

T E T R A E T H Y L

L E A D

A new industrial poison

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Tetraethyl lead is an industrial poison of extraordinary interest in medicine on account of its treacherous nature, varied modes of entrance into the body and the unusual grouping of symptoms which it may produce. These symptoms in great part are so unlike those of ordinary chronic lead poisoning as not to suggest the latter to anyone unfamiliar with the effects of this soluble and even volatile form of metal.

This substance was produced first by chemists in 1854 and has long been recognized by them to be extremely toxic when carelessly handled in concentrated form. Two chemists in the Massachusetts Institute of Technology were poisoned by it some years ago. Only recently, however, has its commercial use as an adjuvant to motor fuel brought it before public attention.

Chemically, tetraethyl lead is simple, being produced from three raw materials, lead, metallic sodium and ethyl chloride. In manufacture a sodium lead alloy, which is quite friable, is automatically ground up in large closed retorts called "autoclaves" so that the added ethyl chloride may the more readily combine with it. The compound is further treated with steam, distilled and filtered. This comparatively simple chemical reaction requires much apparatus, however, and as in similar chemical plants, despite the greatest care, valves sometimes may leak, gaskets may become insecure and "spills" and "blowouts" may occur. Even under moderate pressure, ethyl chloride is several times more difficult to confine than steam.

Hence, workmen may be exposed to the potential hazards of (1) inhalation of dust of lead or its sodium alloy (2) the inhalation of fumes of ethyl chloride

either with or without admixture with lead, or (3) skin contact with the finished fluid product, tetraethyl lead. This substance is a slightly oily, somewhat yellowish mobile fluid which, in undiluted strength may be absorbed through the skin as quickly almost as nitroglycerine and far more readily than mercurial imunctions.

The duration of exposure necessary to produce toxic symptoms varies from a few hours to several weeks, naturally depending somewhat upon the form and quantity of the substance, whether it be inhaled as a vapor or applied as a fluid over a large surface of the skin, after contact with an extensive "spill". Slight variations in the poisoning have been noted occasionally depending apparently upon personal idiosyncrasy, as observed with many other active chemical poisons.

The symptoms in an average case are as follows: The patient complains of persistent and intractable insomnia, or, if he sleep at all, he has unwonted and disagreeable dreams, as of catastrophies, pursuit, etc. He notices nausea, anorexia and sometimes morning vomiting. He becomes restless, nervous and weak and loses weight up to a dozen pounds in a fortnight perhaps. Subjectively the most striking phenomenon in many cases is a marked drop in both systolic and diastolic blood pressures. With this, there often but not invariably, is a lowering of two or three degrees in body temperature, a fall of several points in pulse rate, tremor of the hands, a rather characteristic faintly icteroid complexion and a slight degree of secondary anemia. If promptly taken off work and made to stay in the open air and to exercise in moderation, the patient often may soon return to work, at least upon some other job.

In the more severe or fulminating cases, the insomnia becomes completely intractable, yielding to none of the ordinary hypnotics. The most violent maniacal delirium ensues, as serious as the worst type of delirium tremens, with shouting, raving, visual hallucinations, and a tendency to spring from bed and run amuck. Two such patients, although carefully watched, dashed through closed windows. The systolic pressure may fall below 90°;—even to 80° in several cases observed. The patient will take neither food nor drink and in consequence the tongue and mouth are parched and the urine secretion is diminished. Lead is obtained in large quantity from the stools, but the urine in most cases remains practically normal and lead has not been found in it in

all cases. With only two or three exceptions, patients with violent delirium have died from exhaustion in from 24 to 72 hours. Of the 12 deaths recorded, all took place in delirium.

The writer has had the opportunity of observing 93 cases of all grades and not one of them remotely suggested the ordinary clinical picture of chronic lead poisoning. There were no paralyzes, there was no distinct "lead line" upon the gums, obstinate constipation was not present and although vague abdominal testicular and thoracic pains were complained of occasionally, the intense and typical "lead colic" centering about the umbilicus was not once complained of. "Stippling" of the red corpuscles was present in only about one-half of the cases.

In some instances curious anomalies presented. For example, one patient, a chemist, who had been testing the manufacturing processes in the work-room where most of the poisoning occurred, felt weak and slept poorly, but although his systolic pressure fell to 80° and an exceptionally heavy precipitate of lead was obtained from the stools, there was no delirium, nor was the patient at any time bed-ridden. There was no "stippling" of the red blood cells and traces only of lead were found in the urine.

