on kerosene, this fuel knocked the daylights out of it.

Determined to learn what was responsible for knock, Mr. Kettering in 1916 assigned a laboratory assistant, Thomas Midgley, Jr., to the problem. Dr. Midgley, and his closest co-worker, T. A. Boyd, didn't realize it, but they were to spend years working on the riddle of knock.

Attacking the Problem

As a first step, Dr. Midgley developed what since has become known as the Midgley Indicator. This was a high-speed recording device which magnified and showed visibly the pressure-curve of each explosion of the fuel as a test engine was running. The indicator didn't solve the basic problem, but it established, among other things, that knocking and preignition were two entirely different phenomena.

In a second attack on the problem, Dr. Midgley had a hole bored in the side of a test engine and a pane of glass installed. The glass broke under the pressure generated so it was replaced with more durable quartz. Now, for the first time, it was possible to see combustion taking place. It was observed that, when normal combustion occurred, the flame was a blue one; but when an engine knocked, a white hot flash resulted.

To test a "beautiful but wrong" theory--that a dark color in the fuel would absorb more of the heat during combustion--the researchers added iodine to the fuel, dyeing it deep brown. The test motor was started up and--miracle of miracles--the knock disappeared!

Here, without anyone realizing it at the time, was the first discovery of an antiknock agent. Iodine stopped the knock in gasoline, but unfortunately it had two serious drawbacks. It was too costly for commercial use, and it would turn an automobile engine into a chemical factory producing iodides.

These and other disadvantages also were noted with hundreds of other chemical compounds later tested. Weeks passed into months; months became years--more chemicals, more tests, more money. The costly research project might have been abandoned on more than one occasion had it not been for the faith and confidence of Mr. Kettering and Dr. Midgley.

The Goal Is Reached

Finally in December 1921, more than five years after his experiments began, Dr. Midgley reached his goal when he discovered the antiknock properties of tetraethyl lead. Only a few cubic centimeters of tetraethyl lead added to a gallon of gasoline, it was found, were sufficient to take the knock out of most gasolines.

Tetraethyl lead, which has been hailed as one of the great automotive discoveries, ushered in a new era of transportation progress. By overcoming the obstacle of fuel knock, "Ethyl" antiknock compound enabled the development of more efficient engines of higher compression ratio by helping to make possible more powerful fuels to operate those engines.

To appreciate the significance and economic importance of tetraethyl lead in gasoline, consider this comparison: The 1912 Cadillac that prompted the antiknock research had a displacement of 314 cubic inches, put out 77 horsepower and realized about 7 miles per gallon of gasoline (at 50 miles-per-hour speed). Today's much smaller Chevrolet engine--283 cubic inches--develops 283 horsepower and gets more than twice as many miles per gallon.

Tetraethyl lead also saves the motoring public money--billions of dollars a year--and helps conserve the nation's oil resources. Here's how: Our automotive vehicles now use about 50 billion gallons of high-octane gasoline a year. If we didn't have this superior fuel, made possible in great measure by "Ethyl" antiknock compound, the nation would require 75 billion gallons of gasoline to do the same transportation job. Thus, while cutting down on the amount of gasoline the average motorist would have to buy, tetraethyl lead also is conserving about 25 billion gallons of fuel a year.

Many Problems to Overcome

But there was a long period of heartbreak and disappointment until tetraethyl lead came into its own. Before it could be produced in quantity, many thorny manufacturing and other problems had to be solved. Its sponsors were more than three million dollars in the red before it became a commercial success. This is what Mr. Kettering refers to as the "shirt-losing period" of a new invention.

One of the early manufacturing problems concerned bromine. Bromine (in the form of ethylene dibromide) is essential to "Ethyl" antiknock compound; it combines with the metallic lead formed during combustion and carries it off in the exhaust. But the problem was where to get enough of it. The only known supplies of bromine, in the early 1920's, were the brine wells of Michigan, and they were woefully insufficient for the anticipated needs.

It was decided that the sea might prove to be a logical source, even though bromine exists in sea water in the ratio of only 67 parts to a million parts of sea water. To test that theory, a former Great Lakes steamer was acquired. After being fitted out with special equipment, it set sail to "mine" the waters of the Gulf Stream.

The S. S. Ethyl's special equipment was used for only about six hours--but that costly experiment more than paid for itself. It proved that bromine could be extracted from sea water on a commercial basis. Today, there is a shore-based plant for extracting bromine from the sea--the Ethyl-Dow Chemical Company plant at Freeport, Texas. This plant produces millions of pounds of ethylene dibromide yearly.

