Toxicity and the Paint User*

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Summary

A brief survey of poisoning in the history of the crafts of painting and paint making leads to a description of some risks to painters and customers today. Skin hazards, solvent hazards and hazards to young children are particularly discussed. Suggestions for improvements are made.

History

Painting is the oldest skilled craft. Cavemen were painting in Southern France and Northern Spain 20,000 years ago or more. They used earth pigments possibly urine as a vehicle. Many civilisations—Egypt, Ancient Greece, and many others—used paint and developed its use in various ways. Imperial Rome developed techniques and designs good enough to arouse today as illustrated by the murals at Pompeii. Of all these ancient civilisations only Rome appeared to recognise any hazard. Both Pliny[1] in his "Natural History" (A.D. 77) and Vitruvius the Architect[2] knew that lead was poisonous although no writer described a craftsman who suffered from painting in any of these civilisations. Pliny described the use of white lead, minium, vermilion and *orpiment in paints* and also has the credit of being the first man to describe an industrial protective device, the use of bladders to cover the face to protect workers making vermilion from the fumes of this dangerous mercurial.

It was a much later date that the first reference to a case of poisoning occurs. Fernel[3] writing in 1656 described the case of the painter of Anjou, who suffered such violent abdominal cramps that they were relieved only by the weight of four men sitting on him—a classical lead colic—and who subsequently became emaciated and anaemic. Fernel concluded that licking his brush to point was the cause, though Fernel could not in those days distinguish lead from other pigments as a cause of poisoning. In 1700 Ramazzini[4], the father of industrial medicine, described the diseases of craftsmen. Diseases of painters mentioned as palsy of the limbs, cachexia, *i.e.* wasting, blackened teeth, earthy complexions, melancholia and loss of the sense of smell, some only symptomatic of lead poisoning.

Until the 18th century when the industrial revolution greatly increased the need for paint, little paint manufacture existed, but in that century first coach painting and later house painting rapidly encouraged the manufacture of paint, though it was still in small batches and there was no separation of the functions of making and using paint—the painter bought his ingredients, ground them and then applied his final products. Mostly it was a time of hand processes. However, it was in this period that the term "painters' colic" came into being, probably a mistranslation of "colica Pictonum" which originally meant "colic of Pictou", a district where an unpleasant endemic bowel complaint was rife[5]. The cap, however, fitted well, and the hospitals of Paris[6] by the

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mid-nineteenth century could describe many cases of lead poisoning of all degrees, about half of them amongst painters. It is chastening to realise that men were dying of this complaint for nearly 100 years without anyone finding a method of prevention. The chief obstructions to progress were a fundamental belief that dirty hands were the vehicle, that alcoholism was an important cause and that milk would protect from poisoning. In short it was the dirty worker's fault and all the management could do was provide milk. It was not until Sir Thomas Legge[7] clearly and convincingly traced the inhalation of lead dust as the essential route that progress was made in its prevention. It is known today that comparatively little lead is ingested by mouth, that alcoholism aggravates but does not cause plumbism and that milk is no preventive of poisoning, but is only a valuable food for an underfed man. The real prevention is, in order, in replacement of noxious materials like white lead by innocuous materials, by preventing dust or fume by plant design and maintenance—*e.g.* total enclosure and dust extractors, and in protective clothing as a last resort. In all these, proper education or training of the man and supervision by men who understand and are determined to eliminate risks are essential. A good foreman is worth his weight in the coinage.

Since the discovery of organic dyes and the development of the chemical industry, there has been from the toxicity point of view a great change in pigments employed in paints. Lead compounds are far less frequently used; titanium and other whites, which are innocuous, have largely replaced white lead. Dyestuff pigments have replaced many inorganic pigments, generally speaking, with a reduction of toxicity hazards.

With the steady diminution of the lead and other pigment hazards, solvents remained the main cause of toxicity. The introduction of cellulose finishes produced new groups of solvents. Tetrachlorethane was one of the earlier of such solvents and caused a group of cases (at least seventy with twelve deaths[8]) in the doping of aircraft in the First World War. It illustrates by its disastrous effects the danger of new materials of unknown toxicity. Although tetrachlorethane is not used at all now, benzene, *i.e.* benzol, is still commonly employed and is a subtle and dangerous poison. It is liable to appear in commercial grades of toluol and some other solvents. Methanol, another poison, is also still occasionally used. Apart from these, many other solvents may give rise to occasional cases of poisoning, especially if treated carelessly.

Another major group of changes started during this century with the introduction of synthetic resins and varnishes which have largely replaced the traditional varnishes based on natural materials only. The earliest known varnish can still be seen on an Egyptian mummy case, dating back to 4,000 B.C., but methods of manufacture changed very little in all these millenia until this century. New classes of resins are now being continually introduced, and many distinct groups of varnishes and vehicles exist. Their chemistry is complex, and the element of toxicity has still to be investigated in some cases. For the manufacturer new hazards demand constant search and research. Monomers have varying properties, but fortunately most polymers of value are non-volatile, water-insoluble, relatively hard and chemically stable in the final paint film. Such substances are seldom dangerous so that the user is unlikely to be in danger. Such dangers as exist lie in monomers and more especially

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in the minor ingredients such as hardeners and anti-oxidants such as organic amines and pentachlorphenol.