Convalescence, as might be expected, is usually much protracted. The lowered blood pressure, general muscular weakness, loss of weight and insomnia are slow in being overcome and although many patients have returned to light work in other occupations at the plant, many have occupied two or three months in complete recovery. In no case thus far observed, however, have any of the typical symptoms of chronic plumbism been found, or have there been any mental sequelae at all.

The following account leaves no doubt that the manufacturing process of tetraethyl lead is an ultra-hazardous industry comparable in danger with those of making high explosives and many chemicals such as the anilines, strong acids and alkalies, war gases etc. But like those industries, it is quite capable of future control and regulation. The entire hazard of manufacture has been confined to two Companies with a third which is concerned in adding to the original tetraethyl lead, bromine to make it more effective for use as an adjuvant to gasoline when diluted one thousand times for

motor fuel, plus the addition of an inert coloring matter to render this diluted product called "ethyl gasoline", distinguishable from ordinary gasoline. These three Companies were well aware of the poisonous nature of undiluted tetraethyl lead and their medical staffs at the very beginning, formulated standards for protective equipment for the workmen employed, such as rubber suits and gloves, masks, etc., besides elaborate general hygienic regulations. They also instituted extensive experiments upon animals to determine all the effects of the poison in all its forms and dilutions. These experiments were not alone conducted in their own laboratories, but in the United States Government Bureau of Mines Laboratories and the Industrial Hygiene Laboratories of Columbia University. One of the two manufacturing Companies which was conducting only a small experimental manufacturing process, has given this up for various reasons, so that at present only one Company is conducting this patented process.

Meanwhile, the manufacturing processes have constantly been improved by being made more and more automatic. But in the earlier phase of the manufacture while new construction was going on parallel with production, accidents with machinery occurred and the deplorable incidents above described followed.

Some fifty-five patients were sent to the Reconstruction Hospital in New York City because it maintains there a special clinic for the treatment of and research in industrial diseases and accidents. Many of these patients were not bed-ridden and showed very few symptoms but were sent in merely for observation and research. They long ago returned to other work. Nevertheless, the sensational public press, not distinguishing that tetraethyl lead can only be used as an adjuvant to motor fuel in a one to one-thousand dilution with gasoline and mistaking the fluid for a "gas", broadcast the most sensational reports implying that the manufacturing Companies were deliberately poisoning the public with lead in the form of what they variously described as "Loony Gas", "Mystery Gas", etc. As a result, various local and state Health Boards began to forbid its use within their jurisdiction. These restrictions (in every instance but one) in the light of proper information, have been withdrawn.

A one-to-one-thousand dilution of any poison is a very different thing from its full strength. Carbolic acid, for instance, is hazardous to make or handle in full strength, but in a one-to-one-thousand dilution is a valued antiseptic.

It never was intended that the general public should have any opportunity to handle the concentrated tetraethyl lead and the filling stations where it is added to gasoline for public use as the one-to-one-thousand dilution are now operated under as careful protective regulations as are the manufacturing processes themselves.

As a matter of fact, in a number of States in the mid-west and south, the dilute "Ethyl Gasoline" has now been in general public use in over 20,000 service stations for over two years, 300,000,000 gallons have been used, and no cases of lead poisoning, either acute or chronic have been discovered. In an experimental garage maintained by a large motor company a number of workmen constantly exposed where "Ethyl Gasoline" had been in use for over two years, were subjected to thorough physical examination to determine the presence of lead or any of its toxic symptoms in their bodies, with entirely negative results.

Meanwhile, the United States Bureau of Mines Laboratories, after a year's experimentation with a large number and variety of animals exposed daily to the exhaust fumes of a motor using "Ethyl Gasoline" in five times the strength employed by the public, has reported officially that such exhaust fumes are non-toxic. Moreover, the tetraethyl lead is decomposed by combustion.

Of course, the public must learn not to use "Ethyl Gasoline" for cleaning or washing purposes or any other purpose than that for which it legitimately is intended, i.e., as a motor fuel. "Ethyl Gasoline" is colored red as a warning against its illegitimate use.

The reasons why "Ethyl Gasoline" is so important a fuel for use wherever gasoline engines are employed whether in the Army, Navy or Aeroplane services, or by the general public may thus be summarized.

1. It will enable the employment of a new high compression engine which cannot be operated successfully with ordinary gasoline.
2. It will thereby increase motor power and, if in universal use, would conserve, as estimated, one-fourth of the world's motor fuel supply.
3. It will enable a reduction in size and weight of motor engines.
4. It removes the "knock" from present motor engines and makes them run more smoothly with increased power.
5. The carbon monoxide concentration of exhaust fumes would be reduced in the same degree that gasoline combustion would be conserved in the motor engine.