

Acute Trichloroethylene Narcosis

*Accident Involving the Use of Trichloroethylene
in a Confined Space*

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Introduction

At the factory in question, large tanks are entered periodically to resurface exposed metal joints with a bituminous paint applied with a brush.

Each tank is porcelain lined, 9 feet in height and 15 feet long, and has 1 entry port 15×16 in. positioned 2 ft. 6 in. from ground level. They occupy most of the floor space of a poorly ventilated basement area, maintained at approximately 32 F. In order to dry out the tanks prior to painting, 4 infrared heaters are placed inside and switched on 16 hours prior to painting: they are left on during painting.

On the day of the accident, 2 experienced painters, who had both carried out this work for 8 years, commenced work at 8 A.M., one man entering the tank and painting for 30 minutes while the other remained outside.

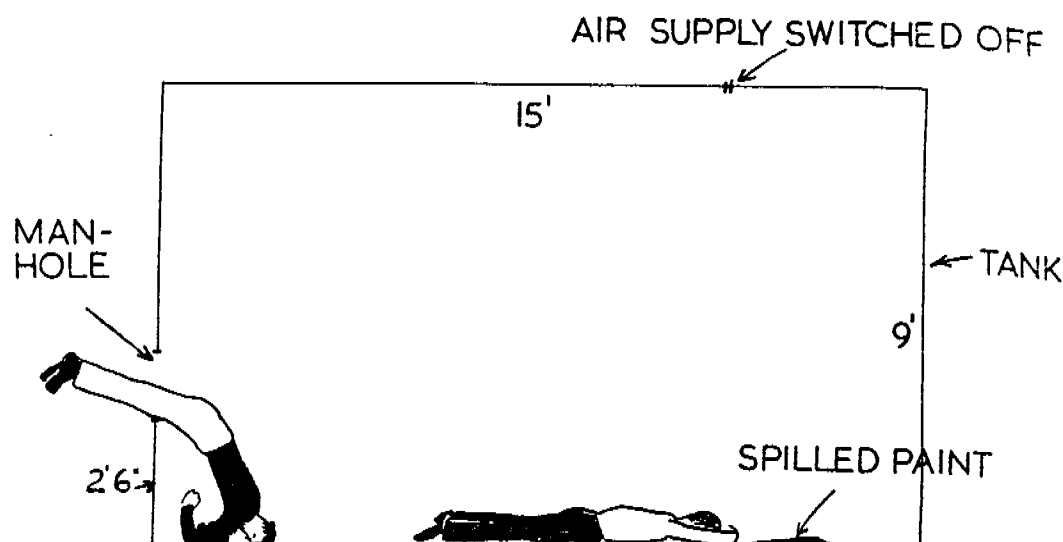
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Each 30 minutes the men changed places. It was normal procedure for the painter inside the tank to wear an air-supply respirator at all times. One air-supply respirator was issued for use by the inside man, and it was stated that the first employee to enter the tank used it for a short period. Air flushing equipment attached to the top of the tank was not used, as this caused moisture from condensation on the surfaces to be painted.

At about 9 A.M. the use of the air-supply respirator was discontinued, as the operator believed the air supply to be contaminated. Detailed tests of the supplied air on the day following the accident and on 2 subsequent days did not show any contamination. A full-face respirator fitted with an all-purpose canister suitable for organic vapors was substituted for the remainder of the work.

At noon, the painter resting outside the tank observed that the man inside the tank was becoming increasingly incoherent, with a staggering gait and the appearance of drunkenness. The former person ordered his



fellow worker to leave the tank and instructed him to get some fresh air. While the affected person walked about outside, the other man entered the tank "for a few minutes" to clean up prior to taking a meal break. It has not been established whether he put on a respirator or not.

Some time later the man outside the tank, having partially recovered, returned to the tank, looked inside, and saw his mate sprawled apparently unconscious on the bottom near an area of spilled paint. Immediately, without waiting to put on a respirator, he started to crawl through the manhole to rescue his friend. While halfway through the manhole, after taking only 1 or 2 breaths inside the tank, he fell forward unconscious head first into the vessel with his legs still protruding from the manhole.

Fortunately for both men, these protruding legs were noticed by another worker at about 12.40 P.M., and both men were removed from the tank by 12.55 P.M. Neither was wearing a respirator.

Both regained consciousness before arriving at the hospital but were somewhat confused and disoriented for some time. The 2 men reported for work the next day and have lost no time since the accident.

Investigations

Officers of the New South Wales Division of Occupational Health were called in the

following day to investigate this accident which so nearly resulted in a double tragedy.