There is one other historical aspect that requires description. After the introduction of cellulose paints, the revolutionary change that marked the beginning of another era was the introduction of an efficient spray gun. Mass production methods in the car industry were introduced in the 1920s, and as an example of what this meant, the number of man-hours taken to paint one type of car was reduced[9], by spraying with cellulose, from 336 to 13½. Mass production methods of all kinds of course meant a vastly increased amount of paint, and the growth of the quantity of paint used in the world still continues. This has meant not only vastly greater total quantities of paints and varnishes but greater batch size. Men now are handling greater quantities of paint individually, and thus individual exposure to any noxious material that happens to be present is likely to be greater because of this and also because of more continuity in the manufacture of a particular material. There are no grounds for complacency, for the research chemists and engineers are treading hard on the heels of the production manager, devising new chemicals and new methods and formulations. New dangers are constantly arising.

Hazards

Introduction

In assessing the importance of a toxic hazard (or for that matter other hazards) an important factor is the extent to which the user of the hazardous material can be expected to take appropriate precautions. Thus, when a paint is used under favourable industrial conditions there may be virtually no limit to the severity of hazards which are acceptable; the problem is to assess the hazard and to define such precautions as will be adequate and practicable.

At the other end of the scale with paints intended for general use, including those used by the general public—the "do-it-yourself" painter, it would be unrealistic to specify elaborate precautions and even simple recommendations may be ignored. With such paints the ideal is to avoid toxic hazards completely or at least avoid those which would cause serious illness if recommended precautions are ignored. The hazards referred to are those occurring during paint application. The possibility of hazards arising with painted articles, *e.g.* contamination of foodstuffs, ill-effects on children from chewing or swallowing painted articles, furniture and even balcony rails and other parts of houses' main wall structure must not be, of course, ignored.

Skin Hazards

Most methods of painting involve some contact of paint with the skin at least occasionally. In some operations there may be considerable contact and in others other factors, such as mechanical abrasion, may be present. It is unusual for any paint product to contain a corrosive agent but some ancillary products such as rust removers and paint removers may blister the skin on prolonged contact. Some such cases may develop a sensitisation dermatitis later. Obviously careful instructions are needed before these materials are used.

Dermatitis may be of internal, toxic or external origin. With external irritants such as croton oil, as tried by Hebra in an experiment in 1868, the skin becomes

reddened, hot, swollen and recovers with some scaling in about twenty-four hours. If this application is repeated over a period, the symptoms are intensified and vesicles leading to weeping, crusting and irritation will appear. This is an irritative eczema, which may also arise from a single application of too strong an irritant.

There is one other factor. Some irritants may result in a change of reaction of the skin itself. This hypersensitivity is called an allergy and means that the skin will react to very small quantities of the irritant, usually not only in the contact region but over a wider area. A single application is then enough to produce the reaction, *i.e.* sensitisation or allergic dermatitis.

There are thus three groups of conditions to be considered: irritative dermatitis, sensitisation dermatitis and other skin conditions unconnected with irritants. The first two may well be avoided by prompt medical care at the onset, but are outnumbered by the third non-industrial group. The first rule should therefore be for all rashes to be seen by a doctor as soon as possible. The next point is that sensitisation dermatitis is comparatively uncommon, but "allergy" is frequently alleged by laymen to account for a worker's rash, to cover up faults in the technique, training and supervision of skin care in their plant. The more common type of industrial rash is irritative and arises only after a period of exposure. Paint seldom causes it, but aggressive methods[10] of cleaning paint off the skin do.

Almost any solvent can have three separate actions on the skin. First, it removes protective fat from the surface of the skin, then it may itself irritate the skin, and lastly and very uncommonly, it may become a sensitising agent. In paint itself the solvent is of course diluted and tied up with solids and other materials so that skin contact is relatively slight. When people wash in solvent to remove the paint they remove the protective fat from comparatively large areas of the skin almost instantaneously. The dried out skin is then liable to crack and is more easily abraded mechanically. It is also in a lower state of resistance when any other sensitising or irritating agent is present. Common examples are various solvents of which white spirit and the useful and invidious "cleaning solvent" are fairly typical—invidious because of their almost unknown constitution.

