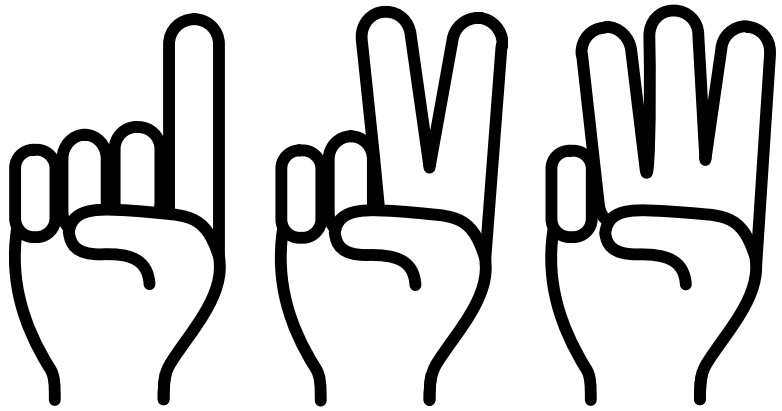
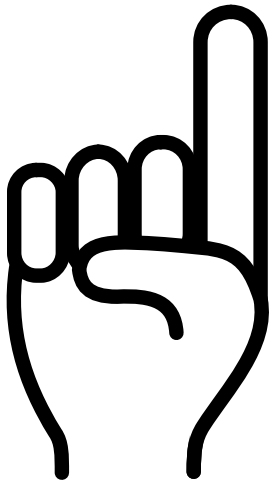
MJPHD

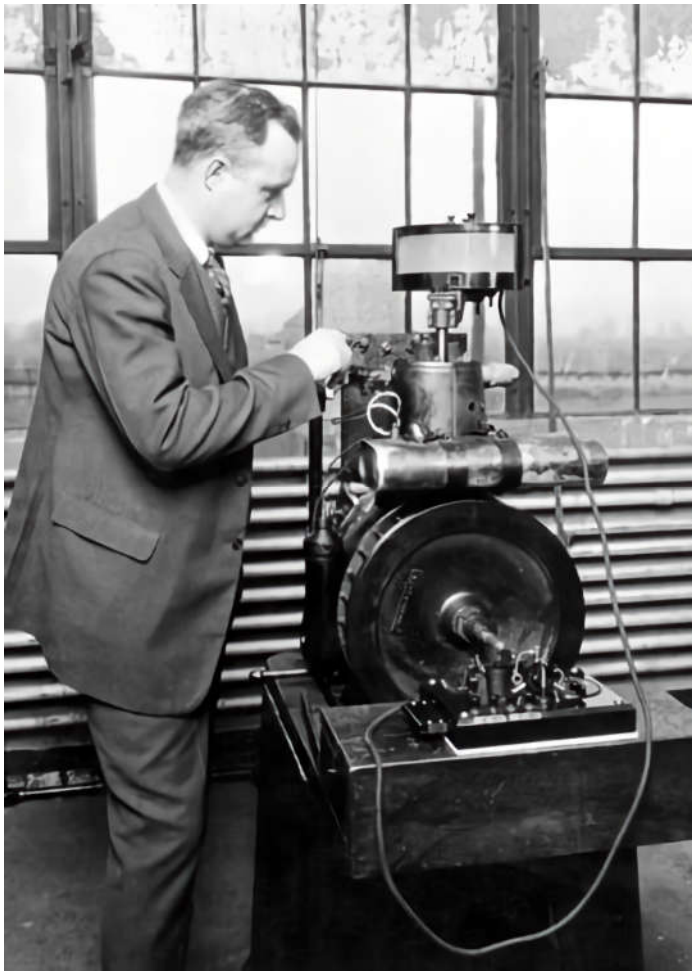
WE'D LIKELY MAKE THE SAME MISTAKES AGAIN:
WHAT HAVE WE LEARNED FROM THOMAS MIDGLEY?