After the initial discovery of tetraethyl lead as an antiknock agent, more than a year was spent in perfecting it, testing it out in the laboratory and on the road, and setting up methods of manufacturing it. Finally it evolved into "Ethyl" antiknock compound, which consists primarily of tetraethyl lead, ethylene dibromide, and ethylene dichloride. To these are added a small amount of dyes for identification purposes.

The First Sale

Gasoline containing "Ethyl" antiknock compound first went on sale at a single service station in Dayton, Ohio, on February 2, 1923. By the middle of that year, "Ethyl" gasoline was on sale at many service stations in Ohio, and a few months later, Standard Oil Company (Indiana) contracted to distribute "Ethyl" gasoline throughout its Midwest marketing area.

"Ethyl" gasoline was only a few months old when it received its first big public test. The time was Memorial Day, 1923; the place, the famous Indianapolis Speedway.

Seeking to show in a dramatic fashion how much "Ethyl" fluid increased the power of gasoline, Mr. Kettering and Dr. Midgley persuaded a number of the drivers in the race to use it in their fuel. At the end of their gruelling 500-mile grind, the first three cars to cross the finish line came in on gasoline plus "Ethyl" antiknock compound.

It was in 1924 that Ethyl Gasoline Corporation was born as the successor to General Motors Chemical Company, which had marketed "Ethyl" antiknock compound previously. In 1942, the corporate name was changed from Ethyl Gasoline Corporation to Ethyl Corporation.

The Octane Scale Developed

Meanwhile, the Corporation's research staff had been busily engaged in another problem: a yardstick for measuring fuel power. Up until that time, there was no generally accepted means of measuring the antiknock value of gasoline. There was a great need for improvement and uniformity in knock-testing methods.

Seeking this yardstick, Dr. Graham Edgar, Ethyl's director of research and later a vice president of Ethyl Corporation, selected two pure chemicals, both hydrocarbons in the gasoline boiling range. One was isooctane, synthesized then for the first time, to provide a hydrocarbon which would not knock in the highest compression engine then in existence. The other was normal heptane, guaranteed to knock in any motor.

To these two chemicals he assigned the arbitrary values of 100 and zero respectively. Thus it came about that a mixture of 40% heptane and 60% isooctane was said to have an octane number of 60; a mixture of 30% heptane and 70% isooctane had an octane number of 70; and so on.

This octane scale, which was generally adopted in 1930, represented a signal contribution. It permitted the oil industry to discard its former cumbersome methods; contributed to the uniformity of antiknock value of fuels; provided a basis for the gradual but sure improvement in antiknock value through the years; and served the automobile manufacturer by permitting him to design engines to take advantage of higher antiknock fuels as they become available.

"Shirt-Losing Period" Over

By 1928, Ethyl was emerging from its "shirt-losing period." New facilities and services to the oil industry were added. The first of Ethyl's gasoline testing laboratories was built. In 1928, too, Ethyl's research headquarters were transferred from Yonkers, N. Y., to Detroit. Through the years, Ethyl's laboratories have worked closely with technical men in the oil and automotive industries on fuel-engine-lubricant problems. In addition to its Detroit Laboratories, Ethyl also has research facilities at Baton Rouge and at San Bernardino, California.

The country was knee-deep in the Depression of the 1930's when Ethyl engineers turned their attention to the field of agriculture. Here they saw an opportunity to apply the benefits of modern gasoline to the power machinery of the farm, thereby helping farmers to produce more in less time with greater efficiency.

They began by converting distillate-burning tractors to gasoline. The advantages of gasoline-burning tractors became so evident that in 1935 the first high compression tractor was manufactured. Today, the great majority of the more than five million farm tractors in use are powered by gasoline.

Manufacturing Facilities

Ethyl is a multi-plant corporation. Its principal product, "Ethyl" antiknock compounds, are made at manufacturing centers in Baton Rouge, Louisiana, and Houston, Texas. A third U. S. plant--at Pittsburg, California, in the San Francisco Bay area--went into operation in 1958. In addition, "Ethyl" antiknock compounds are manufactured at Sarnia, Ontario, in a plant operated by Ethyl Corporation of Canada Limited, a wholly-owned subsidiary.

The Baton Rouge plant went into production in 1937, and is today the largest plant of its kind in the world. When the Houston plant went on stream in 1952, it increased Ethyl's antiknock compound manufacturing capacity by approximately one-third. The Canadian plant began operations in the fall of 1956.

All in all, since the end of World War II, Ethyl Corporation has invested well more than $125 million in new plant construction and expansion of the Baton Rouge manufacturing center.

