

SKIN CONDITIONS RESULTING FROM EXPOSURE TO CERTAIN CHLORINATED HYDROCARBONS*

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FOR a number of years there has been sporadic interest in the occurrence of a rather characteristic acneform eruption in workers handling the chlorinated naphthalenes† and diphenyls. Manufacturers of these substances recognized this condition among workers in their factories years ago, and found that the cases could be materially reduced or even completely eliminated by the introduction of adequate ventilation and by the practice of good personal hygiene on the part of their employees.

During the World War when perchloronaphthalene suddenly began to be used in quantity in Germany under the name of "Perna" as a substitute for resin and rubber, large numbers of workers contracted this

type of skin eruption. It was again found that improvement in hygienic conditions in the factory immediately reflected itself in a reduction in the incidence of this disease. German experience along these lines was, however, interrupted when the war came to a close. Since that time, however, there has been a growing demand in industry for the chlorinated naphthalenes and diphenyls wherever resistance to heat and moisture are essential, as for example in the insulation of wire or the manufacture of electrical condensers. Their heat and moisture-resisting properties, together with the fact that they are non-inflammable, appear to give these materials a unique place among the substances now available for such purposes.

In New York State a number of cases of skin eruptions occurring in workers engaged in the manufacture of electrical condensers have from time to time come to the attention of the Department of Labor, either in sporadic reports or because the workers applied for compensation. In following up these cases it was found that while many of the eruptions ap-

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peared to be very disabling or serious, were very severe even involving the skin and causing disfigurement as tissue formation. Infection was also a serious complication further revealing that relatively few physicians were sufficiently familiar with this disease to entitle them to pronounce the condition. It was not always recognized and applied to their treatment. Not only was it to be misdirected under these conditions, but it was permitted to these substances exposure is definitely because of hypersensitivity.

It was for the present study was an occupational disease potentially which relatively medically. Never reason to believe satisfactorily control measures. It was the use of these State of New York survey was made plants employing their manufacture of these plants and the remaining condensers. The don, and their fully appraised workers inspected

* Received for publication December 23, 1937.

† The chlorinated naphthalenes are sometimes referred to as "Halowax" by purchasers and users. While the Halowax Corporation manufactures these substances, it also manufactures many others. The term "halowax" is merely a trade name for substances manufactured by this company and should not be used indiscriminately. In all instances substances should be designated by their chemical names only.

in some detail. These waxes, it was learned by personal communication with the authors were chlorinated naphthalenes.* The fact that one of us (M.G.S.) had the opportunity to examine these cases at the time proved an added stimulus to the present investigation.

Another illuminating contribution along these lines was a bulletin from the Pennsylvania Department of Industry and Labor in 1936, in which Fulton and Matthews (2) presented the results of a study of 101 cases of dermatitis which occurred in a wire insulating plant in their State. In addition to describing the lesions as they found them, they showed that it is possible for a worker suffering from this type of dermatitis to transfer the skin disease to other members of his family through intimate contact with the clothing worn in the factory. Through the courtesy of Dr. Fulton, the authors had the opportunity to see one such worker, his wife and two children, one a young baby, who were all affected by contact with him and his clothes when he came home from work.

As long ago as 1899 Herxheimer (3) accused the halogen, chlorine, of being the direct cause of acne, coining the word "chloracne." Considerable attention was thereafter concentrated on chlorinated substances as the cause of acne. However, it gradually came to be felt that it was not the chlorine that was responsible but that a chlorinated hydrocarbon was to blame in most cases. Tar, mineral oil, vaseline, paraffin and similar hydrocarbons have long been recognized as causative

agents in follicular and acneiform eruptions.

The use of a chlorinated naphthalene known in Germany as "Perna" had already been mentioned. When this material came into use again after the war, Teleky (4) described many cases of skin eruptions that were observed during the years 1928-1930. Improvement in hygienic conditions in the factory appeared to be the key in controlling this disease. In Teleky's final conclusion that the deciding factor as to the potency of any particular chlorinated wax in causing acneiform dermatoses depended not so much on its chlorine content as upon the amount of unbound or loosely bound chlorine that it contained. A method was subsequently introduced and patented for so treating the chlorinated naphthalene as to remove all loosely bound chlorine. It was believed that the incidence of acne in workers exposed to this material was greatly reduced thereby.

Courtois-Suffit, Touraine and Ménérel (5) in 1934 drew attention to this condition in France in an admirable paper in which they pointed out that the coal products that are most apt to give rise to lesions of the pilo-sebaceous apparatus are those of the second distillation fraction. These writers noted erythematous and vesiculo-edematous symptoms in their workers as well as the acneiform type. They believed that seborrhea was a predisposing factor and reported that patch tests with the chlorinated waxes were negative in all cases.