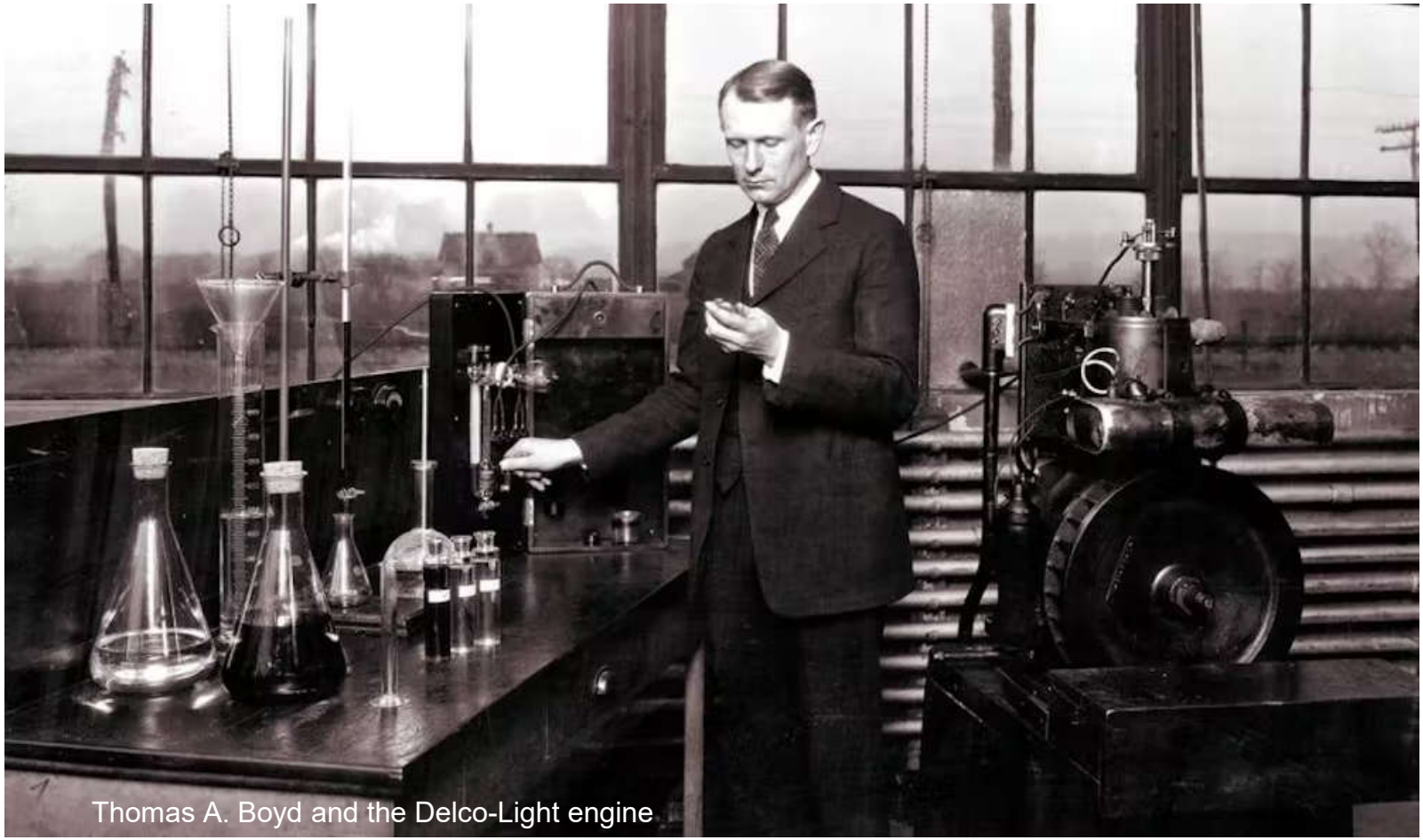
MARK JONES
CREATIVE DIRECTOR
MJPHD, LLC

14 August 2023



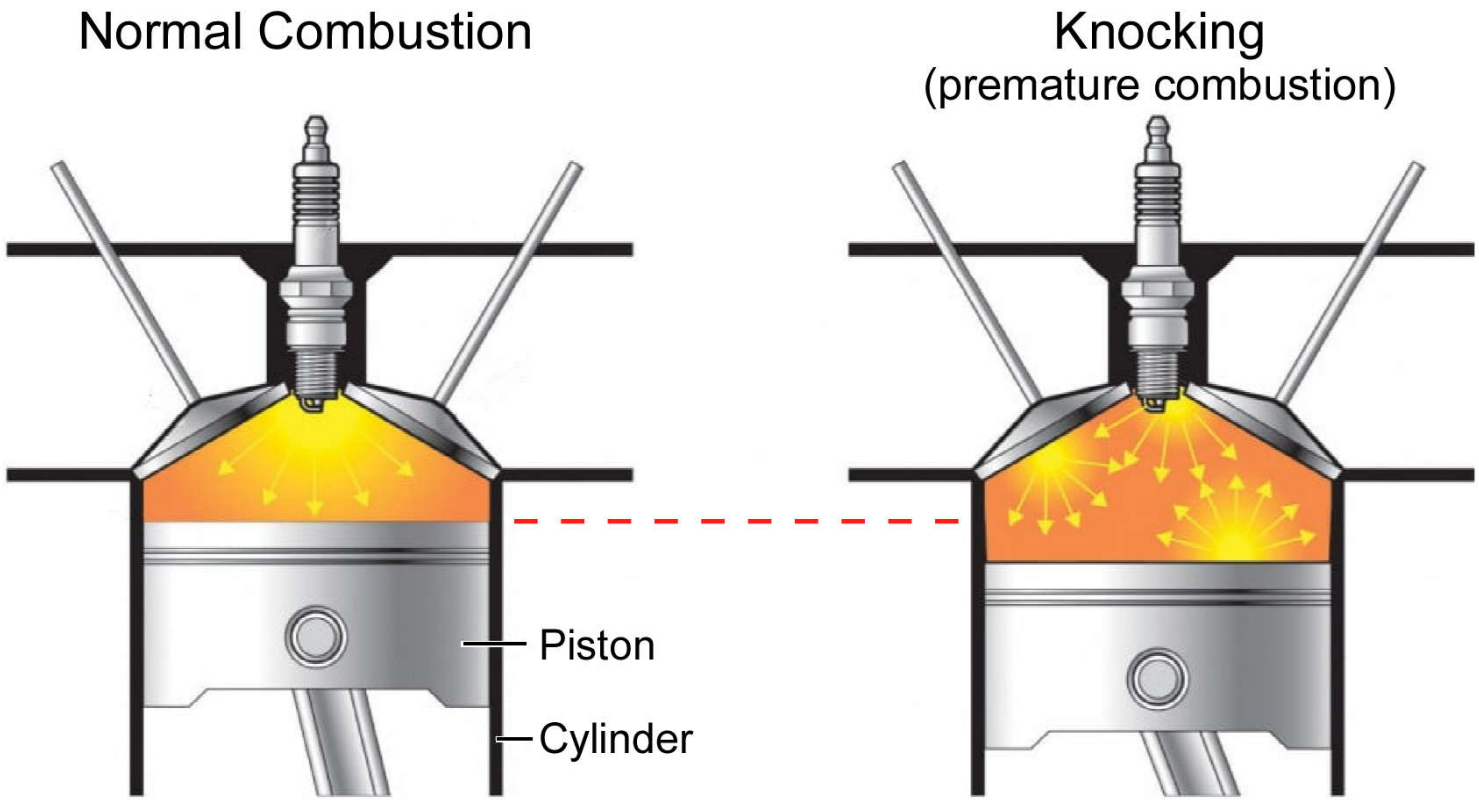






Thomas A. Boyd and the Delco-Light engine

KNOCKING


Normal Combustion
Knocking
(premature combustion)
Piston
Cylinder

Tetraethyl Lead

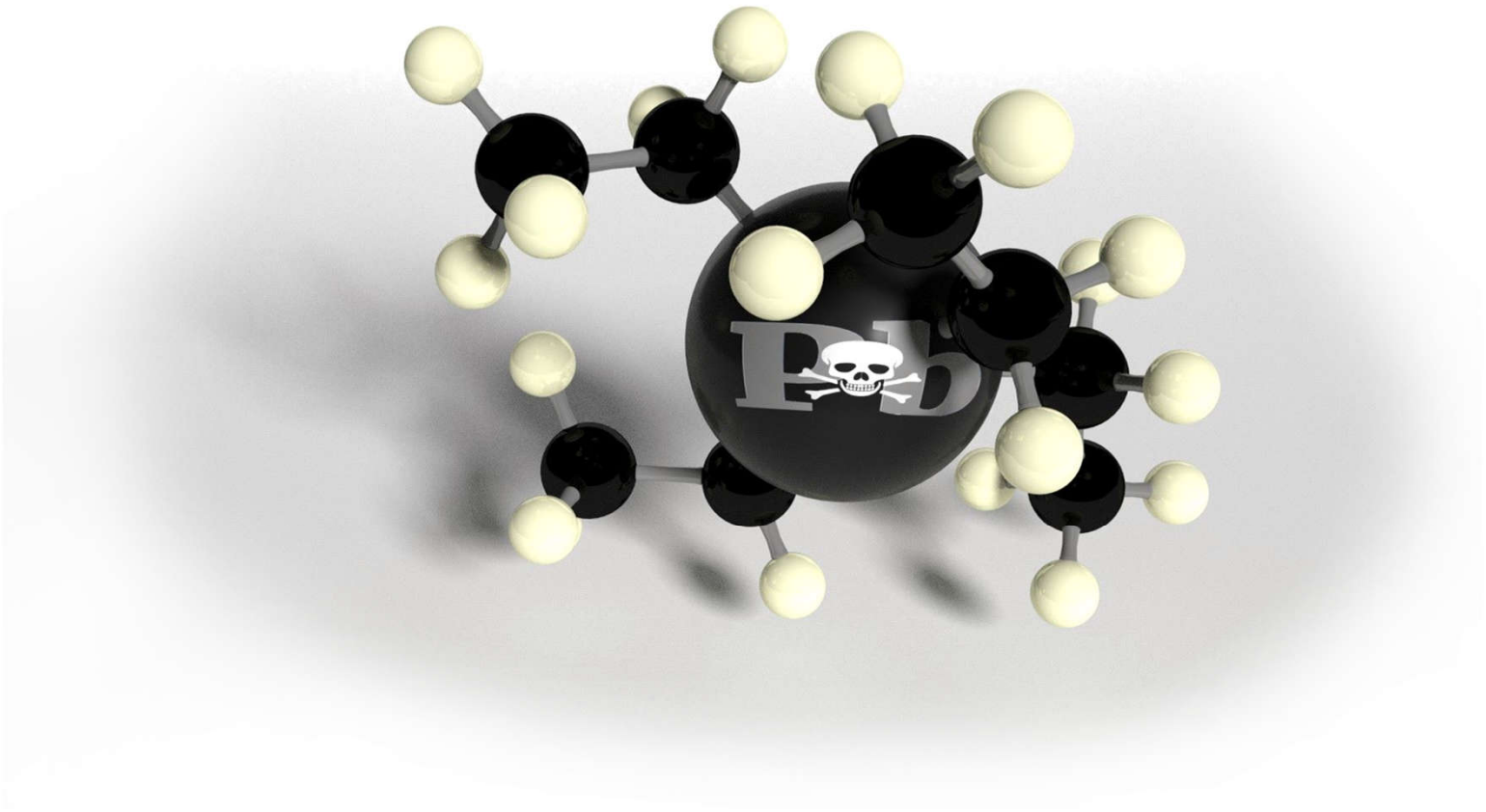


Table 1. Relative Antiknock Effectiveness of Various Compounds[a]

tetraethyllead	118	tetraethyltin	4
tetraphenyllead	73	triphenylarsine	1.6
iron pentacarbonyl	50	xylidine	1.6
nickel carbonyl	35	diphenylamine	1.5
diethyl telluride	27	*N*-methylaniline	1.4
triethylbismuth	24	dimethylcadmium	1.2
diethyl selenide	7	aniline	1.0
stannic chloride	4.1	ethanol	0.1

[a] Vs aniline = 1 on a mole basis. From ref 1e, by permission of Springer-Verlag and Ethyl Corp.

TEL stops knock at 1 part per thousand

Ethanol requires 10%

Patented Feb. 23, 1926. 1,573,846

UNITED STATES PATENT OFFICE.

THOMAS MIDGLEY, JR., OF DAYTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO GENERAL MOTORS CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF DELAWARE.

METHOD AND MEANS FOR USING MOTOR FUELS.

Application filed April 15, 1922. Serial No. 553,270.

To all whom it may concern:

Be it known that I, THOMAS MIDGLEY, Jr., a citizen of the United States of America, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Methods and Means for Using Motor Fuels, of which the following is a full, clear, and exact description.

This invention relates to fuels, such, for example as kerosene and gasoline, employed in the operation of internal-combustion engines and to the art of burning the fuels in an engine. The present tendency is to produce lower grades of gasoline in order to obtain a sufficient output for the increasing demand for motor fuels and to reduce the compressions of the engines so that these lower grades of fuel may be used without knocking. As the lowering of engine compression reduces the efficiency of the engine, a still greater output of fuel is required to meet the increase in fuel required to operate larger and less efficient engines. The principal objects of the present invention are to overcome these difficulties and to provide a means for using either low or high grades of motor fuel more efficiently and so reduce the quantity of fuel used.

The present application is a continuation

duced, the engine heats rapidly, the efficiency of the engine is reduced and, if the initial pressure is very high, engine parts may be injured. The highest pressure at which a mixture may be burned in a cylinder without producing a fuel knock varies with the different fuels and, to some extent, with the temperature, position of spark plugs and other conditions within the engine. This pressure I term the "critical compression pressure" of the fuel.

The average critical compression pressure of kerosene is about 50 pounds, of the proper grades of gasoline about 75 pounds and of the better grades of gasoline about 125 pounds. The latter grade of gasoline is produced in limited quantities and is not available universally to the consumer. The commoner grades of fuel, such as kerosene and gasoline, having critical compression pressures below 75 pounds are used generally, and in internal-combustion engines for house lighting systems, trucks, tractors, and automobiles are designed to operate on these kinds of fuel.

I have found that the critical compression pressure of a fuel of the type mentioned above is increased by incorporating therewith any one of a large number of compounds containing metallic elements, i. e.,

Tetraethyl Lead Poison Hazards[1]

By Thomas Midgley, Jr.

Ethyl Gasoline Corp., New York, N. Y.

Last fall in a semi-work's production plant manufacturing tetraethyl lead by a newly developed process there occurred an accidental poisoning which cost the lives of five men. The newspaper publicity engendered by this accident gave rise to a variety of opinions and opened an attack upon the general proposition of using tetraethyl lead in gasoline.

Although these opinions were in almost every case the result of assumptions as to the facts, rather than knowledge, it is believed that the best interest of the public will be served by a clear statement as to the actual hazards involved in carrying out the ethyl gasoline program.

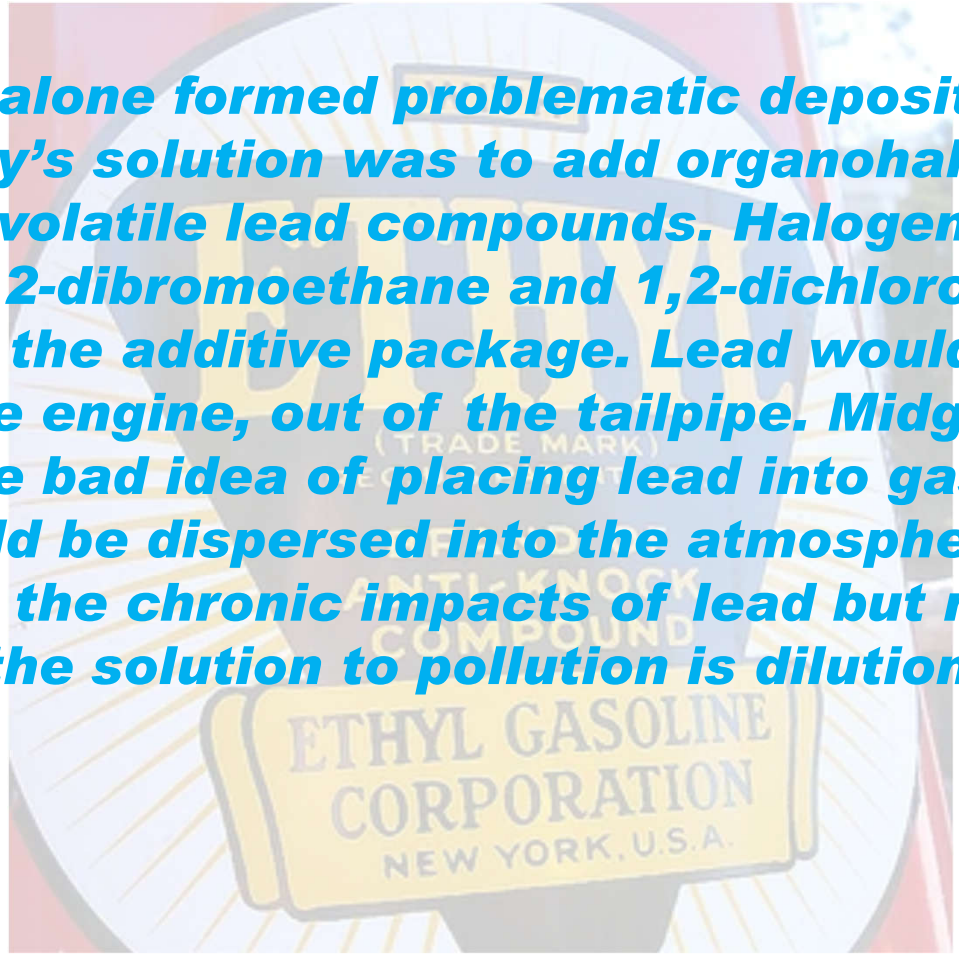
It is not the purpose of this paper to enlarge upon the benefits of the use of tetraethyl lead in gasoline. It may not be amiss, however, to mention broadly the advantages to the public which will follow upon its general use. These are (1) conservation of petroleum due to the increased mileage obtainable by using a nonknocking gasoline in a high-compression motor, (2) reduction of carbon monoxide contamination of the atmosphere due to increased efficiency of combus-

they may in time contract poisoning if there is any possible chance of exposure to it. This has been the history of practically every individual who has suffered from tetraethyl lead.

