

from exposure to any toxic material throughout this large plant.

Chlorinated Naphthalenes and Diphenyls

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THE chlorinated naphthalenes comprise a group of chemical substances made by the addition of various amounts of chlorine to a naphthalene base. The amount of chlorine may vary from three to six or possibly more atoms providing compounds from trichloronaphthalene to hexachloronaphthalene.

In the same manner, the varying amounts of chlorine are added to a diphenyl base providing a group of compounds of varying chlorine content.

As a rule, the final substances, as used in industry, are mixtures of differing chlorinated naphthalenes. Earlier, these were, as a rule, possessed of a lower degree of chlorination and later on the compounds were usually of a higher degree of chlorination with varying amounts of chlorinated diphenyls added thereto.

These substances are not new. Perchlornaphthalene was used in Germany during the last war.

It is to be clearly understood that these groups of compounds are not manufactured by any one company but rather by approximately five in the United States, and they are sold under varying trade names by the manufacturers.

The chlorinated naphthalenes and diphenyls are valuable industrial products. Because of certain properties which they possess, we may briefly state these valuable properties as follows:

1. Resistance to water and alkali.
2. High insulating value. They possess high dielectric constant.
3. Thermo plasticity.
4. Quite stable chemically.
5. Flame resistant.

For these reasons, these substances possess much value industrially in the making of electric condensers, and in the insulation of wire and cable, etc.

Method of Use in Industry

THE chlorinated naphthalenes and diphenyls are used in industry by two methods:

1. A cold method in which the material is dissolved in a solvent usually a mixture of petroleum naphtha and toluene, and
2. A hot method wherein the material is rendered plastic by heat.

Toxic Effects

IN THE United States, the first three cases of acne produced by chlorinated naphthalenes were reported by Sulzberger¹ and his co-workers in 1934. Fulton and Matthews,² of the Pennsylvania Department of Labor, reported 101 cases of dermatitis in a wire insulating plant in 1936.

In 1936, Dr. Louis Schwartz,³ of the United States Public Health Service, described cases of acne produced by chlordinophenyls, and in the same year, Jones and Alden⁴ reported similar findings.

In 1938, Mayers and Silverberg described acneform skin eruptions in workers making electrical condensers.⁵

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In general, it can be said with a fair measure of certainty that these changes are brought about to the skin, primarily by the contact of the skin with the vapors of these compounds, or by actual contact with them in the form of solid or particulate matter. We have found, for example, that workers exposed to these fumes have more acne than those exposed to the solid material or its particulate form have developed dermatitis. In this connection, the report of Fulton and Matthews is very interesting. They report and describe a case of an infant, 2½ years of age, who developed the dermatitis as a result of contact with soiled working clothes of its father who was in the habit of playing with the child prior to changing his clothing.

More recently, Schwartz⁶ has described cases of dermatitis among cable strippers employed at building establishments and working with cables which had been impregnated with these compounds.

Systemic Effects

IN THE United States, systemic effects in the form of acute yellow atrophy of the liver were reported by Flinn and Jarvik⁷ in 1936 among men working with tetra and pentachloronaphthalene. These findings were verified by animal experimentation. In 1937, Driehs, Warren and Bennett⁸ reported such liver changes among animals exposed to the material by inhalation and similar findings were obtained with the chlorinated diphenyl compounds. These latter authors also reported four non-fatal cases among humans and the three fatal cases previously cited by Flinn and Jarvik.

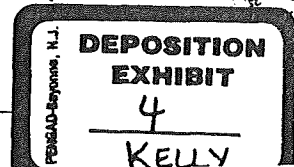
I should like to cite two or three cases which we have encountered in our own experience and which may be of interest from the point of view of duration of exposure prior to this type of poisoning. A girl 17 years of age was engaged in soldering electrical condensers which were impregnated with tri- and tetra-chloronaphthalene for a period of approximately three months. The autopsy for this case showed mild to severe degeneration of the liver and presented a clear picture of what is generally known as acute yellow atrophy. It was apparent in this case that the latter organ displayed areas of healing and new areas of pathology.

In the second case, a man 24 years of age developed jaundice after five months of exposure in the coating of wires with wax containing the higher chlorinated naphthalenes. He was away from work for a period of time and four months later the jaundice became quite intense, with general malaise and loss of appetite. After two months more of work he was sent to the hospital, where he rather rapidly passed away. The autopsy in this case showed extensive areas of necrosis and fibrosis of the liver with regeneration.

In a third case, published by Drs. Mayers and Smith,¹⁰ of the staff of the New York State Department of Labor, an 18 year old girl became ill after five months of exposure in the soldering of electrical condensers. The waxes in this case were composed principally of trichloronaphthalene. She was hospitalized and recovered after a long and slow period of convalescence.