In 1935, Jones and Alden (6) of Atlanta, reported their observations concerning industrial skin eruptions of an acneiform type in workers and

engaged in the manufacture of chlorinated diphenyls. It was noted that the eruptions were due to impurities rather than to the chemicals themselves.

Schwartz (7) in a report published in *Synthetic Waxes* in 1936 confirmed the results of other investigators with these substances and gave negative results.

The literature with reference to possible systemic effects of these chemicals is sufficiently pertinent to the present investigation to be discussed briefly.

CHEMISTRY AND TOXICOLOGY
The chlorinated naphthalenes are a series of compounds in which one or more hydrogen atoms has been replaced by chlorine. Thus, there are monochlorinated naphthalenes, dichlorinated naphthalenes, up to the octochlorinated naphthalenes. The monochlorinated naphthalenes are commercially, however, rare, each of which has more than one of the isomers. The so-called "Perna" is a mixture of the tri- and tetra-chlorinated naphthalenes, for example, which are commonly used for the manufacture of condensers, in the production of both the tri and tetra-chlorinated naphthalenes. Similarly the higher chlorinated naphthalenes may be used in various ways. The tetra, penta, and hexachlorinated naphthalenes are so used in combination with diphenyls.

Generally speaking, the higher the degree of chlorination, the higher the boiling point of the wax and the more difficult it becomes. Since heat and moisture are

* Personal communication from Dr. M. Sulzberger.

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Schwartz (7) in a report on "Dermatosis from Synthetic Resins and Waxes" in 1936 confirmed the reports of other investigators that patch tests with these substances regularly gave negative results.

The literature with reference to the systemic effects from exposure to these chemicals is not considered particularly pertinent to the present investigation to be discussed here.

CHEMISTRY AND TOXICOLOGY

Chlorinated naphthalene is a naphthalene in which one or more of the hydrogen atoms has been replaced by chlorine. Thus, there are many chlorinated naphthalenes beginning with the monochloronaphthalene and ending with the octochlor derivative.

Chlorinated naphthalenes as used commercially, however, are usually

each of which contains one of the chlorine derivatives. The so-called trichloronaphthalene, for example, which is most

commonly used for the impregnation of condensers, in reality contains

the tri and tetra derivatives. The higher chloronaphthalenes are used in various combinations.

The tri, tetra, penta, and hexachloronaphthalenes are sometimes used in combination with chlorinated

phenyls. Generally speaking the higher the chlorination, the higher is the melting point of the wax and the more water-

resistant becomes. Since resistance to heat and moisture are the outstanding

characteristics of these materials, the higher chlorinations are in great demand commercially. Unfortunately, however, the higher the chlorination of the naphthalene, the more toxic does it become. That is the dilemma which manufacturers of these products are working hard to solve.

Diphenyls are manufactured by passing benzene through molten lead so that C_6H_6 is converted into $C_{12}H_{10}$. Chlorine is then bubbled through, displacing one or more of the hydrogen atoms and forming substitution products ranging from the monochlorodiphenyl to the decachlorodiphenyl, all of the hydrogen atoms having finally been displaced ($C_{12}Cl_{10}$).

THE PROCESS OF MANUFACTURE

The manufacture of electrical condensers is not carried out in exactly the same way in all factories, but it usually follows the same general lines, depending upon whether the condensers manufactured are of the so-called "Inductive" or "Non-inductive" types.

Winding and soldering.—In making inductive condensers, long ribbons of paper alternating with tinfoil (three sheets of paper with two of tinfoil) are rolled on small spools by winding machines. When the winding is completed the paper is seen to extend out beyond the tinfoil. In this type of condenser ingoing and outgoing metal leads are introduced at right angles to the direction of the winding and the condenser is then impregnated. In finishing condensers of this type, a wire is soldered to each lead by means of a soldering iron.

In winding non-inductive condensers, the tinfoil strips are wider

than the strips of paper, so that when the winding on the spool is completed, the tinfoil extends beyond the paper. Sometimes aluminum foil is used instead of tinfoil. No leads are introduced after impregnation. The soldering of these condensers is done by passing the tin or aluminum foil portions over a hot plate, using a stick of solder to solder on the wires. This process gives off far more fumes than does the soldering of the inductive condensers above described.

Impregnation—After the spools are wound they are placed in wire baskets, several dozen to the basket, which are subsequently put into an enclosed oven in which they are impregnated with one of the chlorinated hydrocarbons. The one most commonly used for this purpose is a combination of trichlor and tetrachlor-naphthalene, a wax-like material heated to a temperature of 248–258° F. After impregnation, the oven is opened, the basket of condensers is removed and immersed in an open vat usually containing mineral oil.