As the result of experience, which, however costly, seems nevertheless to have been the only possible teacher, tetraethyl lead poisoning can now be detected by a well-informed physician before the slightest danger develops. In this connection it will be well to mention the difference between tetraethyl lead poisoning and the ordinary type of lead poisoning familiar in the lead industry. Ordinary or chronic lead poisoning is denoted by the following symptoms: stippling of the blood cells, lead line at the base of the teeth, stomach cramp (commonly called painter's colic), paralysis (most commonly wrist drop), and in extreme cases spasms and death. None of these symptoms are observed in poisoning due wholly to tetraethyl lead, in which case the symptoms are, in the order of their appearance, drop of blood pressure, drop of body temperature, reduced pulse, sleeplessness, loss of weight, sometimes nausea, sometimes tremor, and, in the most serious cases, delirium tremens. The first three


WITH
ETHYL
(TRADE MARK)
REG. U.S. PATENT OFF.
BRAND OF
ANTI-KNOCK
COMPOUND
ETHYL GASOLINE
CORPORATION
NEW YORK, U.S.A.

Tetraethyl lead alone formed problematic deposits in engines. Midgley's solution was to add organohalides to purposely form volatile lead compounds. Halogenated organics, like 1,2-dibromoethane and 1,2-dichloroethane, became part of the additive package. Lead would be swept out of the engine, out of the tailpipe. Midgley compounded the bad idea of placing lead into gasoline by ensuring it would be dispersed into the atmosphere. He clearly knew of the chronic impacts of lead but must have believed "the solution to pollution is dilution."



1923 Nichols Medal given by ACS for original research in chemistry. Others Jackie Barton, Harry Gray, Barry Sharpless, Carolyn Bertozzi, Barry Trost, Tobin Marks, Chad Mirkin

Oct 1924: 32 of 49 workers at the Bayway Standard Oil Refinery TEL plant impacted. 6 died and the rest were hospitalized. They became disoriented, then burst into insane fury and collapsed into hysterical laughter. Some of the workers started getting lost on the familiar plant grounds, had trouble even remembering their friends. 2 died at at DuPont plant in Dayton, OH. TEL shutdown for about a year until federal government intervened.

Tetraethyl lead . . . THE REASON WHY AMERICA'S CARS ARE BEING TUNED UP . . . NOT DOWN !

DO YOU KNOW that if it weren't for the universal availability of high anti-knock gasoline every modern auto engine would have to be tuned-*down* . . . the spark *retarded* to eliminate "knock" or "ping"?

But today oil refiners have a way of making vast quantities of high anti-knock gasoline economically. By just adding a small amount of anti-knock fluids containing *tetraethyl lead* to each gallon of gasoline they can produce fuels that actually permit motor service men to tune-*up* a car . . . *advance* the spark to give better performance and mileage.

Since the oil industry has made this "leaded" gasoline generally available to the motorist, there have been two important results:

1. Automobile engineers in designing new cars can take advantage of the inherent advantages of high-compression engines requiring high anti-knock fuels . . . for they know that such fuels can be purchased anywhere in the United States and Canada.
2. Cars now on the road can be tuned-up for greater power and economy.

So, from the standpoint of both present and future needs, it is easy to see why it has been said that "Tetraethyl lead is almost as important as gasoline itself!"

* * *

THIS MONDAY NIGHT TUNE IN ON "TUNE-UP TIME" featuring Andre Kostelanetz and his Orchestra, Tony Martin as Master of Ceremonies, Kay Thompson and her Rhythm Singers. Columbia Broadcasting System, 8 P. M., E. S. T.

ETHYL GASOLINE CORPORATION, *manufacturer of anti-knock fluids used by oil companies to improve gasoline*

MAKING THE FARMER'S IRON HORSE WORK HARDER...

...tetraethyl lead!

ONLY FOUR YEARS AGO there were no high-compression tractors in the United States. Until then tractors were built with low compression engines in order to burn the poorest grade of fuel sold. Most farmers thought that this was the way to "economize."

But in 1933 oil refiners made "leaded" regular gasoline generally available . . . that is, gasoline which has been improved by the addition of anti-knock fluids containing tetraethyl lead.

So tractor engineers began to experiment with high compression engines designed to take advantage of this new, better fuel. They ran practical tests on farms and tractor proving grounds. They discovered that Farmer Jones, with a high compression tractor, could pull three plows instead of two, that he could operate in a higher gear and get more work done in the same time, or that he could pull the same equipment on four gallons of fuel instead of five.

Today twelve tractor manufacturers sell high compression tractors designed to use "leaded" gasoline. Thousands of these tractors are now in use. And a recent national survey indicated that nearly three out of every four farmers who are planning to buy a new tractor will buy a high compression tractor.

Tetraethyl lead has helped the farmer's iron horse work harder . . . just as it has the automobile owner to get greater power and economy from his car.

Ethyl Gasoline Corporation

manufacturer of anti-knock fluids used by oil companies to improve gasoline

THIS MONDAY NIGHT tune in on "Tune-Up Time" *Columbia Broadcasting System, 7 p.m., E.S.T.; 6 p.m., C.S.T.;—9 p.m., M.S.T.; 8 p.m., P.S.T.*

Even the man in the moon wouldn't know for certain when the war is going to end. But one thing you can be sure of—as long as American soldiers, sailors and airmen are in action, the best gasoline America can produce will be with them in the fight.

Today, the manufacture of combat gasoline is taking the cream of the U.S. petroleum industry's production, plus most of the Ethyl fluid manufactured. That's why gasoline at home must still be limited both as to quantity and quality.

But when final Victory is achieved, you can look forward to getting unlimited quantities of top-quality Ethyl gasoline again—Ethyl that will bring out the best performance of any car.

Ethyl CORPORATION

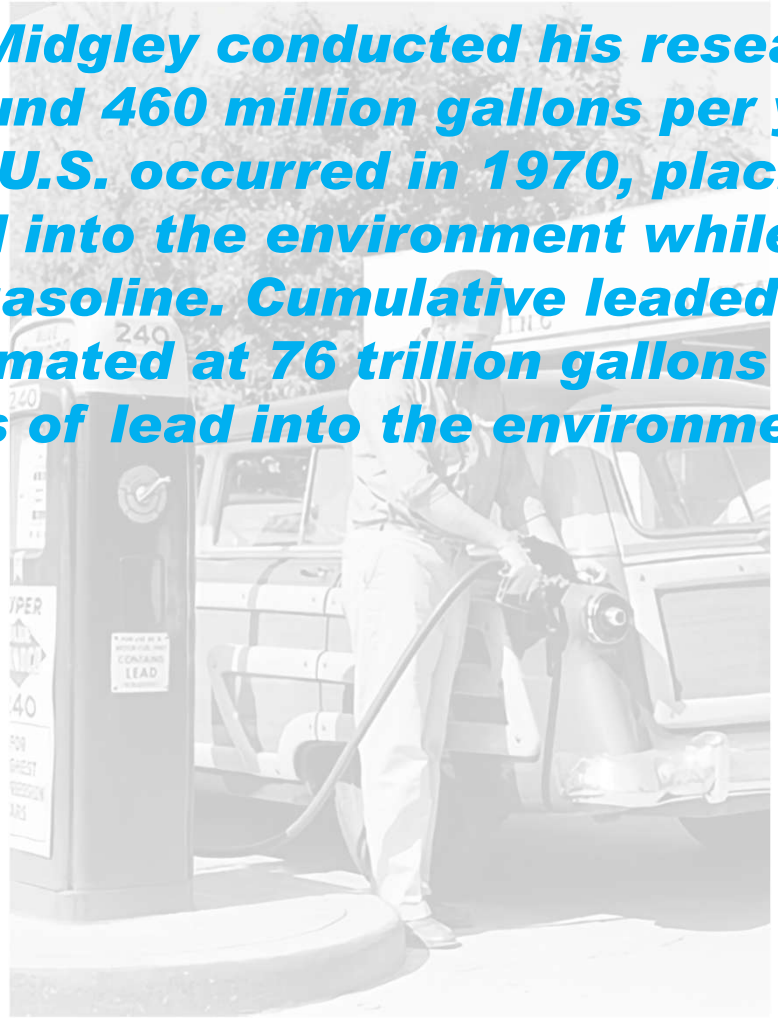
Chrysler Building, New York 17, N. Y.