Recent Industrial Experience

DURING the past year the Division of Industrial Hygiene of the New York State Department of Labor has conducted an investigation in two cable plants using chlorinated naphthalenes and diphenyls. In this



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among workers in the industry.

The examination of workers in the two factories showed relatively few cases of enlarged liver—five in all, on palpation.

Comparison in these two plants showed a very much higher incidence of acneform dermatitis in one of the plants as compared with the other; namely 21% as compared with 60%, the former being in the cold process establishment and the latter being in the establishment employing the hot process only. The dermatitis appeared to take place on the average in about 7½ months in the hot process plant as compared with 10 months in the cold process plant.

Conclusions

AS A RESULT of our general re-study of this whole problem and our experience in two recent outbreaks, as well as several isolated experiences we desire to draw several basic conclusions:

1. Chlorinated naphthalenes and diphenyls are in general highly toxic compounds and must be used with extreme care. Industrial hygienists should make every effort to see that such exposures are controlled, in so far as humanly possible. In this effort, we do not believe it safe to rely on limiting atmospheric concentrations but rather to depend on a maximum of maintenance and engineering control.

2. Toxic exposures may be more readily controlled where the cold or solvent method of impregnating cable is employed than where the hot process is used.

3. Of the known cases of liver disease in our experience, the available history and experience generally points to exposure to vapors or fumes from the hot process. There is no clear evidence in our experience, although it is possible that skin absorption may produce systemic poisoning. Physiologically we see no reason why this is not possible. However, most dermatitis cases do not develop liver damage.

Finally, I should like to call attention to a group of recommendations which were agreed upon by all of the groups involved in the last outbreaks of poisoning as being of utmost importance in control of this hazard.

Recommendations

UNLESS there is a very good reason for using the hot method of impregnation all new installations should use the cold or solvent method of impregnation with chlorinated naphthalenes and diphenyls. Where the hot method is now being used it should be changed over to cold, if possible, or surrounded with every known protective measure.

2. General hygienic measures should be followed, but in no case should these be allowed to supersede engineering control of the primary source of the exposure, the operations in the plant.

The following hygienic measures may be considered good practice where these compounds are handled.

- (a) Two lockers for each worker exposed to chlorinated waxes (one for working and one for street clothes).

- (b) All work clothes above the underwear should be provided and laundered at least twice a week by the management.

- (c) The workers should change to clean underwear at the end of each shift before getting into his street clothes.

- (d) Supervised cleaning: (1) At noon the workers should remove outer clothing and scrub hands and face under supervision. (2) At the end of the shift they should be required to take a supervised shower before changing back to street clothes.

tion of the foreman, nurse, medical, or plant superintendent.

- (f) All departments handling chlorinated synthetic waxes should be thoroughly cleaned according to a prearranged schedule. This should include the removal of all deposits of waxy material from the machines, floors and surrounding objects. Workers doing the cleaning should be provided with protective clothing and supplied air or organic vapor masks where exhaust ventilation is inadequate or not possible.

3. The foremen of all departments where this material is handled should be apprised of the toxic nature of the material and instructed in safe handling procedures. These men should make it their duty to check up on the workers in their departments and instruct them in safe practice.

4. Pre-employment and periodic physical examinations should be made of all exposed workers. These should include the taking of a full clinical history, with special emphasis on gastro-intestinal disturbances and dermatitis. In addition, the skin should be carefully examined periodically and the more reliable liver function tests performed. Gastro-intestinal complaints developing in a worker at any time should be a signal for an immediate medical check-up. A history of liver disease, jaundice, or antisyphilitic treatment should automatically exclude a worker from jobs involving a possible toxic exposure. Pregnant women should not be employed where there is a possible exposure to the synthetic chlorinated waxes.

5. Engineering control of plant operations cannot be overemphasized but specific recommendations are not applicable to all cases. It would be wise for a plant using this class of materials to check their control measures with the state industrial hygiene agency, the insurance carrier and some competent consultant before occupational disease occurs.

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Abstract of Discussion

MANFRED BOWDITCH (Boston): A few issues ago an article appeared in the *Journal of the American Medical Association* dealing with that subject of cable wire treating. One of the two authors is here; he might say a word or two on that subject.

DR. IRVING R. TABERSHAW (Boston): Those were experiments to remove wax from the skin, and, as you know, it is practically impossible to get off. DR. GREENBURG mentioned scrubbing, but that doesn't do it. As a matter of fact, workers themselves have attempted everything, even washing their faces with ether and using the harshest abrasive soaps.