Finishing operation—The basket of condensers is then transferred to a so-called finishing department where workers, mostly young girls, sit at long tables and perform various finishing operations, including what are known as sealing operations and the soldering of metal parts to the condensers.

The sealing of condensers may be done either by dipping them into a small pot containing a molten sealing compound, or by pouring such a molten compound into them. In many plants, including the two which were selected for special study, a pitch preparation was poured into the

condensers to seal them. This did not contain any chlorinated naphthalene. Since this latter material is difficult to pour in the ordinary way because of the ease with which it solidifies on cooling, it is more customary in using this wax to dip the condensers into a pot in which the chlorinated naphthalene is kept at a proper temperature. When it is desired, however, to pour molten chlorinated naphthalene into condensers, an especially designed small closed tank is used, in which the chlorinated naphthalene is kept at a proper temperature. When a key is pressed the molten wax drops from the tank into the condenser. The highly chlorinated naphthalenes are used in these operations.

The soldering operations have
ready been mentioned.

In handling the condensers in finishing rooms, there is constant contact of the hands with the chlorinated naphthalene in its cold wax state, usually somewhat moistened with mineral oil.

All workers engaged in testing finished condensers or employed in any other processes carried on in the "finishing room" are apt to be directly exposed to the vapors of the chlorinated naphthalenes given off in the soldering and sealing operations unless the ventilation of the room as a whole is adequate.

EXAMINATION OF WORKERS

In the present investigation, two plants in which a mixture of tri- and tetra-chloronaphthalene was employed in impregnating condensers were studied, and 31 workers examined. All of these workers were employed in the

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to seal them. This did not prevent any chlorinated naphthalene from being poured since this latter material is poured in the ordinary way with the ease with which, on cooling, it is more easily using this wax to dip into a pot in which the naphthalene is kept at a low temperature. When it is desired, however, to pour molten chlorinated naphthalene into condensers, a specially designed small closed container in which the chlorinated naphthalene is kept at a proper temperature. When a key is pressed, the wax drops from the container into the condenser. The high-boiling naphthalenes are used in the following operations having been mentioned.

When the condensers in the work rooms, there is considerable contact of the hands with the chlorinated naphthalene in its cold state, which is usually somewhat moistened with mineral oil.

Workers engaged in testing the condensers or employed in the processes carried on in the "work room" are apt to be exposed to the vapors of the chlorinated naphthalenes given off during the covering and sealing operations. Adequate ventilation of the room is required.

EXAMINATION OF WORKERS

In the present investigation, 111 workers were examined, of which a mixture of tri- and tetra-chlorinated naphthalene was employed. The sealing condensers were still in use.

called "finishing departments" where exposure to the material resulted from flaming the impregnated garments or otherwise causing a volatilization of the wax.

Age and duration of employment—The ages of the workers and the length of time that they had been employed in the same plant at the time the process are presented in the following tables:

	Number of workers
Less than 25 years	26
25-30	4
30-40	1
Over 40	0
Total	31

Duration of Employment:

Less than 6 months	11
6 months to 1 year	4
1 to 2 years	15
2 years and over	1
Total	31

In examining the workers the following data were taken in each case in addition to age, (2) sex, (3) process at which the worker was engaged, (4) duration of employment before rash appeared, (5) duration of rash, (6) total area of rash, (7) family history of acne vulgaris, (8) personal history of acne vulgaris, (9) family history of dermatitis venenata, and other allergic eruptions, (10) whether work with chlorinated naphthalene was continued without interruption or permanently discontinued at the onset of the skin eruption.

Examination—The skin of the workers was fully examined and finally photographs were applied with the following substances: (1) potassium bromide 25% in anhydrous lanolin, (2)

potassium bromide 25% in anhydrous lanolin, (3) sodium chloride 25% and 50% in anhydrous lanolin, (4) naphthalene, and (5) mineral oil in use in the factories, with (6) anhydrous lanolin and (7) ammoniated mercury ointment 5%, as controls.

Dermatological Observations

From an analysis of the observations made, the skin conditions appeared to fall into three main categories, as follows:

1. Acneform eruptions with pustules, papules and large comedones.
2. Vesiculo-erythematous eruptions usually observed in dermatitis venenata.
3. Simple erythematous eruptions with pruritis.

In addition, localized dry scaling patches of dermatitis were observed in cases presenting any of the three types of eruptions listed. These patches were never a prominent part of the picture, and were never seen in the absence of one or another type of eruption mentioned. They were less than 5 cm. in diameter, and occurred on the face, neck or arms. Such scaling patches are often associated in the lay mind with eczema, and are frequently seen in all types of patients who complain of any of the longstanding itching dermatoses. They are sometimes at least secondary to friction applied for relief of the itching.