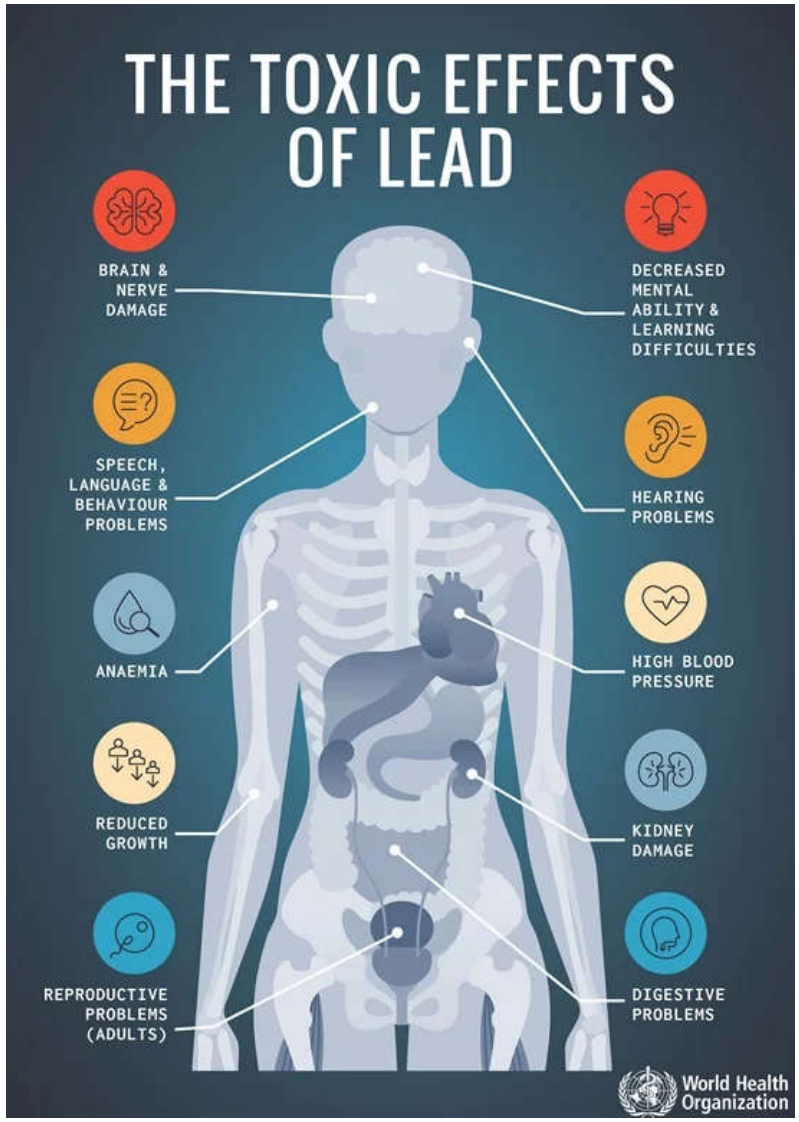
ETHYL IS A TRADE MARK NAME

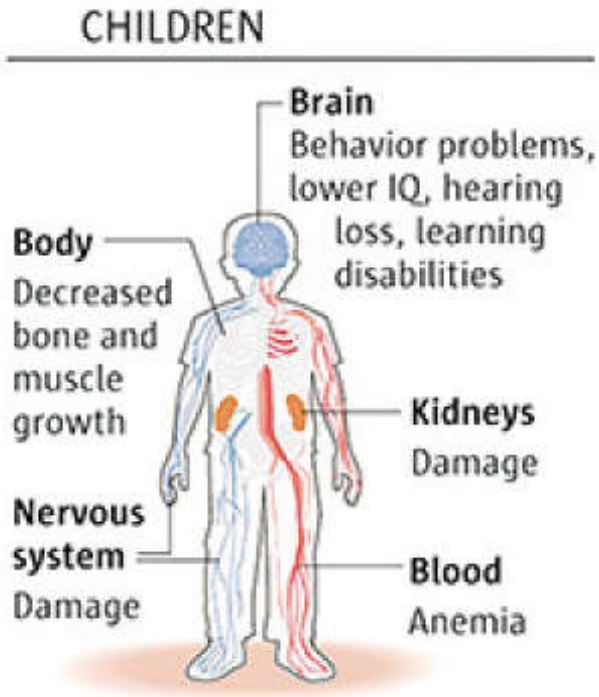

240
LUBRICA
CONTAINS
LEAD

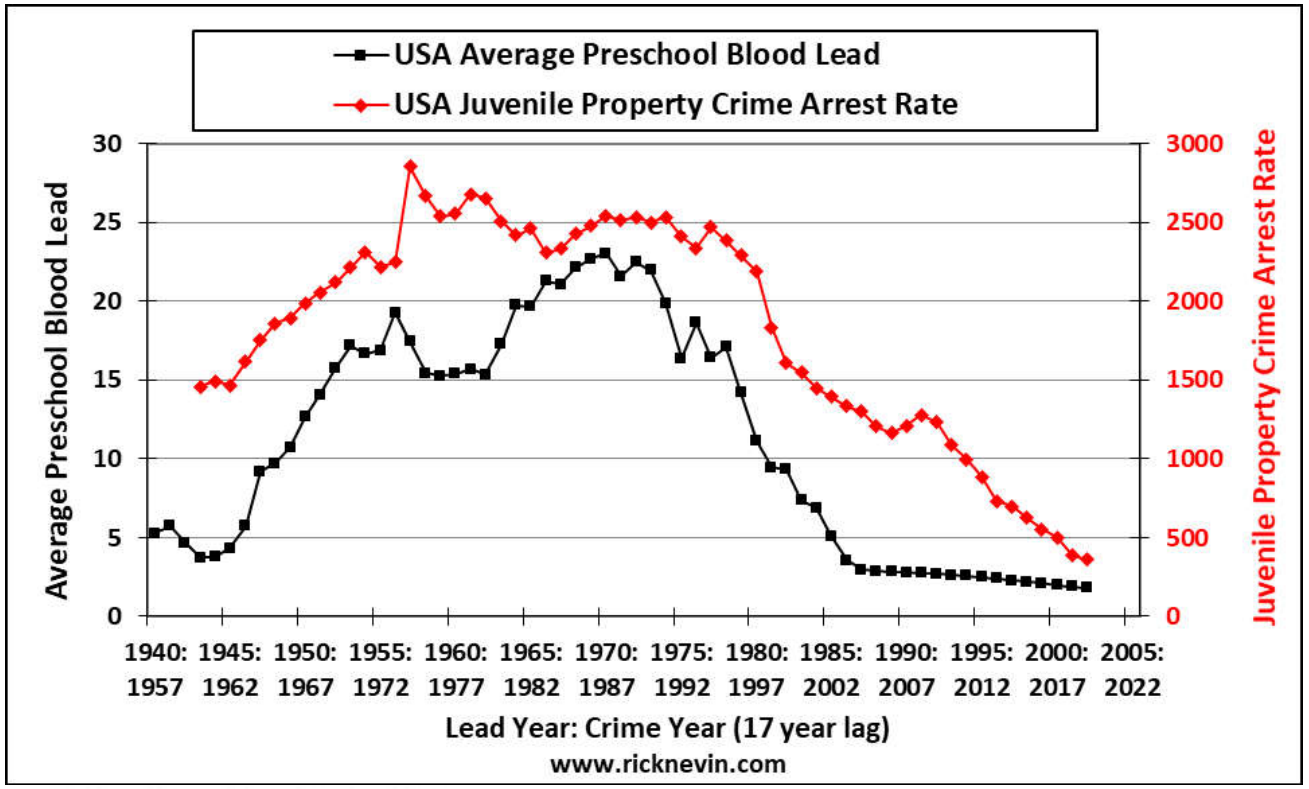

FOR USE AS A
MOTOR FUEL ONLY
CONTAINS
LEAD
(TETRAETHYL)

As Midgley conducted his research, gasoline demand was around 460 million gallons per year. Peak leaded gas use in the U.S. occurred in 1970, placing 250,000 metric tons of lead into the environment while burning 90 billion gallons of gasoline. Cumulative leaded automotive gasoline use is estimated at 76 trillion gallons — releasing 8 million metric tons of lead into the environment.




THE TOXIC EFFECTS OF LEAD
BRAIN & NERVE DAMAGE
DECREASED MENTAL ABILITY & LEARNING DIFFICULTIES
SPEECH, LANGUAGE & BEHAVIOUR PROBLEMS
HEARING PROBLEMS
ANAEMIA
HIGH BLOOD PRESSURE
REDUCED GROWTH
KIDNEY DAMAGE
REPRODUCTIVE PROBLEMS (ADULTS)
DIGESTIVE PROBLEMS
World Health Organization


CHILDREN
Brain
Behavior problems, lower IQ, hearing loss, learning disabilities
Body
Decreased bone and muscle growth
Kidneys
Damage
Nervous system
Damage
Blood
Anemia



