

S T A N D A R D O I L C O M P A N Y
(Incorporated in New Jersey)

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REPORT OF THE INVESTIGATIONS MADE BY DRS. THOMPSON AND SCHOENLKBER

AT THE

GENERAL MOTORS RESEARCH LABORATORIES,
DAYTON, OHIO

AND THE

UNITED STATES BUREAU OF MINES LABORATORIES,
PITTSBURGH, PA.

Date of Investigations:
May 17th & 18th, 1924.

KE 0005744

N 7412

STANDARD OIL COMPANY
(Incorporated in New Jersey)

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TETRA-ETHYL LEAD POISONING

OBJECT:

The object of these investigations was to determine -

- (1) The extent of poisonings already observed and the symptoms.
- (2) The relative hazards to -
 - (a) The manufacturers.
 - (b) The marketing and garage men.
 - (c) The consumers and the general public.
- (3) The means of prevention of poisoning.
- (4) The effects of treatment.

MANUFACTURE:

At the Dayton Laboratories the only manufacturing process con-

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sists of the addition to the tetra-ethyl chloride of lead, prepared chiefly by the Dupont Company, of a small quantity of bromine and a red distinguishing aniline pigment known as "Sudan Red". Neither of these two added substances appears to be a factor in the poisoning for the reason that all toxic symptoms have also been observed previous to their addition. This product is put into containers for distribution to the filling stations. Poisoning occurs among men employed in this process. In the past they apparently were exposed in varying degrees to direct contact with ethyl lead. One of the men who died is said to have frequently had his clothes wet with it. It appears that the risk of poisoning is of a two-fold source, first, from direct contact of ethyl lead with the skin and, second, from inhalation of the vapor. Contact appears to be by far the most important factor.

INTENSITY OF THE POISONING:

All the soluble lead combinations have long been known by chemists to be highly toxic, but the extreme toxicity of ethyl lead was at first not fully appreciated by the manufacturers of this compound. Although all employees were warned against the danger of wetting the skin with this substance, they were careless in taking adequate precautions. Quite recently, however, this great danger is better appreciated by all and more rigid rules are being enforced. It has been found that gloves of all kinds, rubber, canvas, leather, etc., afford no protection as they are eaten through by the product.

Ethyl lead being an oily substance it readily penetrates the skin upon brief contact. Mr. Midgley, the Director of the process, stated that he had himself had mild toxic symptoms from a single brief immersion of the hands in the lead fluid although he at once washed them.

It becomes therefore imperative that the fluid shall under no circumstances be allowed to come in contact with any part of the body

surface. Should this by accident occur it must be washed off immediately with soap and water or a neutralizing solution.

A rabbit whose thin skinned ears were painted with ethyl lead died of poisoning within twelve hours.

This is analagous to the promptness with which certain nitrites and anilines are absorbed, causing toxic symptoms. Furthermore, some degree of poisoning may occur through inhalation of the ethyl lead vapor. Dr. McCann, physician to the Dayton patients, stated that after sitting for half an hour in the room where the cans were being filled from a pipe which lead to a small opening in them admitting of spattering, he had a fall in blood pressure of some twenty points below normal, although none of the fluid had touched him.

SYMPTOMS:

The symptoms of ethyl lead poisoning are definite and unique and from the medical viewpoint extremely interesting for they are not observed as a whole with any other known poison, but combine the symptoms of several types of poisoning. All of the forty persons who have taken part in the filling process in Dayton are said to have suffered in varying degree from poisoning.

The first symptoms observed are a marked fall in blood pressure sometime as low as sixty points below normal. There is an accompanying fall in body temperature which has been recorded as low as 94.6 degrees Fahrenheit or four degrees below normal. The heart action is slowed, the pulse having dropped in one case as low as 48, that is, twelve or more counts below normal. There is at first some digestive disturbance, such as loss of appetite, vomiting and a tendency to looseness of the bowels. Vertigo may be present. The red blood corpuscles show marked changes in size and shape. The blood

in one of the fatal cases failed entirely to coagulate and at autopsy showed an unusual color such as is observed in monoxide poisoning. There is no cyanosis and no shortness of breath, nor is headache or other pain complained of. The urine remains normal usually but in one case reported treated by Dr. Alb at Harvard lead was present in it. Following these symptoms in severe cases other phenomena appear indicative of profound cerebral disturbance. The victim suffers from persistent insomnia and becomes delusional, extraordinarily restless and talkative. His gait is staggering like that of a drunken man, but there is no paralysis and convulsions do not appear. There is exaggerated movement of all the muscles of the body accompanied by perspiration and the patient finally becomes violently maniacal, shouting loudly, leaping out of bed, attempting to smash furniture or windows and behaving like a violent case of delirium tremens. Morphine only accentuates the symptoms. The victim may finally die in exhaustion. One man smashed a window and cut his hand badly. He had delusions of vision, seeing imaginary groups of persons, and accusing the Doctor of trying to cut him up. Another man saw the wall paper converted into swarms of moving flies and thought pictures of his family on the walls were alive and moving about.