I. *Acneform Eruptions.*

To the uninitiated the acne which is seen among workers in this industry, and acne vulgaris look very much alike. Their clinical differentiation will be considered later.

Severe cases—Among the 31 workers whose skins were carefully examined in the present series, there were six (4 females and 2 males) with marked acneform eruptions, showing pustules, papules and large comedones. One had a coexistent dermatitis venenata and was suffering from paronychia, involving the index fingers especially.

* There is an unconfirmed belief among employees in this industry that blondes are more susceptible to skin irritation than brunettes, so that the latter are usually selected for employment whenever possible.

Mild cases—In four cases the eruption was discernible but so slight that its presence was noted but not regarded as significant. Along with a few pinpoint papules or scattered comedones on the face there were found a few pinpoint papules surrounding hair follicles around the elbows or on the extensor surfaces of the arms. In none of these cases was there any pruritus. In some instances there was an apparent aggravation of a pre-existing very mild acne vulgaris. The eruption was so mild in these cases that one hesitated to make a definite diagnosis. The distribution of the lesions, however, more than anything else, tended to

Description of the lesions.—31 workers examined had a very severe acneiform eruption. In these cases the lesions pinpointed to peripheral areas or slightly pinpointed, distinctly perifollicular, surrounding large comedones. There was an area of closely grouped comedones could be seen. The surrounding reactive skin a black spot, although pustulation or not, a prominent feature. Occasionally there were some small blotchy areas present or scaly itching. The workers themselves were impressed with the itching, so that the latter aptly characterizes the "blackhead itch". They seem to have the character of the

se of one young girl examined. The acneform eruption was so long had persisted for so long in the deep layers of the skin, the me involved; and though receiving excellent treatment, marked scarring of the resulting permanent facial ent.

Investigation in the case of one contracted a severe acneform eruption in one of the plant out who was not present. plant examinations were so is not one of the series reported, revealed the site of an itching acneform on the cheek, a furuncle. er aspect of the cheek, which, probably due to infection from scratching, eczema and resulted in the tendency for this type eruption to develop pustules go on to abscess formation recognized and reported ure.

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express a differentiation of these skin findings from a true acne vulgaris.

Distribution of the eruption—The eruption appeared principally on the face and neck and the extensor surfaces of the arms. Sometimes the hands were also involved, and very occasionally the chest, back and inner surfaces of the legs. The forehead, cheeks and chin were most involved, the line along the jaw being a site of special predilection. The eruption appeared more often than elsewhere, and had a marked tendency to persist after it had cleared up elsewhere. It was striking that the nose was always spared. The importance of the distribution of the eruption as a means of differentiating it from acne vulgaris will be subsequently discussed.

Description of the lesions—Six of the workers examined suffered from very severe acneform eruptions. In these cases the lesions were pinpoint to pea size, yellowish or slightly pinkish papules, distinctly perifollicular and surrounded by large comedones. Some of the area of closely packed large comedones could be seen without surrounding reaction. This gave the face a black spotty appearance. If pustulation occurred, it was a prominent feature in these cases. Occasionally there were also small blotchy areas of erythema and/or scaly itching patches.

The workers themselves were especially impressed with the comedones and the itching, so that the rash was aptly characterized by them as the "blackhead itch"—a term which they seem to have coined. The primary character of the eruption was

mentioned by Fulton, but has not been greatly stressed in the literature as a whole. Though not a constant finding it is an important diagnostic sign when present because acneform eruptions as a group are not usually associated with pruritus. Acne vulgaris seldom itches. Four of the workers in this group complained of intense itching.

In one very severe case, the acneform eruption was associated with a dermatitis venenata, and a paronychia which persisted long after the eruption had disappeared. This case will be mentioned later.

Period of exposure preceding eruption—The period of employment before the acneform rash appeared varied from a few weeks to a little less than 1½ years. On the whole cases tended to be more numerous in the summer. On removal from exposure the rash tended to disappear in 2 or 3 months, though in very severe cases it apparently may persist for a much longer period of time.

Family predisposition—Though the cases were few, it was noted with some interest that there appeared to be a family predisposition to exposure to the chlorinated naphthalenes which was not apparently based on a susceptibility to acne vulgaris. For example, three of the workers who were suffering from severe acneform eruptions had sisters or brothers who had had to give up that type of work because of serious skin eruptions. Two of these workers, both girls from two different families, each had two brothers so affected. One of these families was using iodized salt at home because the mother was suffering from goitre. This may have supple-

mented the occupational hazard in that family, but the fact remained that no member of the family had ever suffered from acne vulgaris, as far as could be determined, and that all three who began working in the condenser plant developed a very severe type of skin eruption—so severe in the case of two of them that they had to go into some other type of work. Both recovered satisfactorily after exposure ceased. In the other family there was no history of the ingestion of iodides or bromides and yet three members in turn were forced to discontinue work in the plant because of severe acneform eruptions. Here again, there was no history of acne vulgaris in the family. The family where iodized salt was being used appeared to have a very poor standard of personal cleanliness, but in the other family a high standard of personal cleanliness was observed.