A timeline of lead reduction

1970
CDC sets acceptable blood-lead level of **40 µg/dL**

1973
EPA mandates a phaseout of leaded gasoline

1978
CPSC bans residential lead paint

1991
CDC sets acceptable blood-lead level of **10 µg/dL**

1996
EPA eliminates lead from some U.S. motor fuel

2012
CDC describes blood-lead level of **>5 µg/dL** as elevated

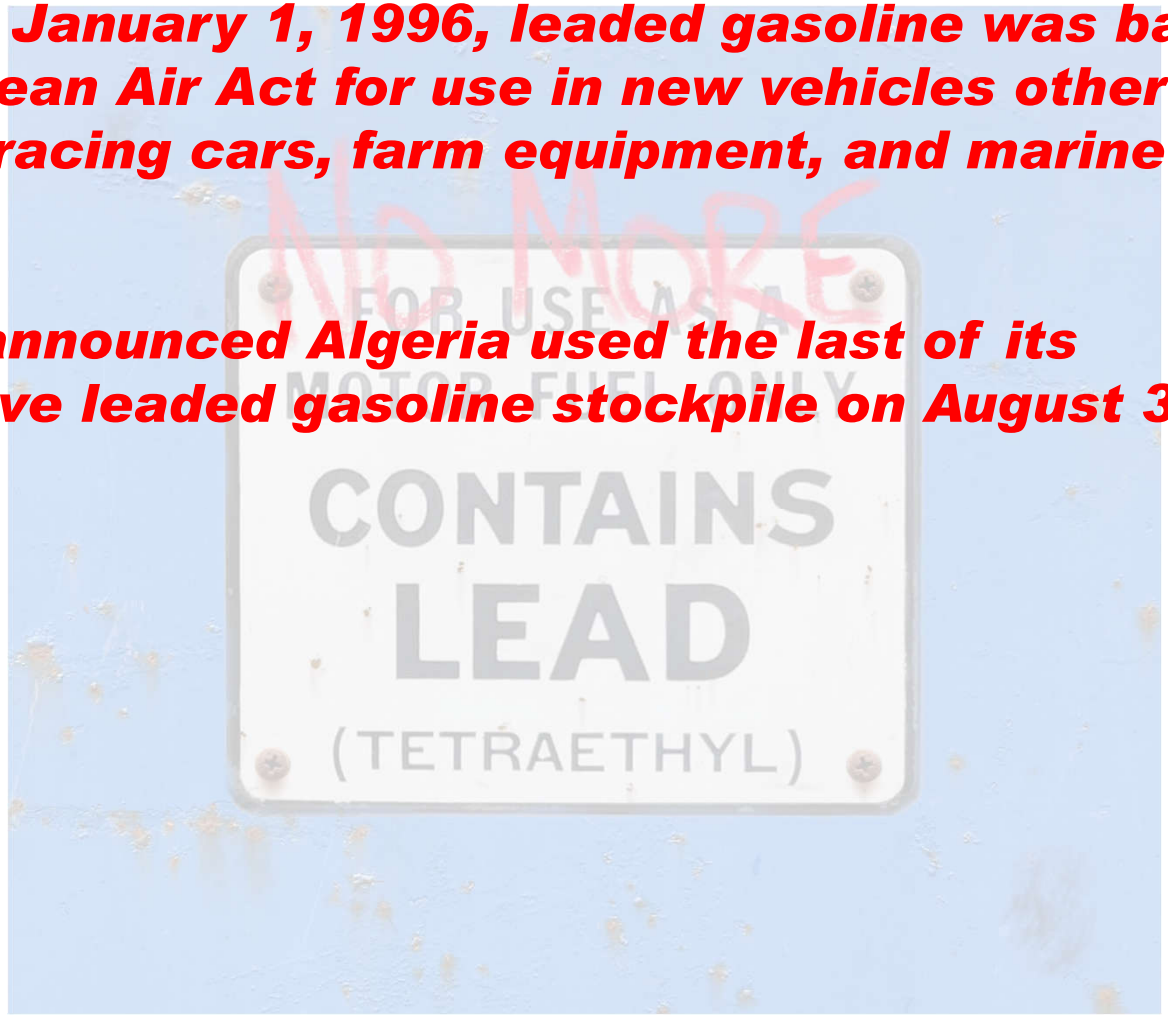
MJPhD

Economists hypothesize that regulation of leaded gasoline and lead paint in the 1970s caused crime rates to drop in the U.S. about 20 years later. SOURCES: Rick Nevin, FBI Uniform Crime Reporting Statistics


NO MORE
FOR USE AS A
MOTOR FUEL ONLY
CONTAINS
LEAD
(TETRAETHYL)

Effective January 1, 1996, leaded gasoline was banned by the Clean Air Act for use in new vehicles other than aircraft, racing cars, farm equipment, and marine engines.

The UN announced Algeria used the last of its automotive leaded gasoline stockpile on August 30, 2021.



Types of Consequences

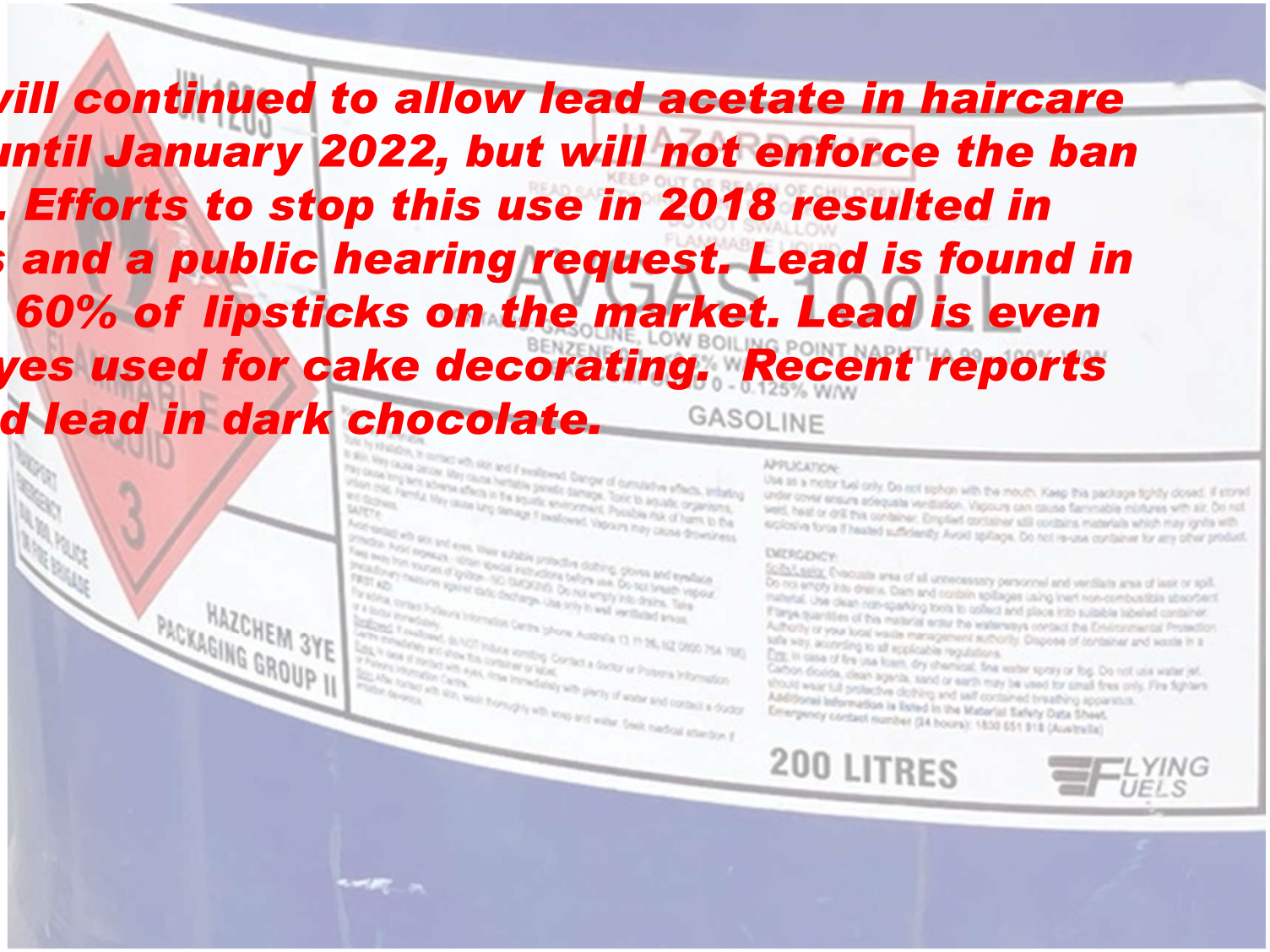
- Unintended Consequences
- Unanticipated Consequences
- Unexpected Consequences

What have we learned?

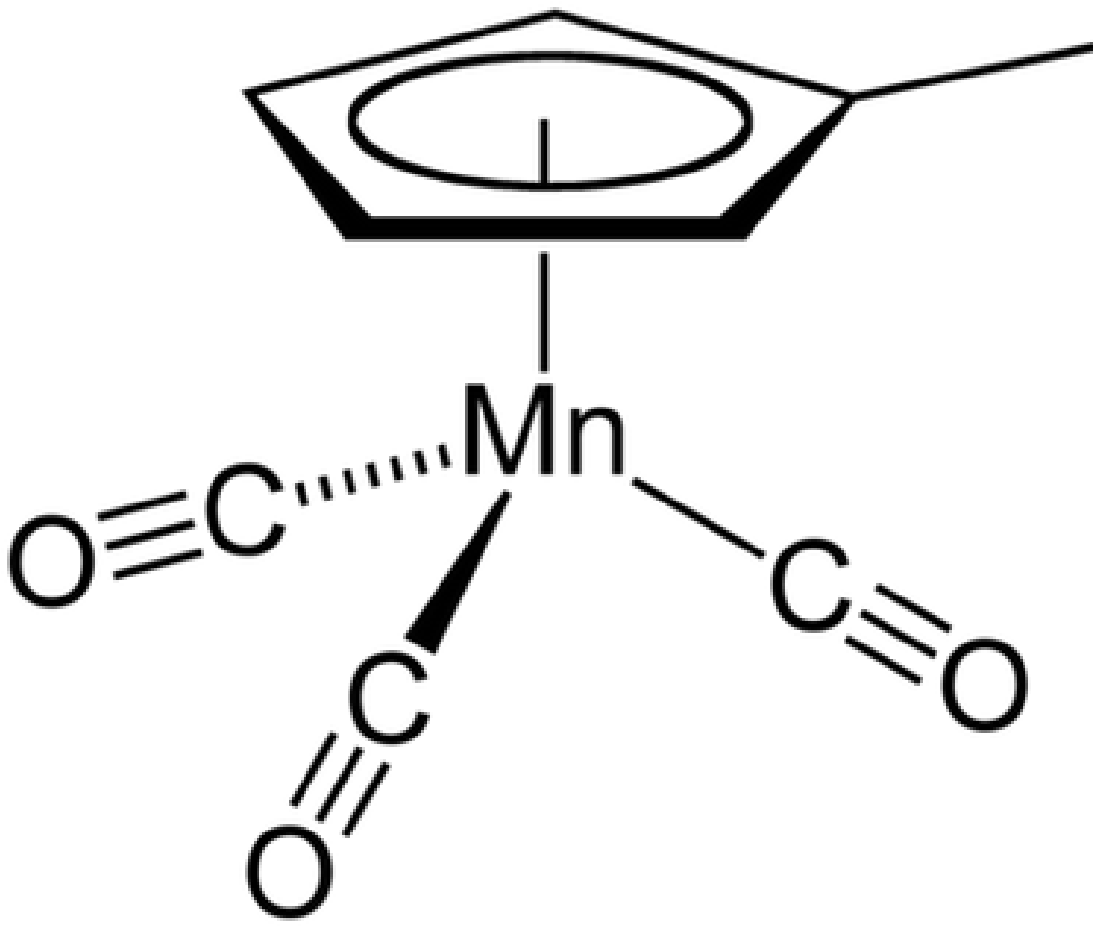
Certainly unintended, likely both anticipated and expected. But we haven't learned. PFAS, antibiotics in farm animals, impact of Round-Up in agriculture, neonicotinoids impacting bees.


UN 1203
FLAMMABLE LIQUID 3
HAZCHEM 3YE
PACKAGING GROUP II
HAZARDOUS
KEEP OUT OF REACH OF CHILDREN
READ SAFETY DIRECTIONS BEFORE OPENING OR USING
DO NOT SWALLOW
FLAMMABLE LIQUID
AVGAS 100LL
CONTAINS: GASOLINE, LOW BOILING POINT NAPHTHA 99 - 100% W/W
BENZENE 0.1 - <0.5% W/W
LEAD COMPOUND 0 - 0.125% W/W
GASOLINE
APPLICATION:
EMERGENCY:
200 LITRES
FLYING FUELS

The FDA will continued to allow lead acetate in haircare products until January 2022, but will not enforce the ban until 2023. Efforts to stop this use in 2018 resulted in objections and a public hearing request. Lead is found in more than 60% of lipsticks on the market. Lead is even found in dyes used for cake decorating. Recent reports of elevated lead in dark chocolate.




