

October 11, 1922.

Memorandum to Assistant Surgeon General
A. M. Stimson, through the Acting Director,
Hygienic Laboratory.

Sir:

My attention has been called to a situation which contains the elements of a serious menace to the public health.

Thomas Midgley, and his coworkers (J. Ind. Eng. Chem., 14 894, 1922), employed in the research staff of the General Motors Corporation at Dayton, Ohio, have discovered that certain compounds when introduced into the gasoline act as "Antiknock" or "Compressionizers" in that they prevent the knocking in engines running at low speed or at high compression. The most important of these compounds are diethylselenide and tetra ethyl lead.

At the present time the Dye Works Plant of E. I. duPont de Nemours and Company (the duPont Company controls the General Motors) is preparing to manufacture 20,000 gallons of lead tetra ethyl per day and it is reported that arrangements have been perfected with the Standard Oil Company of New Jersey to distribute the same.

In the preliminary work of manufacture of lead tetra ethyl several very serious cases of lead poisoning have resulted.

It is proposed to employ lead tetra ethyl in gasoline in the proportion of 2.5 c.c. per gallon. This is equivalent to approximately 1 part of lead tetra ethyl in 740 parts of gasoline.

The lead is eliminated from the engine exhaust in the form of oxides of lead, principally litharge, as an exceedingly fine dust.

The burning of 1 gallon of gasoline will throw into the atmosphere this dust to approximately the amount of 4 grams and since the average automobile engine will consume 2 gallons of gasoline per hour, 8 grams of litharge dust will result.

In the case of a gasoline engine operated in a building without means for leading out the exhaust gases, or in the case of a busy thoroughfare with continuously passing lines of motor cars or in the case of vehicular tunnels, it is possible that various results may follow.

Attention is called to the fact that the lead oxides turned into the atmosphere are not diffusible as is carbon monoxide and that on busy thoroughfares it is highly probable that the lead oxide dust will remain in the lower stratum.

Very respectfully,

Wm. Mansfield Clark
Professor of Chemistry.

WMC:FL.

Respectfully forwarded,
approved

R. E. Dyer
Acting Director.

Report on Gaseous Detonation and Control
with reference to Lead

Roberts, Surgeon.



OFFICE OF
MEDICAL OFFICER IN CHARGE
U. S. QUARANTINE STATION

TREASURY DEPARTMENT

UNITED STATES
PUBLIC HEALTH SERVICE

ROSEBANK
STATEN ISLAND, N.Y. November 13, 1922.

Surgeon General, U.S. Public Health Service,
Washington, D.C.

FILE B. L. J.

Sir: (Through Chief Medical Officer, Ellis Island, N.Y.)

I have the honor to report that I have accomplished the purpose of the following Bureau telegram to the Chief Medical Officer:

DIRECT SURGEON NORMAN ROBERTS ATTEND MEETING AMERICAN CHEMICAL SOCIETY RUMFORD HALL FIFTY TWO EAST FORTY FIRST STREET NEW YORK CITY NOVEMBER TEN EIGHT PM REPORT ON ADDRESS BY THOMAS MIDGLEY GASEOUS DETONATION AND ITS CONTROL PERIOD SERVICES INTEREST IS IN POSSIBLE POISONOUS EFFECTS OF LEAD COMPOUND IN GASOLINE

Midgley has sought to increase the efficiency of gasoline as a fuel for internal-combustion engines. To this end he has sought to compress the air-vapor mixture (before the combustion stage in the cycle) beyond the present practicable limits. To this end he has sought a chemical substance which, when added in small amounts to the gasoline, would prevent the combustion of the highly-compressed explosive mixture from assuming a violent or detonating character, this tending to destroy the motor. In chauffeur's language, he has tried to increase the mileage of gasoline by adding to it an "anti-knock" substance.

Midgley found that the best and indeed practically the only worth-while anti-knock substance was tetra-ethyl-lead, $Pb(C_2H_5)_4$, a hitherto little-known metallo-organic liquid freely soluble in and volatile with gasoline. Tetra-ethyl-lead in concentrated form is described as a heavy, mobile liquid, smelling like witch hazel. As a vapor, it irritates the eyes and nose. As a liquid, it irritates the skin of the hands. If improperly manipulated, it can produce lead poisoning. But as an antiknock, it is required in the proportion of only 3 cubic centimeters to the gallon of gasoline; and such a mixture can be handled in any reasonable way without toxic effects.

When this lead-containing gasoline is burned in a motor-cylinder, the lead is converted into a solid inorganic form. It

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would naturally be supposed that the exhaust would contain finely-divided particles of some lead compound; and this free evacuation of the lead is a necessity for the practical continuous use of the fuel in a motor. But Midgley states that thus far in his experiments no lead has been demonstrable in his exhaust gas. On the contrary, it all seems to cling to the walls of the combustion chamber, imparting to the "carbon" a grayish appearance, attacking the nickel of the spark-plug points, and necessitating unduly frequent cleanings and replacements inside the cylinders. Midgley is experimenting with other compounds which, added to the gasoline, will obviate this drawback, and will cause the lead to scavenge out with the other waste products.