Differential diagnosis from acne vulgaris—In the severe cases, there is usually little or no difficulty in differentiating these conditions. In the milder ones, however, the diagnosis is apt to be more difficult. Certain points of differentiation are helpful, however. When present, the intense pruritus, for example, is of great importance, since this is seldom found in cases of true acne vulgaris. The prominence of comedones in workers exposed to the chlorinated naphthalenes, and the frequency with which these comedones may be seen crowded together, is so striking as to suggest definitely this type of acneform eruption rather than acne vulgaris.

The distribution of the lesions tends to throw further light on the differential diagnosis. The distribution

along the extensor surfaces of the arms, and particularly around the elbows; and its predilection for the area along the whole length of the mandible is not characteristic of acne vulgaris. Furthermore, the back, which is an important site of predilection for acne vulgaris, was often involved in the workers examined. Lesions may also be observed on the legs and abdomen along the belt line, or other areas where there is friction from clothing, sites not usually involved in acne vulgaris.

II. Vesiculo-Erythematous Eruption

One worker, in addition to having a severe acneform eruption, suffered from a weeping vesiculo-erythematous eruption of the dermatitis venerea type. The eruption had a widespread distribution on the face, neck, arms, and trunk. It began about 6 months after starting work with the chlorinated naphthalenes and cleared within a month after exposure was permanently discontinued. The worker returned to work in the same plant and was given a job in a department where she would not come into further contact with the substances to which she was sensitive. Nevertheless, she continued to complain of recurrent attacks of moderately severe itching. This case, among others, showed chronic paronychia involving both index fingers which was extremely persistent.

III. Simple Erythematous Reactions

Two of the workers examined were found to be suffering from what appeared to be a simple erythematous eruption with severe itching. This appeared mainly on the face and

chest, though in one case it could also be seen on the extremities. There was no typical acneform eruption in these cases.

In one of the cases the eruption appeared twice—once 6 months and again 1 year after beginning employment—each time clearing up within a few weeks. In the second case the eruption made its appearance after beginning employment with a duration of about 1 week.

In both cases the eruption involved the face, neck, and extensor surfaces of the arms; a severe pruritus was complained of by the workers. The time of the eruption was intermittent attack after the eruption subsided.

Patch tests—As was to be expected in these acneform cases, all patch tests performed with the chlorinated naphthalenes in this series gave a negative result. This is in accord with the experience of workers including Louis Schwartz of the U. S. Public Health Service.

In the case which was associated with a dermatitis venerea, patch tests with the triiodo and tetrachloro naphthalene (to which the worker was exposed) was positive, but the patch tests with the potassium iodide, 25% potassium iodide, and the 5% ammonium iodide were negative. In other words, this worker apparently had no sensitivity. The substances to which she had worked were one of many substances which are known to be hypersensitive.

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In both cases the erythema involved the face, neck and extensor surfaces of the arms; and was associated with a severe pruritus. Both workers complained not only of itching at the time of the eruption, but also of intermittent attacks of itching after the eruption was no longer present.

Patch tests—As was anticipated in the acneform cases, all of the patch tests performed with the chlorinated naphthalenes in this series gave essentially negative results. This was in accord with the experience of previously reported workers including that of Dr. J. H. Schwartz of the United States Public Health Service.

The case which was associated with the dermatitis venenata the patch tests with the tri and tetrachloronaphthalenes (to which the worker was exposed) was positive, as were also the patch tests with the 25% potassium iodide, 25% potassium bromide and the 5% ammoniated mercury. In other words, this worker when exposed apparently had a polyvalent hypersensitivity. The substance with which she had worked was thus only one of many substances to which she was hypersensitive.

Of the two workers who had a

simple erythematous eruption, one refused to be patch tested, and the other was negative.

Mechanism of acne production—Because of the resemblance between the acneform lesions found among these workers and acne vulgaris, the question arose as to whether the same mechanism might not be operative in both conditions. If this were so, one might expect the sporadic cases to break out in those individuals who had already suffered from attacks of acne vulgaris or in whose families there was a predisposition to such a condition. A careful examination of the evidence in this series of cases did not, however, appear to support this conclusion although a more extensive series might throw additional light on the question.