3X
THE BOOST
LUCAS
OIL PRODUCTS INC.
A REAL
OCTANE BOOSTER
RACING FORMULA
TESTED - Increases Octane Rating by 3 Full Numbers
STOPS PINGING
DANGER: COMBUSTIBLE. Harmful or fatal if swallowed. Read carefully DIRECTIONS and DANGER on side panel.
5.25 fl oz. U.S. Made in USA 155 mL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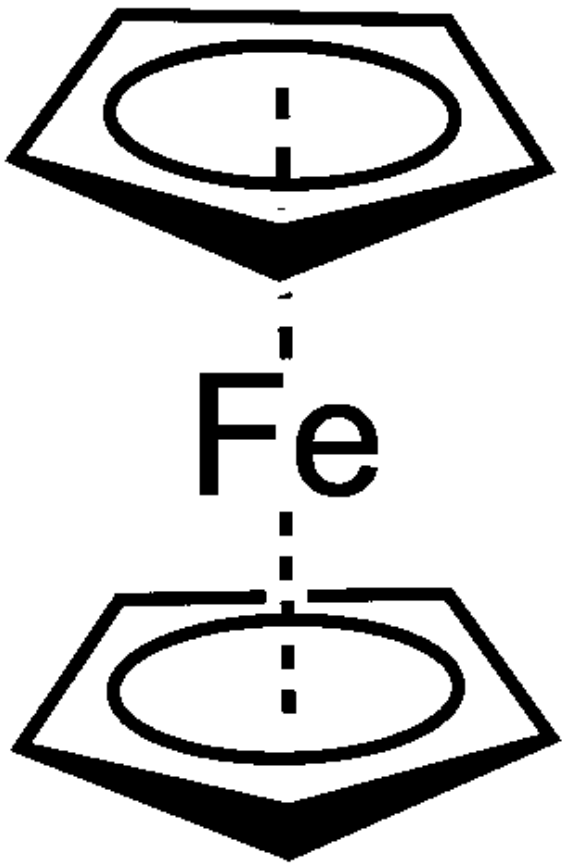

Fe

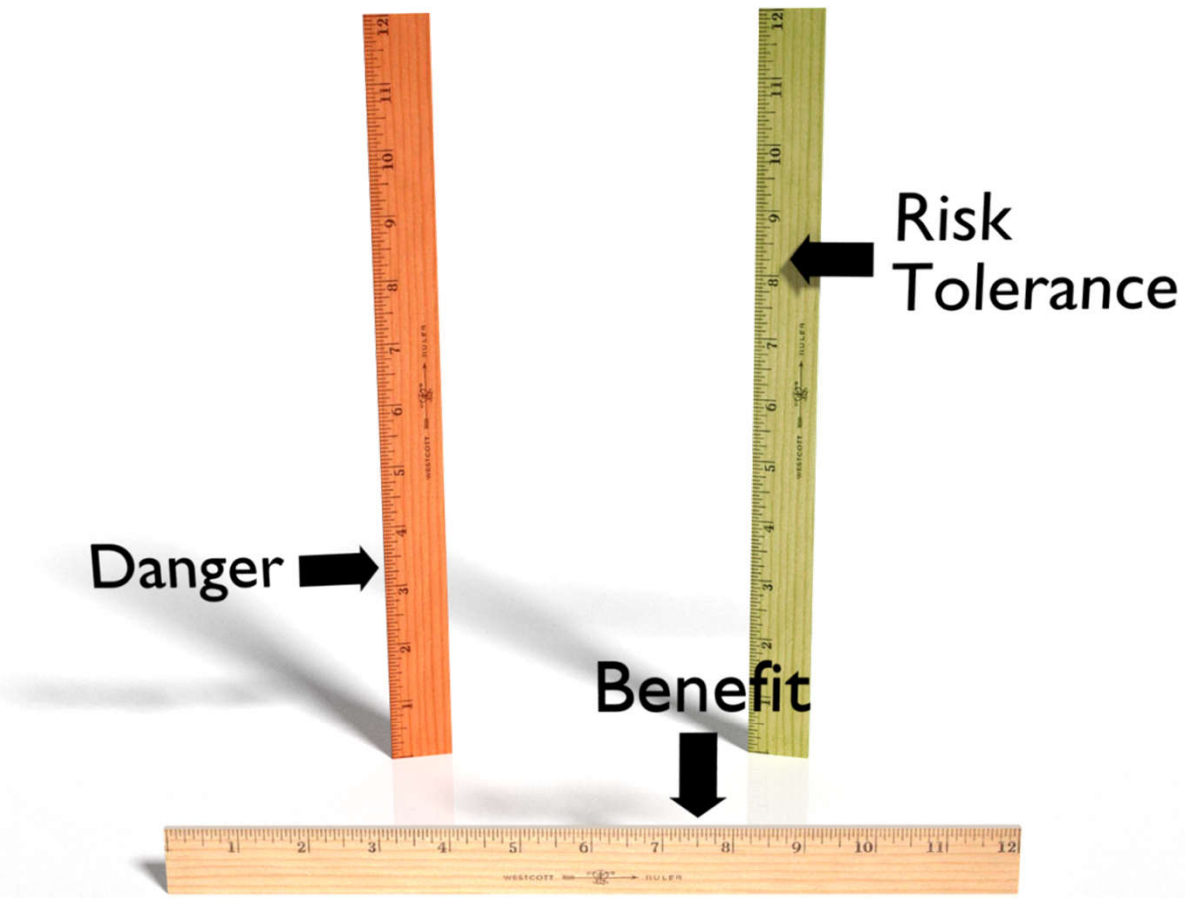
Methylcyclopentadienyl manganese tricarbonyl (MMT) is a gasoline octane enhancer produced by the Afton Chemical Corporation, formerly known as the Ethyl Corporation. MMT is allowed in U.S. gasoline at a level equivalent to 1/32 grams per gallon manganese around 11 ppm

Mn fumes damage the lungs, liver, and kidneys. Exposure to manganese dust or fumes can also lead to a neurological condition called manganism. Manganism's symptoms, similar to those of Parkinson's disease, may include the following: trembling, stiffness, slow motor movement and potentially severe depression, anxiety and hostility.

54-year-old man who developed seizures and altered mental status after drinking 12 oz. of MMT-containing NOS Octane Booster Racing Formula. Intubated but lived.