How the Product is Made

A gallon of gasoline usually contains the equivalent of about one teaspoonful of "Ethyl" antiknock compound. As small as that average concentration per gallon of gasoline may be, the manufacture of the antiknock fluid draws upon many raw materials and entails a series of complicated chemical operations.

Tetraethyl lead, the active antiknock ingredient of "Ethyl" antiknock compounds, is produced by the reaction of ethyl chloride with a lead-sodium alloy. Three major manufacturing processes are involved. These are the so-called sodium process, the ethyl chloride process, and the final reaction to make tetraethyl lead.

In the sodium process, salt brine is purified and evaporated to complete dryness. The dry salt is then charged to a battery of electrolytic cells which decompose it into its elements, sodium and chlorine. The molten sodium is then combined with molten lead to form lead-sodium alloy. The alloy, after being cooled and processed, is transferred to a tetraethyl lead building for the final reaction.

Meanwhile, the chlorine gas given off in the sodium operation is transferred to an ethyl chloride unit, where it is reacted with hydrogen to form hydrogen chloride. The hydrogen chloride, after being compressed, then passes to an ethyl chloride reactor, where it is reacted with ethylene to form ethyl chloride. Another unit is the ethylene dichloride plant, where ethylene is added to chlorine to form ethylene dichloride.

In the final tetraethyl lead operation, the ethyl chloride and lead-sodium alloy are reacted at moderate pressures and temperatures. At the completion of the reaction, the product is distilled with steam to separate the tetraethyl lead from the mixture. The use of four pounds of metallic lead is required for each pound that appears in the finished product. At the conclusion of the tetraethyl lead reaction, the remaining three pounds of lead are recovered in the form of sludge, and resmelted to pig lead.

The completed tetraethyl lead is finally transferred to the blenders, where it is mixed with ethylene dibromide, ethylene dichloride, and dye to form finished "Ethyl" antiknock compound.

Interestingly enough, the manufacturing requirements for "Ethyl" antiknock compounds are so large that Ethyl Corporation is not only the world's largest manufacturer of antiknock compounds but also the leading producer of sodium and ethyl chloride.

Most shipments of "Ethyl" antiknock compounds originate at Ethyl's manufacturing plants. These shipments are supplemented by deliveries made from Ethyl's field distribution and storage terminals, located at Edge Moor, Delaware; Wilmington, California; and Everett, Washington. Shipments from the manufacturing plants are made in tank car, tank truck and drum quantities. The field terminals are also equipped to make tank truck deliveries.

Makes Good Gasoline Even Better

Since it was first marketed in 1923, "Ethyl" antiknock compound has come to be used to improve the great majority of gasolines. Of corresponding importance is the fact that it has contributed to the broad progress in fuels and engines that has been seen in recent decades. Originally, by reducing the degree of fuel knock, it permitted the development of more and more powerful engines with higher compression ratios, thereby promoting greater utilization of the inherent energy of gasoline. At the same time, it has enhanced the contribution of each advance in refining technology, until today even the most powerful aviation gasolines in use are improved with the addition of "Ethyl" antiknock compound. "Ethyl" antiknock compound is used to give the final, decisive lift in octane rating to fuels. That is why it is an integral part of modern aviation and motor gasolines.

Other Ethyl Products

During its brief three and a half decades of corporate life, Ethyl Corporation has grown to be a multi-plant, multi-product enterprise. While this account has spoken of "Ethyl" antiknock compound as a singular product, actually the Company makes and markets several different formulations of antiknock compounds for increasing the antiknock quality of both motor and aviation gasoline, two formulations of ignition control compounds for further gasoline improvement, and an ignition improver for diesel fuel.

In addition, Ethyl makes and sells vinyl chloride monomer (used in manufacture of floor tile, garden hose and a host of other household and industrial products), ethyl chloride (used in the manufacture of synthetic rubber and plastic), metallic sodium (used in high energy fuels for rockets and jet aircraft, as well as in pharmaceuticals) and a multi-purpose gasoline additive (which eliminates carburetor deposits, prevents engine stalling caused by carburetor icing and protects metal surfaces against corrosion).

Other Ethyl-made products in commercial usage are ethylene dichloride, ethylene dibromide, sodium-lead alloy, hydropolymer oil, liquid chlorine and a series of antioxidants. The latter, based on a process discovered by Ethyl scientists, are new additives for fuels and lubricants, to preserve their properties and so contribute to better engine performance and durability.

The list of Ethyl products is a continually expanding one, and it is expected that several other important industrial chemicals will be added to the array in the not-too-distant future.

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