The further question suggested itself as to whether or not a relationship might exist between hypersusceptibility to the chlorinated naphthalenes and a general hypersensitivity to members of the halogen group generally, such as, for example, the iodides, or the bromides. That these latter substances are frequent causes of acneform eruption is well known. The relation of chlorides to the other halogens in these conditions is not entirely clear. It is of interest to note, in this connection, that the chlorides are at present being prescribed by ingestion and injection in cases of iodide or bromide poisoning with a view to mobilizing the other halogens.

Sulzberger, Rostenberg and Sher, as well as other writers, have felt that acne vulgaris may occur as a result of a hypersusceptibility of the pilo-sebaceous system to stimuli ema-

nating from specific circulating endocrine substances. A hypersusceptibility to potassium iodide, if clearly demonstrated by patch tests, might indicate that such individuals had an especially labile pilo-sebaceous system, easily responsive to a number of common insults to the pilo-sebaceous apparatus. It might on the other hand indicate a specific response to insults from members of the halogen family.

Because of these theoretical considerations, all cases studied were patch-tested with an ointment of potassium iodide, and an ointment of potassium bromide. Though the patch tests seemed to indicate a slight increase in susceptibility to these substances among the workers with the acneform eruptions, unfortunately, none of the reactions were sufficiently strong to warrant any definite conclusions on this point.

There is still a question whether the eruption here discussed is due to mechanical plugging of the sebaceous glands in the skin, or whether the sebaceous glands are overstimulated either when end products are circulating in the blood or are being excreted by the skin after absorption of the waxes by the body. That these substances are not excreted unchanged by the skin has recently been demonstrated by feeding experiments conducted by Dr. Cecil Drinker.* He found no increase in the chlorine content of the skin of rats who had been fed toxic amounts of the higher chlorinated naphthalenes. As a final point in relation to the skin lesions, it may be pointed out that no correla-

tion existed between these lesions and systemic effects of any sort. This failure to connect skin and possible liver lesions corroborates the experience of others.

PREVENTION

The process of impregnating electrical condensers has always presented so obvious a health hazard that all effort in the past to protect workers in this industry from injurious exposure to fumes and vapors of the chlorinated naphthalenes has been concentrated at this point. In the early days, condensers were impregnated in the general workroom. The covered pots were sometimes used for this purpose and everyone in the plant was more or less exposed to vapors vapors were given off. The incidence of skin eruptions was high. Nowadays, the impregnating rooms in these plants are completely separated from all other workrooms; the ovens are, with few exceptions, tightly constructed and well covered; and the incidence of skin eruptions has dropped so low that one rarely sees a case in this department.

It is the very innocuous looking finishing departments which are responsible for most of the cases of skin eruptions one sees. In the dipping, pouring and soldering operations the chlorinated naphthalenes are volatilized by heating or flaming. Because the fumes are given off in relatively small amounts from a great many different points in the workroom, their importance as a health hazard is apt to escape the attention of the casual observer. Consequently no concerted effort is usually made to correct this situation.

While each plant has its own ventilating problems, a special study, the following principles are applicable and should be carefully adhered to.

Impregnation of Condensers

All impregnating ovens should be enclosed and tightly covered so that no vapors may escape through leakage.

Each oven should be provided with a hood and equipped with exhaust ventilation so that when the door is opened the vapors may be immediately removed from their source. A velocity of 1000 f.p.m. is recommended.

This process should be carried out in a room which is isolated from the other portions of the plant.

Dipping

When the chlorinated naphthalenes are used for sealing condensers or pots into which the condensers are dipped should be provided with lateral exhaust ventilation with a velocity of 1000 f.p.m. Chlorinations are employed for sealing compounds, and these are more toxic than are the tri- and tetra-chlorinated naphthalene used for dipping. A hood over the pot, with upward exhaust ventilation, is frequently employed at the present time, but is inadequate for this purpose. There should instead be a hood completely surrounding the pot through which the vapors are exhausted laterally.

Pouring

Where condensers are being poured instead of dipped,

* Private communication.

between these lesions and acts of any sort. This connect skin and possible corroborates the exper-

PREVENTION

As of impregnating ele- sers has always presented health hazard that in past to protect work- stry from injurious ex- mes and vapors of the naphthalenes has been at this point. In the condensers were impreg- general workroom. They were sometimes used and everyone in the plant r less exposed to what given off. The incidence of tions was high. Now, pregnation rooms in most mpletely separated from rkrooms; the ovens used few exceptions, tightly and well covered; and e of skin eruptions has ow that one rarely sees department.

very innocuous looking artments which are r most of the cases of is one sees. In the dip- ; and soldering operations, ed naphthalenes are vol- heating or flaming. Be- umes are given off in all amounts from a great nt points in the work- importance as a health t to escape the attention observer. Consequently effort is usually made to ituation.