Danger

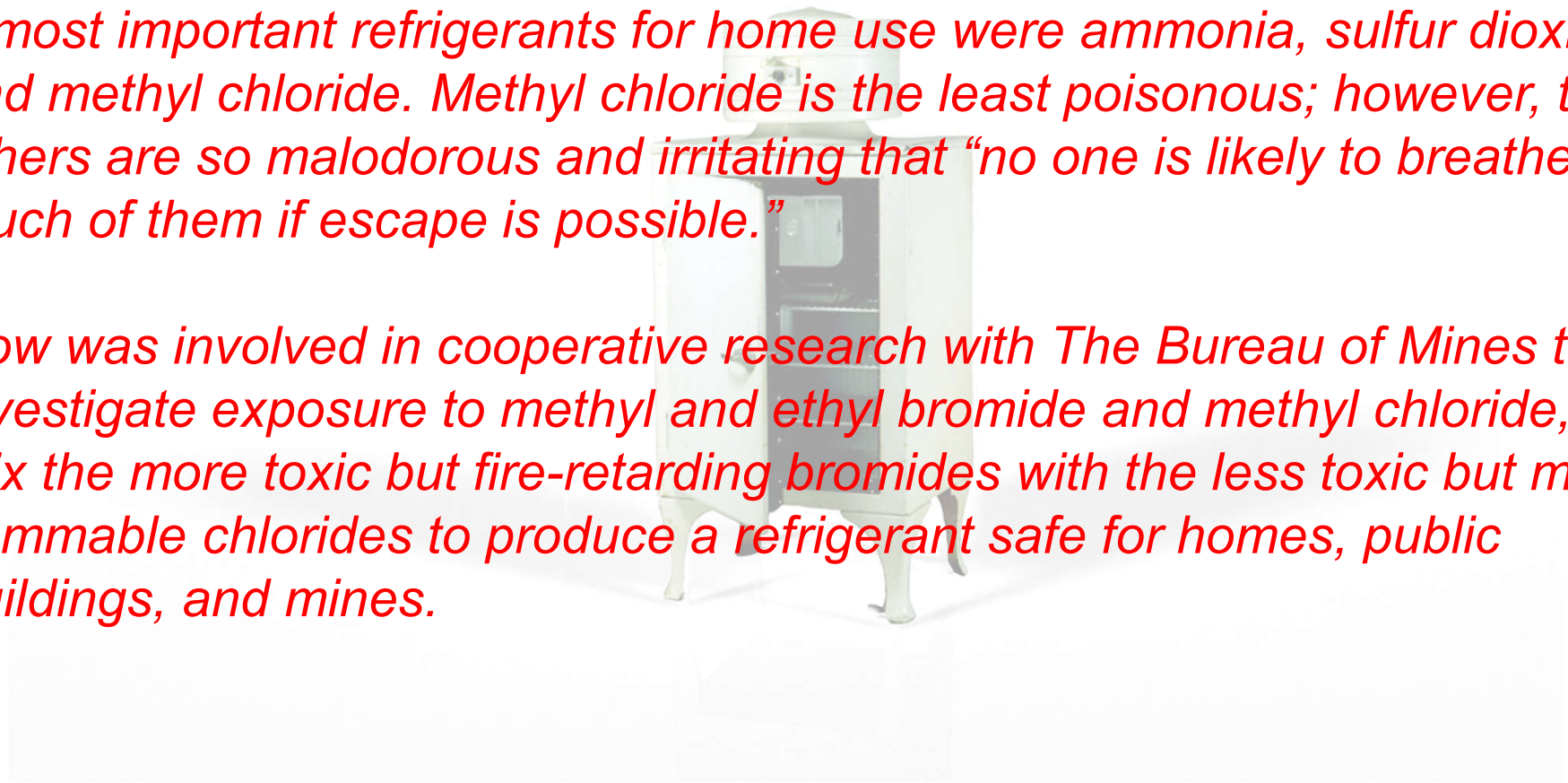

Danger
Risk
Tolerance

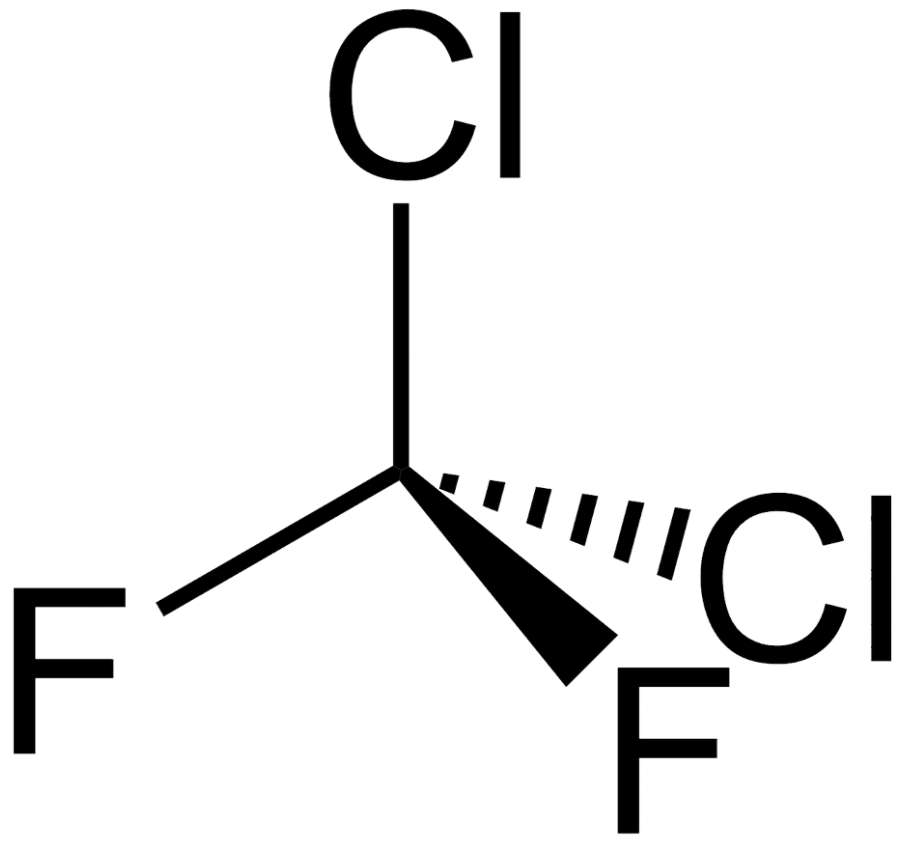

Risk
Tolerance
Danger
Benefit

Thomas Midgley, Jr

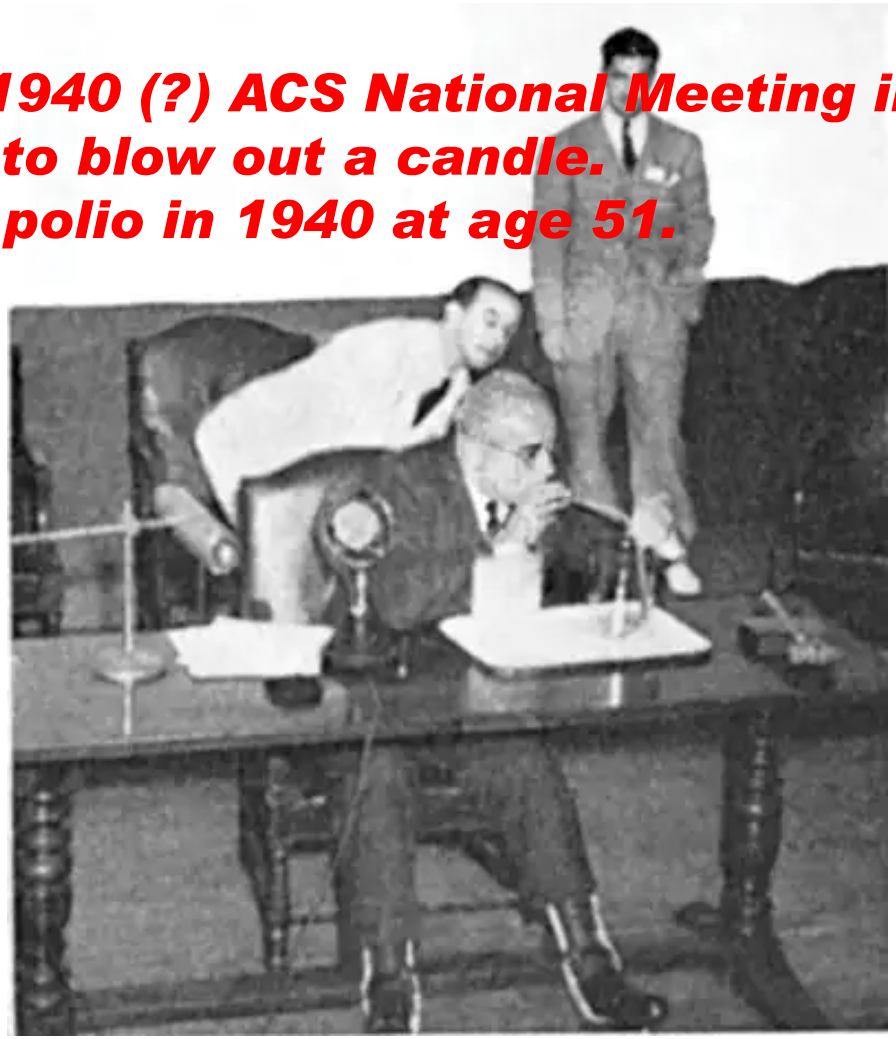
3 most important refrigerants for home use were ammonia, sulfur dioxide, and methyl chloride. Methyl chloride is the least poisonous; however, the others are so malodorous and irritating that "no one is likely to breathe much of them if escape is possible."

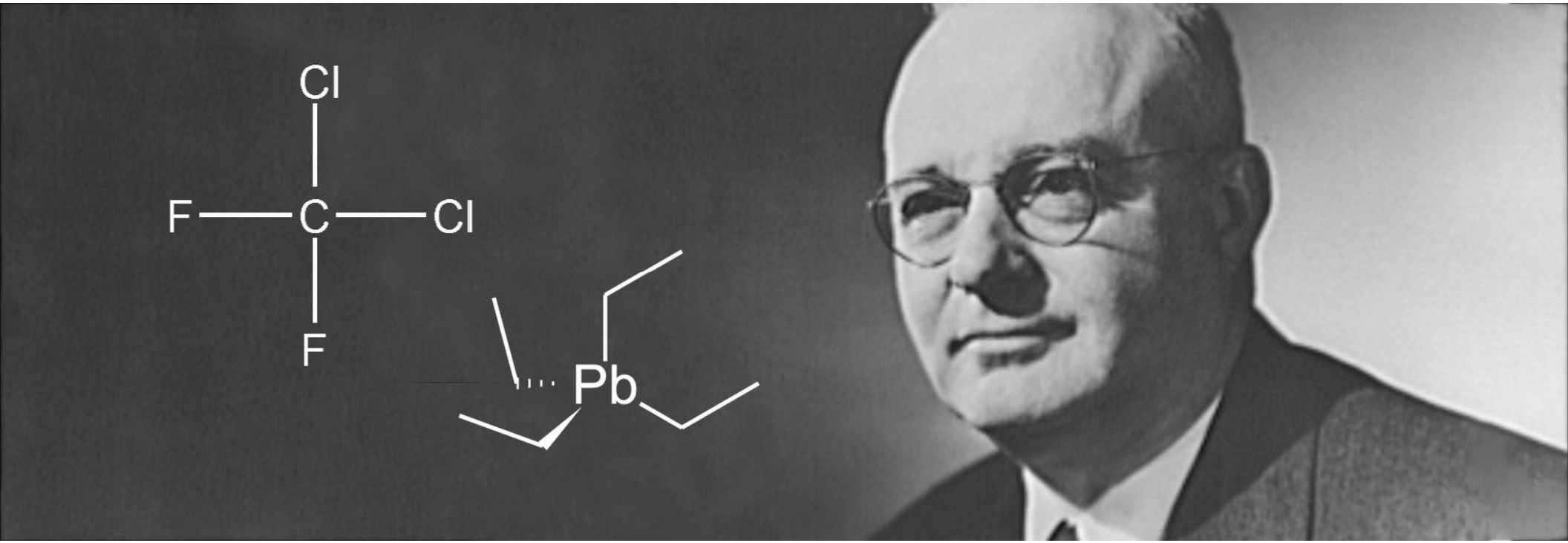
Dow was involved in cooperative research with The Bureau of Mines to investigate exposure to methyl and ethyl bromide and methyl chloride, to mix the more toxic but fire-retarding bromides with the less toxic but more flammable chlorides to produce a refrigerant safe for homes, public buildings, and mines.

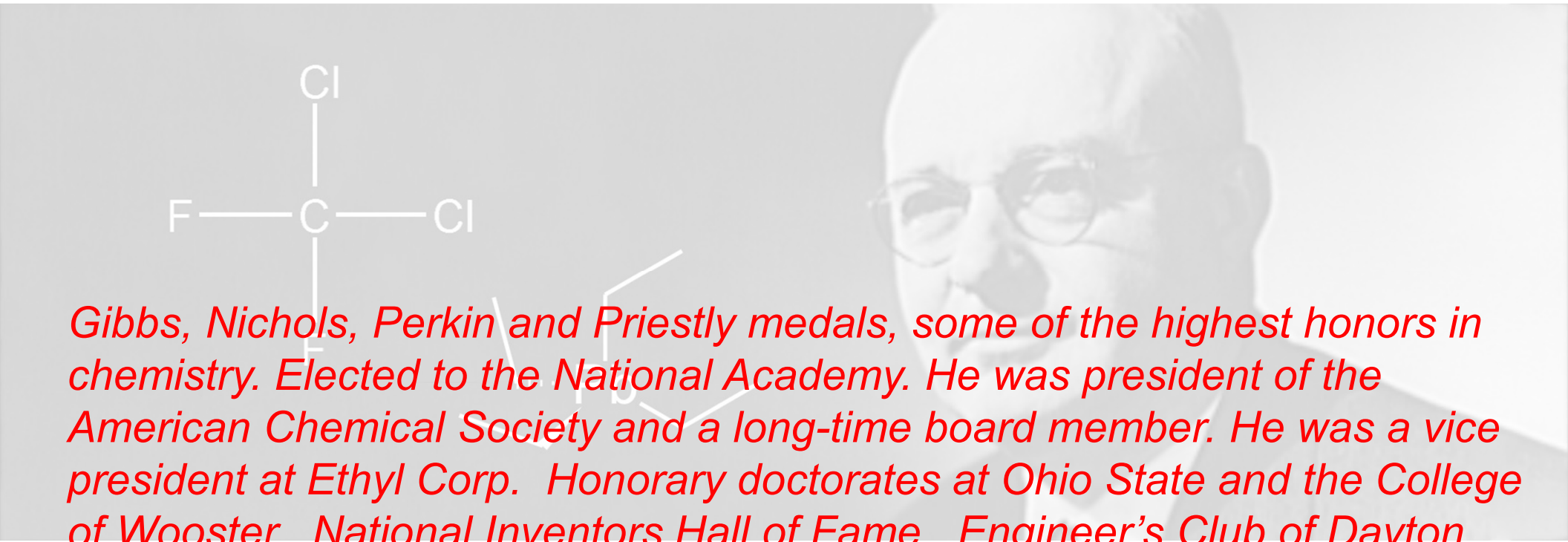



Cl
F
Cl
F

Midgley at 1940 (?) ACS National Meeting inhaled CFC-12 and used it to blow out a candle.
Contracted polio in 1940 at age 51.