The presence of lead in the exhaust will (when the process has advanced to this stage of development) add another poisonous constituent to the carbon monoxid already present in the exhaust gases. Moreover, lead as a poison is cumulative. Hence the public-health question arises: Will the use of lead for this purpose cause lead poisoning in those breathing the exhaust gases? The probable answer, according to Midgley, is No; and for the following reason:- Owing to the carbon monoxid present in all automobile and similar exhaust gases, there must be free ventilation in all spaces into which these gases escape, if the air of these spaces is to be breathed. Experiments preliminary to the construction of the Lower-Manhattan-Jersey-City vehicular tunnel show that the highest reasonably-safe concentration of carbon monoxid is about 0.01 of 1 percent, this proportion being breathable, without demonstrable harm, for as much as four hours every day indefinitely. Even if all automobiles using the vehicular tunnel used this lead-containing gasoline, and even if all the lead in the gasoline were discharged into the air of the tunnel, the concentration of lead in the air of the tunnel would still be too low to produce any toxic effect whatever. In other words, the more toxic substance, carbon monoxid, would probably prevent the absorption of the less toxic substance, lead, even under the most unfavorable conditions known to exist, in spite of the more cumulative character of the lead. This, however, is theory only; and Midgley says that he would welcome co-operation and extend facilities for toxicologic investigation if desired.

COMMENTS BY ROBERTS.

There are available, here and now, no figures showing the actual total amount of accumulated lead necessary to cause chronic human plumbism, nor the amount of lead which, after being ingested in small quantities, the human body is able to get rid of day after day, without causing undue strain on the organs of elimination. As an estimate, the human body would probably require a rather large amount of lead, over one gramme at the least, to saturate it to a harmful degree; and it could get rid of only a small amount over about 5 milligrammes, each day. A fair-sized car, working properly on Midgley's lead-containing gasoline would consume say 3 or 4 gallons daily and discharge into the air about 7 gramme

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of lead. If as much as one-one-thousandth of the total exhaust were absorbed by any one man, day after day, he would probably accumulate lead and ultimately be poisoned. But as no such proportion of the total exhaust is ever breathed by anyone day after day, the possibility of lead poisoning from this source is to be regarded as remote.

It would nevertheless seem advisable if practicable to detail a competent Service representative to study the effects of this lead-containing exhaust, suitably diluted with air, on animals. If Midgley's work is commercially successful, as seems likely considering its nature and the financial standing of the parties interested, large quantities of lead-containing gasoline will soon begin to be used as motor fuel; and even if such turns out not to be the case, the toxicologic facts obtainable would be of permanent value.

I desire to acknowledge Mr. Midgley's courtesy to me personally and ^{as} a Service representative, in explaining and amplifying the points of his address in which the Service is most interested.

Respectfully,

Norman Roberts

Surgeon.

Respectfully forwarded:

W. A. Ziehl

Surgeon,

Chief Medical Officer.

TREASURY DEPARTMENT

BUREAU OF
THE PUBLIC HEALTH SERVICE
WASHINGTON

OFFICE OF THE SURGEON GENERAL
IN REPLYING
ADDRESS THE SURGEON GENERAL
U. S. PUBLIC HEALTH SERVICE

October 13, 1922.

Hygienic Laboratory
RECEIVED
Hygienic Laboratory
OCT 14 1922

Passed Assistant Surgeon R. E. Dyer,
Acting Director, Hygienic Laboratory,
U. S. Public Health Service,
Washington, D. C.

Sir:

Receipt is acknowledged of a memorandum dated October 11,
signed by the Professor of Chemistry, relating to the possible
health menace of a new fuel for gasoline engines.

It appears to this office that the possibilities of a real
health menace do exist in the use of such a fuel and it is deemed
advisable that the Service should be provided with some experimental
evidence tending to support this opinion.

You are requested, therefore, to take up with the Divisions
of Chemistry and Pharmacology in the Laboratory the question of
designing certain experimental work calculated to furnish dependable
data on the subject, and to transmit this plan with your recommenda-
tions to this office.

By direction of the Surgeon General.

Respectfully,

A. M. Stimson

(A. M. STIMSON)
Assistant Surgeon General.

AMS:AEB.

Organic lead compounds as additions
to gasoline.

Hygienic Laboratory
McG-Man

copy

November 23, 1922.