While each plant has its own special ventilating problems which require special study, the following general principles are applicable to all, and should be carefully adhered to.

Impregnation of Condensers

All impregnating ovens should be enclosed and tightly constructed so that no vapors may escape as a result of leakage.

Each oven should be provided with exhaust and equipped with lateral exhaust ventilation so disposed that when the door is opened, the vapors may be immediately exhausted at their source. A velocity of 1000 f.p.m. is recommended.

The process should be conducted in a room which is isolated from other portions of the plant.

Dipping

When the chlorinated naphthalenes are used for sealing condensers, all the pots into which such condensers are dipped should be equipped with lateral exhaust ventilation having a velocity of 1000 f.p.m. The higher velocities are employed in these operations, and these are more than are the tri and tetrachloroethylene used for impregnation. The pot, together with the exhaust ventilation as frequently employed at the present time is inadequate for the purpose. There should instead be a duct connecting the upper part of the pot through which the vapors are exhausted laterally.

Pouring

Where condensers are filled by pouring instead of dipping, various

pitch preparations are used more frequently than are the chlorinated naphthalenes. However, when these latter materials are employed for this purpose, the molten wax may be kept in a small tightly enclosed storage tank on the table. The condenser is placed under a slot beneath the tank, and when the operator presses a key the wax drops from the storage tank into the condenser. Such a tank should be supplied with lateral exhaust ventilation. The storage tank is refilled by dropping in lumps of the solid wax.

Soldering

Workers doing soldering should be similarly protected. Work benches at which this is done should be supplied with a series of small hoods, one for each worker, under which the soldering operations are carried out. Each hood should be equipped with lateral exhaust ventilation so disposed that the fumes given off are carried back and away from the workers' faces. An air velocity of 1000 f.p.m. is required.

Where soldering of tinfoil condensers is carried out by rubbing the end of the condenser on a hot plate, the hazard is greater than where wires are soldered on to leads. All such hot plates should be equipped with a hood having a slot at the end of the plate and supplied with lateral exhaust ventilation. An air velocity of 1000 f.p.m. is required.

General Ventilation

In addition to the local exhaust ventilation above outlined, careful attention should be directed to adequate ventilation of the room as a

whole wherever any worker is exposed directly or indirectly to fumes or vapors of the chlorinated naphthalenes or diphenyls.

Personal Hygiene

This may be briefly summarized as follows:

1. Employers should supply workers with highly starched uniforms, underwear, caps and gloves; these clothes should be laundered every day.

2. Two lockers should be provided, one for street clothes and the other for uniforms.

3. Employers should provide workers with sanitary eating facilities, removed from their workroom.

4. Wash periods should be scheduled on company time, and washing up before lunch and before leaving work at night should be done under factory supervision.

5. Cold cream, plenty of hot water, soap and individual towels, together with a protective lotion for the skin should be supplied by the management.

Since the chlorinated naphthalenes are not soluble in water, the wax-like film which is deposited on the skin should first be removed with cold cream in which it dissolves. Workers should then wash thoroughly with plenty of warm water and a mild soap. This ritual should be carried out conscientiously before lunch, and again before leaving the factory in the evening. A shower before leaving work is desirable.

All workers should apply a protective lotion to all exposed parts of the body before starting work in the morning and before starting work again after lunch. A lotion which

has been recommended for this purpose is the following:*

Zinc oxide $\frac{1}{2}$ oz.
Calomine lotion $\frac{1}{2}$ oz.
Salicylic acid 20 grams
Adeps Lan. Hyd. 4 fluid oz.

Medical Supervision

1. All workers should be instructed as to the hazardous nature of their work and the rules to be followed in order to keep well. They should be encouraged to report promptly any evidence of a skin eruption or of general ill health.

2. Young workers suffering from acne vulgaris should not be employed in this industry.

3. Because of the possibility of severe scarring of the face following a severe acneform eruption, it would seem particularly desirable not to employ young girls.

4. Workers developing skin eruptions of any severity should be immediately removed from further exposure to the chlorinated naphthalenes. In rare cases the skin eruptions may be a forerunner of systemic poisoning, such as acute yellow atrophy of the liver.

5. All workers developing skin eruptions, particularly of the itchy variety, should be carefully watched so as to guard against infection.

6. Workers should be given periodic physical examinations.

SUMMARY

1. Exposure to the chlorinated naphthalenes in the manufacture of electrical condensers may result in

* Recommended by the Halowax Corporation.

acneform eruptions, characterized by pustules, papules and

The association of comedones in large numbers, with a severe itching) has given it the name "blackhead itch" among the workers.