Of the two fatal cases the body temperature in one patient rose to 110 degrees just before death. Both these men had been at work only five weeks. The elder, 53 years of age, was not very vigorous, originally having a chronic fibroid condition of the lungs. The younger man was of fine physique. Dr. McCann, who has had a very extensive general practice, stated that he never in his life had seen anyone die in such agony as these two men as he said "they

died yelling". One man had to be strapped in bed by an expert accustomed to restraining the insane.

As in nearly all poisonings of industrial origin considerable personal idiosyncrasy may exist as to bodily resistance. Many of the workmen showing only slight symptoms have continued at work. In other cases quite marked symptoms have developed within from three to six hours. In one case the blood pressure dropped in only three and a half hours after beginning work - from 190 to 112 - a fall commensurate with that which occurs in excessive hemorrhage. Convalescence from the severe symptoms is quite protracted and may occupy from six to ten weeks.

TREATMENT:

Treatment in severe cases avails little. One of the fatal cases received blood transfusion but without benefit. Sedatives are of little value. Morphine makes matters worse. Bromides and hyoscin have been tried. Alkalies, such as soda and magnesia, are given to counteract supposed acidosis and elimination is favored with magnesium sulphate. Future experience may develop more successful treatment. In the mild cases the only treatment followed has been the removal of cases from exposure and abundant air and sunlight.

EXPERIMENTAL DATA REGARDING EXHAUST:

Some five months ago the General Motors Chemical Company arranged that the U. S. Bureau of Mines in Pittsburgh should make a scientific experimental study of the effects of inhalation of the exhaust gases from gasoline mixed with ethyl lead. We visited the laboratories of the Bureau on May 18th, 1924, upon our return from Dayton, conferred with Mr. W. P. Yant, the expert in charge of the

study under direction of Mr. A. C. Fielder, and with him inspected all the animals under experimentation. These animals included monkeys, dogs, guinea pigs and rabbits. All were found in perfect health, none having exhibited any symptoms whatever even after exposures of three and six hour periods daily for five months. Other animals had been purposely killed after exposure and autopsy showed no lead in any of their organs. There were no blood changes discoverable in any of the animals. The lead from the exhaust is discharged mainly as a chloride.

Under ordinary conditions the carbon monoxide given off from the exhaust and derived from the gasoline of the mixture used amounted to 7% of the total exhaust. In order to eliminate possible evil effects of carbon monoxide, however, this percentage was reduced by one-half and a proportionate increase in the ethyl lead was made. Thus an increased proportion of ethyl lead was added so as to make the experiments doubly conclusive. By this adjustment the lead measured .016 milligrams per cubic ft. of the total exhaust gases.

Lead chloride, moreover, is not especially toxic as compared with tetra-ethyl lead. Furthermore, much of the lead discharged is deposited in the muffler and exhaust pipe.

It was an amusing incident that a setter bitch who was enciente was delivered while actually in the experimental cage of six lusty pups who with their devoted parent have all continued to share in the daily treatment with the exhaust and the entire offspring has thriven upon it.

The final report upon the results of these experiments is not quite ready as they have another month to run.

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On February 24th, 1924, Prof. Vandell Henderson, the distinguished physiologist of Yale University and a consultant for the new Hudson Tunnel, made a statement which, by reason of his broadcasting it through The New York Times, deserves comment here. In it he asserts (see Exhibits "A" and "B") that there is imminent danger of universal lead poisoning of the public through inhalation of the lead oxide (S 1 c) given off in the exhaust where ethyl lead has been consumed and that such inhalation "will very probably occur in appreciable degree among all persons using or living on or having places of business on congested streets". Such absurd, inaccurate and utterly unfounded public statements are likely to cause alarm in serious degree. In the first place, it is not "lead oxide", which is given off but lead chloride and as for the rest of the statements they are sufficiently controverted by the researches of the U. S. Government Laboratories above described.

CONCLUSIONS:

Although tetra-ethyl lead is exceedingly poisonous, we believe that with proper precautions, continuously enforced, the risk to the manufacturers from ethyl lead poisoning may be reduced to a minimum no greater than that which obtains in dealing with other strong poisons, such as benzol or anilines, or the high explosive.