It was quickly established that the most likely cause was vapor from the paint used. The latter contained 75% trichloroethylene and had been thinned with an equal amount of thinners containing 98% trichloroethylene.

The materials stored in the tank were of a nontoxic nature.

As the tank was a very confined space situated in a basement area which was poorly ventilated, the possibility of oxygen deficiency and carbon dioxide excess was also considered as contributing factors, as both men had complained of "air-hunger."

Preliminary tests were commenced 24 hours after the accident. At this stage the paint was dry, as was the area of paint spilled on the bottom of the tank. The 4 infrared heaters had been switched off after the accident. Trichloroethylene estimations were carried out with a Davis Halide Meter. In the center of the tank 2 ft. from the floor, the trichloroethylene concentration was 120 ppm.

To simulate the conditions resulting from an area of spilled paint, 3 shallow trays of prepared paint were then placed on the bottom of the tank. After some minutes, the trichloroethylene concentration had risen to more than 1,000 ppm beyond the range of the Davis Halide Meter.

On the same day at 8.30 P.M. level was found to be 19.5% and dioxide level 0.7%. The trich level near the trays and the manhole to 2,390 ppm by this time, as determined by "grab" samples and the method over platinum.¹

Because these preliminary tests were exclusive, it was decided to duplicate, as possible the conditions inside the tank leading up to and at the time of the accident and then to carry out a further series of tests. An exactly similar tank in the same area was used for the final tests. The red heaters were switched on 16 hours before testing was begun. On this occasion inside the tank began at 10.45 P.M. painters worked inside alternate minutes. At 12.50 P.M. 3 trays of paint and thinners (approximately 1 gallon) were placed on the bottom of the tank to simulate spillage. Apart from the use of an air-supply respirator was used throughout the painting, conditions approximated those leading up to the accident. Painting ceased at 1.20 P.M. (Table 1).

Trichloroacetic acid estimations were carried out on the urine of the 2 subjects and on one other subject who took part in the final investigation (Table 2). The substitute painter was detailed to work during the tests, as No. 1 painter who first became unconscious and was not to work in a confined space.

Protective Device

In theory, the full-face respirator should give adequate protection.

TABLE 1.—Results of 7

Time	Situation	Trichloroethylene in Air (ppm)
11.15 A.M.	Center, bottom of tank	1.8
11.45 A.M.	" " "	2.8
12.20 P.M.	" " "	2.8
12.45 P.M.	At manhole, inside tank	1.7
1.10 P.M.	Center, bottom of tank	3.3
1.20 P.M.	Far end of tank	3.2

On the same day at 8.30 p.m. the oxygen level was found to be 19.5% and the carbon dioxide level 0.7%. The trichloroethylene level near the trays and the manhole had risen to 2,390 ppm by this time, as determined from evacuated "grab" samples and the combustion method over platinum.¹

Because these preliminary tests are inconclusive, it was decided to duplicate as closely as possible the conditions inside the tank leading up to and at the time of the accident and then to carry out a further series of tests. An exactly similar tank in the same confined area was used for the final tests. Four infrared heaters were switched on 16 hours before testing was begun. On this occasion painting inside the tank began at 10.45 a.m., and 2 painters worked inside alternate shifts of 30 minutes. At 12.50 p.m. 3 trays containing paint and thinners (approximately 1 pint) were placed on the bottom of the tank to simulate spillage. Apart from the fact that an air-supply respirator was used throughout the painting, conditions approximated as closely as possible those leading up to the accident. Painting ceased at 1.20 p.m. (Table 1).

Trichloroacetic acid estimations were carried out on the urine of the 2 affected men and on one other subject who took part in the final investigation (Table 2). The No. 3 substitute painter was detailed to carry out the work during the tests, as No. 1 subject (the painter who first became unconscious) elected not to work in a confined space.

Protective Devices

In theory, the full-face respirator with an all-purpose organic vapor canister attachment should give adequate protection for a period

TABLE 1.—Results of Tests

Time	Situation	Trichloroethylene in Air, ppm	% Oxygen
11.35 a.m.	Center, bottom of tank	1,905	Not done
11.45 a.m.	" " "	2,800	"
12.20 p.m.	" " "	2,800	20.5
12.45 p.m.	At manhole, inside tank	1,714	Not done
1.10 p.m.	Center, bottom of tank	3,310	20.5
1.20 p.m.	Far end of tank	3,230	Not done

TABLE 2.—Trichloroacetic Acid Estimations

Days After Accident	Subject	Trichloroacetic Acid in Urine, Mg. per Liter
1	No. 1	55
	No. 2	37
2	No. 1	*
	No. 2	187
7	No. 1	37
	No. 2	75
11	No. 1	4.5
	No. 2	24.5
	No. 3 (substitute)	3.5

* Not obtained; on leave due to back injury.

of at least one-half hour in an atmosphere containing 1% trichloroethylene, at a rate of 16 liters per minute.³ The respirator was tested after the accident by passing trichloroethylene at a concentration of 0.3% through the canister. Complete absorption occurred, indicating that the canister was still effective.