2. The 31 workers examined at the plants using a combination of trichloronaphthalene in the manufacture of condensers were

employed in the finishing department doing soldering or testing of condensers which had already been in use.

3. The eruption observed was of three main types, which are discussed.

4. The eruption may become disabling.

It usually occurs within a few months of employment.

There are exceptions to this rule. There appears to be a difference in the susceptibility of workers to these substances. Some are never affected.

The incidence of the eruption appears to be higher in summer than in winter.

The acneform eruption is commonly found in adolescents in the following respects:

1. Severe pruritus, which is usually accompanied by

2. Association of acne with

titis venenata or a

of the fingers, especially the index fingers.

3. Comedones are far

merous, more closely grouped together to form papules.

4. Distribution along the surfaces of the arms, especially around the

recommended for this purpose
ring.*

..... ½ oz.
lotion ½ oz.
acid 20 grams
1. Hyd. 4 fluid oz.

Medical Supervision

Workers should be instructed of the hazardous nature of their work. The rules to be followed should be kept well. They should be instructed to report promptly any skin eruption or other ailment.

Workers suffering from skin eruptions should not be employed in the factory.

Because of the possibility of disfigurement of the face following an acneform eruption, it would be particularly desirable not to employ young girls.

Workers developing skin eruptions of any severity should be removed from further contact with the chlorinated naphthalene. In rare cases the skin eruption may be a forerunner of poisoning, such as acute hepatitis of the liver.

Workers developing skin eruptions, particularly of the itchy variety, should be carefully watched so as to detect any secondary infection.

Workers should be given periodic examinations.

SUMMARY

Exposure to the chlorinated naphthalenes in the manufacture of condensers may result in skin eruptions induced by the Halowax

acneform eruptions, characterized by papules, papules and comedones. The association of comedones in large numbers, with a severe pruritus (itching) has given it the name "head itch" among the workers.

The 31 workers examined in two months, using a combination of tri and chloronaphthalene in the manufacture of condensers were all employed in the finishing departments, in soldering or testing of condensers which had already been impregnated. The eruption observed fell into two main types, which have been described.

The eruption may or may not be disabling.

The eruption usually occurs within the first few months of employment, though there are exceptions to this rule.

There appears to be great differences in the susceptibility of individuals to these substances. Some workers were affected.

The incidence of the acneform eruption appears to be higher in the summer than in winter.

The acneform eruption differs from the acne commonly found among adolescents in the following important points:

1. There is severe pruritus, which very seldom accompanies vulgaris.

2. The association of acne with a dermatitis venenata or a paronychia of the fingers, especially of the index fingers.

3. Comedones are far more numerous, more closely crowded together to form patches.

4. Distribution along the exterior surfaces of the arms and especially around the elbows, an

area almost never affected by acne vulgaris. The back, so often affected in acne vulgaris is not commonly affected here except in very severe cases. The legs and abdomen may be affected. The line of the mandible is an area of predilection.

e. The condition may be transferred to other members of the family by contact with the skin and clothing, when these have a coating of the chlornaphthalene on them.

10. The mechanism for these acneform skin eruptions is not clearly understood.

11. The eruption may in severe cases involve the deeper layers of the skin and result in permanent scarring. One case of permanent facial disfigurement in a young girl was observed in the course of the present study.

12. In severe cases, there is a tendency to secondary infection, especially when there is a coexisting pruritus and the worker scratches the lesions. In the present investigation a furunculosis of the cheek superimposed on a severe acneform eruption resulted in death from septicemia.

13. There is every reason to believe that attention to adequate local and general ventilation, good personal hygiene on the part of the workers and adequate intelligent medical supervision will effectively eliminate the hazard.

14. Fumes and vapors should be exhausted laterally at their source, the velocity of air being maintained at 1000 f.p.m.

15. General ventilation for the room as a whole should be introduced when necessary.

16. Principles of personal hygiene and medical supervision have been briefly outlined.

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AN ELECTROSTATIC PRECIPITATOR

Westinghouse Electric Corporation

IT HAS been long known that an electrostatic precipitator is a very efficient means for removing small particles of dust from air. This method, however, has been applied to the design of instruments for sampling of dusts and for the removal of particulate material from air. A very reliable electrostatic sampler has been developed by Westinghouse and Thomson, and is now being used by others (1, 2, 3). During an investigation of electrostatic air cleaners (4, 5), it was found that direct current and alternating current electrodes with some capacity of this type could be increased in size and efficiency materially.

The sampler consists of a blower to draw the sample air into a precipitation chamber which is supplied with a supply which furnish all the power. It is mounted in a cabinet 15 in. high. The complete unit weighs 100 pounds.

The precipitation chamber is essentially of a group of parallel plates.

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