The potential hazard to the marketing men is considerably lower than that of the manufacturers. There is, however, a possibility of poisoning, especially of the chronic type. Proper precautions along the lines suggested by Mr. Midgley should reduce this hazard, but the question deserves further study.

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We believe that there is no special hazard for the garage men, chauffeurs or general public from exhaust products of ethyl lead.

We are unable at the present time, through lack of any experimental or other data, to make a positive statement as to potential danger to the consumer who might handle, for any purpose, ethyl lead diluted with gasoline in the present standard extreme dilution of one to a thousand.

While on the one hand this new product has now been distributed for more than a year in rapidly increasing quantity until it is being supplied to more than 10,000 filling stations and no poisoning has been reported, yet, on the other hand, the symptoms of poisoning by this agent are as yet almost wholly unknown to physicians and symptoms of mild poisoning might easily pass unrecognized or be attributed to other sources. We further are unable to state whether after long continued exposure to quite minute doses of ethyl lead symptoms might not develop ultimately akin to those of ordinary lead poisoning just as a painter may escape lead poisoning for a number of years and then rather suddenly develop it.

RECOMMENDATION:

In view of the present lack of scientific experimental data regarding any possible danger to the consumer coming in contact with gasoline treated with tetra-ethyl lead, we suggest the desirability of arranging with the U. S. Bureau of Mines to conduct a series of experiments, similar to those already made with the exhaust gas, of ethyl lead. Such experiments conducted by so impartial a source as

the Government Bureau would be extremely useful for refuting ignorant and alarmist assertions which might possibly be damaging to the proper exploiting of this highly useful product.

Respectfully submitted,

W. GILMAN THOMPSON
Medical Consultant

A. W. SCHOENLEBER
Asst. Medical Director.

RCB.

May 19th, 1924.

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EXHIBIT "A"

Laboratory of Applied Physiology
Yale University
New Haven, Conn.,
Feb. 29, 1924.

EDITOR OF THE TIMES:

One of the largest automobile interests is now advertising and introducing quite widely a lead compound (tetra-ethyl lead, with the trade name, "ethyl gas") which tends, when added to gasoline, to prevent back firing and "knocking" and to cause a smoother and better explosion in the cylinders. (It was described in an article on "Motor Cars of 1924", in the New York Times of Sunday, January 6, 1924). The amount which needs to be added to gasoline to obtain this good effect is very small; but lead compounds of this type are toxic even in very small amounts. Lead poisoning is one of the best known and one of the most serious industrial health hazards, as for instance among painters and typesetters. Reasoning from what is already known it is a fairly safe prediction that in any garage where the cars use this leaded gasoline many of the men employed will develop lead poisoning, unless effective measures are taken to prevent the inhalation both of the unburned gas and of the exhaust. Even if part of the lead sticks in the muffler, the dust in the air in such garages must contain appreciable quantities of lead oxide. If the use of this leaded gasoline becomes common the inhalation of lead oxide will very probably occur in appreciable degree among all persons using, or living on, or having places of business on congested streets.

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(Signed) Yandell Henderson

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EXHIBIT "B"

March 1, 1924.

I enclose a communication which I am sending to the New York Times, in which I take occasion, incidentally, to call public attention to the fact that substances like benzol, and particularly a lead compound, are being mixed with gasoline.

I have not quite told the whole story of my relation to the matter of lead. The General Motors Research Corporation consulted me, two years ago, on the health hazard involved and I told them that in my judgment widespread lead poisoning was almost certain to result. Disregarding this advice, they have gone on with the development until tetra-ethyl lead is being introduced quite widely. I have learned privately that some of the research chemists who participated in this development were severely poisoned with lead and I have heard quite recently from Dr. Alice Hamilton that the factory which is manufacturing the lead-ethyl has had a regular outbreak of acute maniacal lead poisoning among the workers.

Some of my information is confidential, and perhaps my personal opinion regarding this matter takes too alarming a view. In case, however, the Public Health Committee of the Academy of Medicine desires to inquire into the matter, there is ample ground in the statement published in the New York Times of January 6th, automobile section, page 2, "Motor Cars of 1924", by H. A. Tarantous. The particular words used are as follows:

"The General Motors Research Corporation has developed tetra-ethyl lead, a liquid which when mixed in small quantities with gasoline makes a carbonized engine operate without a knock. In three States, at least, the motorists can obtain gasoline already mixed with this material from the gas vendor. It is called ethyl gas."

(Signed) Yandell Henderson

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