In practice, its use could be attended by difficulty due to misting of the goggles and restriction of head and neck movement in a confined space. Because of this, early intoxication of both operators may have occurred due either to the removal of the facepiece or to the fact that it was ill-fitting.

An air-supply respirator should be worn to avoid such mishaps. Furthermore, as the use of protective equipment is subject to human error, respiratory protection should be regarded as a last resort, and every effort should be made to reduce the vapor concentration from a toxic to a safe level by the use of nontoxic substitute solvents.

Comment

According to McCord (1932), the narcotic action of trichloroethylene appears at a concentration of about 10,000 ppm.⁴ L. T. Fairhall (1957) is less specific and states that severe narcosis is produced only by high concentrations and prolonged exposure.⁵

In this accident, both men suffered acute unconsciousness, following 2 hours of earlier exposure and mild intoxication, after which they reentered an atmosphere containing an estimated 3,000 ppm of trichloroethylene. In one instance unconsciousness occurred after

working about 10 minutes; in the case of the second employee unconsciousness apparently occurred immediately as he entered the tank in the second occasion.

Conclusions

1. Under certain conditions at least, the narcotic action of trichloroethylene can cause acute unconsciousness in concentrations much lower than the generally accepted level of 10,000 ppm.⁴

2. Acute unconsciousness can result from the inhalation of trichloroethylene in a concentration of 3,000 ppm if the subject has had an immediate earlier exposure resulting in a mild intoxication.

3. This could explain the almost instant unconsciousness which has occurred when degreasing tank operators have entered a tank for some purpose.

4. No prodromal symptoms were described, so no warning is received by a subject that unconsciousness is imminent.

5. The accident described further underlines the necessity to wear a safety rope when entering a confined space. In this case, this precaution had been neglected.

6. Ahlmark and Frossman² have intimated that a limit of tolerance of trichloroacetic acid in urine be fixed at 20 mg. per liter. They also state that effects occur in about half of the persons excreting 40-75 mg. per liter and in almost all those excreting 100 mg. or more. Levels of trichloroacetic acid in urine have been observed by us, in subjects chronically exposed as high as 310 mg. per liter, and apart from some headache these subjects had no complaints. After unconsciousness, urinary trichloroacetic acid levels of the 2 men were 55 and 37 mg. per

liter 24 hours after the accident, and in one case the level had risen to 187 mg. per liter 48 hours after the accident. This suggests a degree of tolerance in those chronically exposed.

Summary

Two cases of acute unconsciousness due to trichloroethylene at an estimated breathing zone concentration of 3,000 parts per million are described. This concentration is consistently lower than previously quoted figures.

Two painters working inside a large tank and using paint containing trichloroethylene solvent, were found unconscious. Both became mildly intoxicated during their first 4 hours of work and had left the tank to recover in the fresh air. Reentry into the tank was followed by acute unconsciousness, in one case almost instantaneous.

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Respiratory Chlorinatec

Introduction

Cotton is the main harvest during the summer months, insect all over the country to control worm. Various degrees of reaction have been observed as a result of exposure to different insecticides: rotenone, nicotine, Lethanes tetrachlorodiphenylethane (T) and the organic phosphates, phosphate (TEPP) and O, nitrophenyl thiophosphate (T).

The purpose of this paper is to describe cases of acute bronchiolitis with shadows following heavy exposure to chlorinated camphene sprays. To this is the first time such lesions have been reported in agricultural work with this chemical.

Report of Cases

CASE 1.—A 43-year-old white male with a chief complaint of onset associated with vague pain in the chest region. He also complained of fatigue for the last 2 months. He was heavily exposed to chlorinated camphene spray in the previous 4 years by using other insecticides. The patient denied any important chest disease before the finding of asthma or allergy in his family history.

Physical examination Aug. 19, 1956, well-developed, well-nourished.

Submitted for publication June 1956. Assistant Professor of Chemistry, Shams University.

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