The attached file with respect to the introduction of lead tetra ethyl as an admixture to gasoline is respectfully returned to the Surgeon General, for the attention of Assistant Surgeon General A.M. Stimson with the statement that the risk of lead poisoning from the use of lead tetra ethyl in gasoline has been carefully considered and this office is not disposed to recommend any experimental investigation of the subject at the present time for the following reasons:

1. To secure trustworthy data would require a considerable period of time, perhaps a year. This delay would probably prevent results of an experimental investigation from being of much practical use since the trial of the material under ordinary conditions should show whether there is risk to man.
2. Experimental data of either a positive or negative nature would be most difficult to interpret with respect to the hazard to human beings since we have almost no information as to the relative susceptibility to lead of man and of laboratory animals.
3. Experimental results would apply to a limited set of conditions which might or might not prevail in the use of the material in gas engines.

It seems, however, to this office that it would be eminently proper to communicate with the manufacturers, pointing out the possibility of harm and inquiring as to whether or not this feature has been given consideration.

It is believed that it would also be proper to advise health officers of the proposed use of lead tetra ethyl and suggest the advisability of careful watch being kept for manifestations of lead poisoning.

G.W. McCoy,
Director.

C O P Y

December 20, 1922.

Mr. P. S. DuPont, Chairman,
Board, E. I. DuPont de Nemours and Company,
Wilmington, Delaware.

Dear Sir:

A representative of this Service who was detailed to attend a recent meeting of the American Chemical Society in New York, has reported to the Bureau upon the proposed use of lead tetra ethyl in connection with fuels for gasoline engines, which subject was discussed at the meeting, and it appeared that the DuPont de Nemours Company was interested in the development and commercial introduction of this substance.

Inasmuch as it is understood that when employed in gasoline engines, this substance will add a finely divided and non-diffusible form of lead to the exhaust gases, and furthermore, since lead poisoning in human beings is of the cumulative type resulting frequently from the daily intake of minute quantities, it seems pertinent to inquire whether there might not be a decided health hazard associated with the extensive use of lead tetra ethyl in engines.

Believing that this phase of the question must have received attention from those interested in the project, I am writing to inquire whether your company has collected any experimental or other data bearing upon the danger of lead poisoning from this source.

Very truly yours,

(SIGNED) H. S. CUMMING,
Surgeon General.

KJDB

GENERAL MOTORS RESEARCH CORPORATION

DAYTON, OHIO.

December 30, 1922.

Doctor H. S. Cumming, Surgeon General,
Bureau of Public Health Service,
Washington, D.C.

FILE B. L. 1

204802

Dear Sir: -

Your favor of December 20th addressed to Mr. P. S. duPont has been referred to the writer for answer.

The question of lead poisoning resulting from the use of lead compounds has been given very serious consideration by this Laboratory although no actual experimental data has been taken. The reason that no experimental data has been taken is due primarily to the fact that so far we have not been able to get the lead compounds to come out in the exhaust of the motor uniformly. Some of these materials remain in the motor cylinder and exhaust lines. However, the following figures have been compiled in an attempt to analyze just how serious the problem of lead poisoning from exhaust gas is going to be.

The most congested district in the world containing the greatest percentage of exhaust gas will be the vehicular tunnel under the Hudson River. In connection with the ventilation of this tunnel, Doctor Fieldner at the Bureau of Mines indicates that the percentage of carbon monoxide in the atmosphere resulting from the exhaust gas of internal combustion engines, must be kept below two one-hundredths of one percent in order that human beings may breathe this atmosphere for four hours per day and avoid the serious consequences of carbon monoxide poisoning.

Under these most extreme conditions the quantity of lead which will be present in the atmosphere as a lead compound, will be so minute that a human being will inhale only a total of one milligram of lead in four hours. This lead compound will be in the form of a finely divided dust comparable to cigar smoke. Consequently,



GENERAL MOTORS RESEARCH CORPORATION
DAYTON, OHIO.

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Doctor H. S. Cumming:

December 30, 1922.

a relatively small portion of this milligram will be retained by the human system. Doctor Yandell Henderson considers the absorption of one milligram of lead per day as dangerous. We feel absolutely confident that under the conditions that will exist in the vehicular tunnel, that people exposed to this atmosphere will only absorb a very small part of one milligram. The worst congested streets will certainly be much better than the vehicular tunnel; while the average street will probably be so free from lead that it will be impossible to detect it or its absorption.

We expect in the near future to place a small quantity of this lead compound on the market in some districts. There will not be enough lead used in the early stages of this development to present any health hazard whatsoever and during this period we propose to investigate the toxicity of these exhaust gases very thoroughly so as to determine just what the ultimate limit to the use of lead compounds actually is. We hope to secure your most hearty cooperation in carrying on this work.

Trusting this information will clarify the situation in your mind, I beg to remain

Very truly yours,

Thomas Midgley, Jr.
Chief Engineer,
Fuel Section.



TM-Jr-D