Cl
F
C
Cl
F
Pb

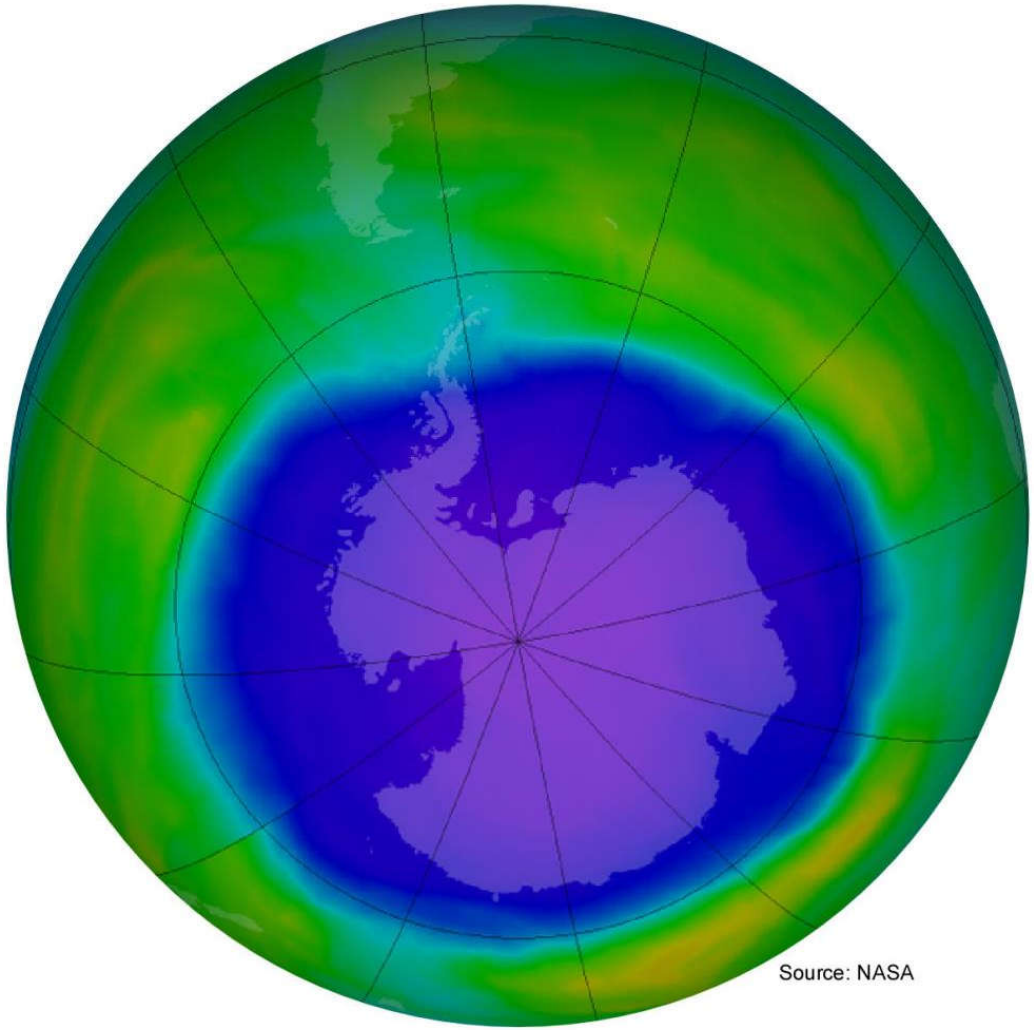


Gibbs, Nichols, Perkin and Priestly medals, some of the highest honors in chemistry. Elected to the National Academy. He was president of the American Chemical Society and a long-time board member. He was a vice president at Ethyl Corp. Honorary doctorates at Ohio State and the College of Wooster. National Inventors Hall of Fame. Engineer's Club of Dayton Innovators List. At time of his death in 1944, he was arguably the most celebrated industrial chemist ever. He still is likely the most celebrated industrial chemist of all time.

1930 Sydney Chapman resolved the chemistry and kinetics involved in stratospheric ozone. Same year Midgley discovered dichlorodifluoromethane.

$$\frac{d[O_3]}{dt} = k_2[O][O_2][M] - k_3[O_3] - k_4[O][O_3] - k_6[Cl][O_3]$$

1972 set the ball rolling. James Lovecock's invention of the electron capture detector showed levels of CFC-12 ~ the total amount produced. 1973 Molina used known kinetics. Nature, 28 June 1974 "Stratospheric sink for chlorofluoromethanes: chlorine atom-catalysed destruction of ozone" by Mario Molina & Sherwood Rowland . k6 100,000X k4



Source: NASA

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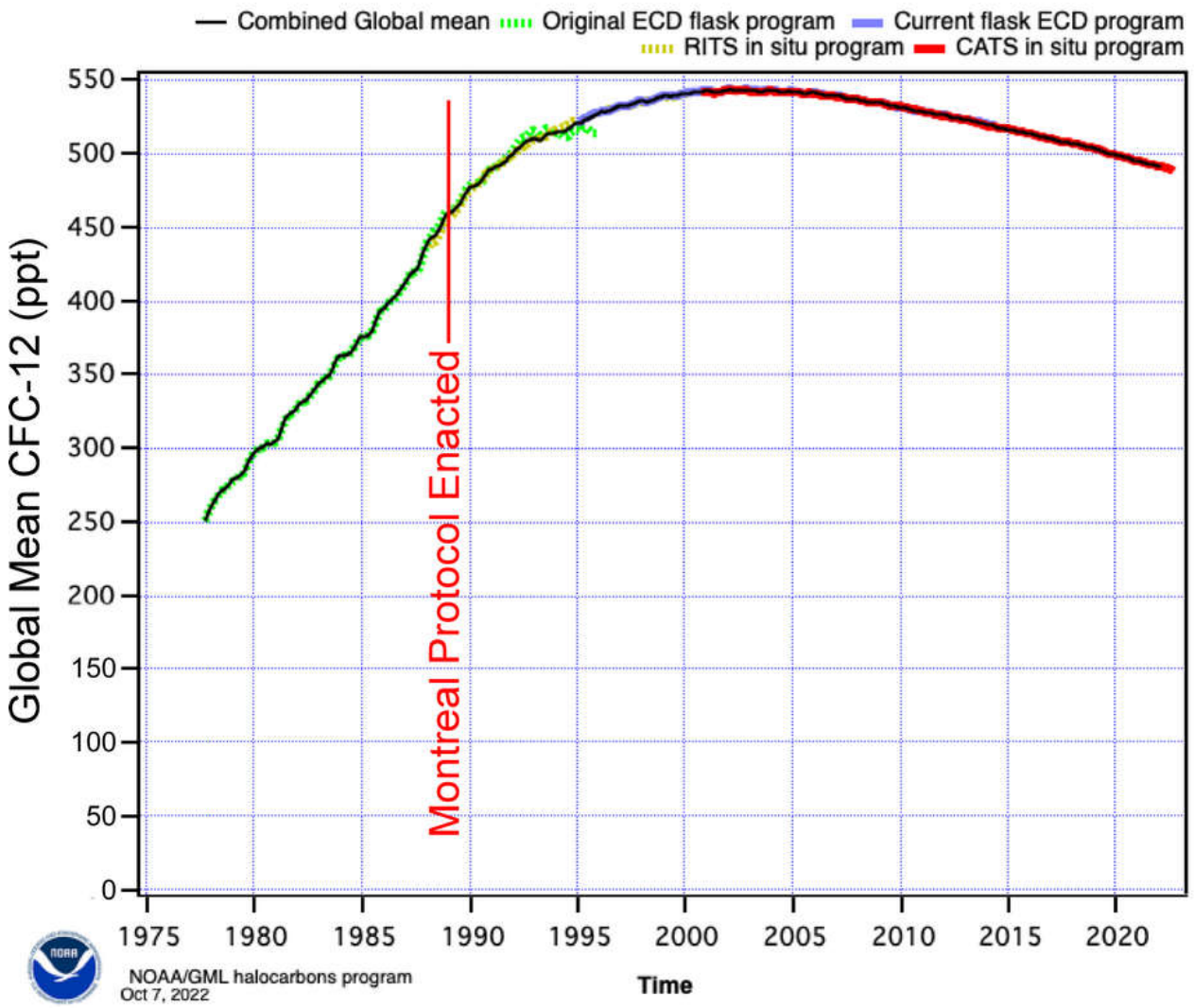
What have we learned?

Chlorofluorocarbons were all of these. But we haven't learned. PFAS falls into the same bucket. We really didn't see the issues coming. Asbestos, naturally occurring as it is, is something we didn't see coming.


Combined Global mean
Original ECD flask program
Current flask ECD program
RITS in situ program
CATS in situ program
Global Mean CFC-12 (ppt)
550
500
450
400
350
300
250
200
150
100
50
0
Montreal Protocol Enacted
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Time
NOAA/GML halocarbons program
Oct 7, 2022

Roast Mortem Cast

When you think of the world's most dangerous person, who do you think of? Genghis Khan? Stalin? Hitler?! Try a gas-huffing, pseudo-chemist that gave an entire generation lead poisoning and singlehandedly melted a hole in the atmosphere. Midgley created an ecological Frankenstein's monster

He died in 1944, certainly killed by a device he designed and made to allow getting out of bed unassisted. The original death certificate listed the death as a suicide. Observers of the scene declared it no accident. Yet, today it is widely reported as an accidental death.

Look no further than U catalysts. Still being investigated for things including polyolefin polymerization.

https://www.mjphd.net/Blogs/ThomasMidgleyRefs.html

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