In recent years epoxy resins have been prominently accused of causing dermatitis. The majority of cases have been caused by the hardener used with the resin, although it is said that a true sensitisation dermatitis can occur with the resin itself. The hardeners generally causing trouble are organic amines, several of which have been tried, but all of which have the property of being strongly alkaline in concentrated form and therefore corrosive to the skin. The resin will be an irritant if there is free amine left in it. There is a distinction to be drawn here between paints and plastics. An article written a year or two ago showed that in epoxide plastics there may be minute bubbles which contain free hardener which, when these materials are being ground or processed by hand, will be released and will irritate the skin. However, paints are a very different proposition from plastics. Much better mixing is necessary in paints and free amine is unlikely to exist in the final film. This article has caused some confusion of thought. The chief hazard with epoxy paints is therefore

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in the hardener and can be eliminated best by substitution of a less noxious agent and also by ensuring that the hardener is fully reacted. In two-pack systems the hardener must be treated with caution. Provided that the risk is known to the user and suitable advice is given to make sure it is fully reacted or that contact with skin is carefully avoided, there should be no hazard.

One of the difficult factors today is the attitude of the patient. Dermatitis has a frightening sound and suggests loss of work or even unemployability to a man. It also suggests compensation, and the unfortunate patient is torn between the two—fear and hope. The longer a case is allowed to continue, the greater the chance of permanency of the rash. The patient should therefore be brought under medical care at once. The only way to ensure this is to have a doctor or nurse attending the factory and instructing all supervisors to see that odd rashes are seen by them immediately. It is not, however, easy to persuade customers to appoint a nurse, although they are of very great value in many other fields as well.

According to Pirila[11], who works in Finland, turpentine caused dermatitis incidences of 10.7 per cent in painters, *etc.*, but, in fairness to the solvent, different grades of turpentine from different trees and prepared in different ways have very different degrees of irritability to the skin.

To summarise the causes of industrial dermatitis amongst users of paints and varnishes, most occur from the irritation of the skin through poor technique. This means ultimately poor training and supervision by management. The biggest single cause is the custom of cleaning the skin with paint solvents.

It is possible for many substances to be absorbed through the skin including turpentine and other solvents and possibly benzene itself. There have been dramatic examples, for instance, of pentachlorphenols being absorbed and causing deaths, though these were not in paint but in wood preservatives, and the skin area exposed was large[12]. However, it is known that such diverse substances as organic mercurials in paints, methanol, possibly benzene and cresols can be absorbed this way. All might be expected to give rise to serious poisoning if absorbed in sufficient quantity.

Inhalational Hazards

The dangers of white lead dust are almost absent from industry today. All dust must be regarded as undesirable and all reasonable measures taken to keep it to a minimum and to prevent its inhalation. There is a possible health hazard from many pigments and powders, *e.g.* silica, chromates, other lead, antimony and possibly cadmium compounds and other materials, and it is always advisable to keep dusts to a minimum. Much is done to ensure careful training and supervision, but dry rubbing down gives rise to occasional cases of lead poisoning, and there is a constant risk of failure to warn operators about these hazards, because of the prevalence of small organisations.

Solvents of nearly all types carry one special hazard—gassing. In sufficient concentrations, all organic solvents act as anaesthetics and a tragic example was described in 1957 by the Chief Inspector of Factories in his Annual Report. A painter was stripping a small lift with automatic doors, using as paint stripper a mixture of "methyl chloride", methyl alcohol and benzol. The doors jammed and

he was gassed and died. Rare as it is, this occurrence highlights the danger of carelessness in using solvents.

Short of unconsciousness, many minor symptoms arise under poor conditions of ventilation,[13,14] such as dizziness, headache, nausea and many vague feelings. With some solvents the symptoms do not immediately disappear on removal from exposure. Some men working in an atmosphere of solvents have complained of a change of attitude off-duty; vigorous and sociable types became sleepy and dull, and some even complained of impotence occasionally. A recent inquiry of this sort came about a vigorous, bustling housekeeper who decided to decorate her basement scullery, which was a small, windowless room. She had typical symptoms. Another came from a caravan dweller who repainted his caravan and that evening went to bed in it; this is an unwise procedure since solvent fumes are bound to persist for a few hours, unless the ventilation is extremely good.

Apart from many queries of this type, there is another which may start "Since repainting my wife's bedroom, she complains . . ." The complaints vary and have usually been present for weeks or months. It is difficult to find a satisfactory chemical cause for this type of story. Paints dry quickly and completely. Some cases are due to some overlooked medical condition which has been associated with the repainting on the usual *post hoc propter hoc* reasoning, so that the first advice given is that the sufferer should consult her own doctor. In other cases, domestic or social factors may determine the symptoms. If the doctor later writes to the author about the complaint, the author tells him frankly all he knows about the materials used and such hazards as they might give rise to, but, after consulting with a considerable number of doctors, in both general and consultant practice, there has never been any evidence that dried paint can cause any disability in this way.

The problem of peoples' disliking the smell of paint is a vexed one. It applies to standard types of paints but not to distempers or emulsion paints, and yet does not seem to be connected with paint solvents. There is no useful published work on this subject, which remains a good field for research. Most fresh-painted rooms retain their smell for some days, and for those unfortunates who suffer nausea or sickness the only remedy is avoidance. Sufferers known to the author are neither psychological weaklings nor neurotics; the condition seems to affect people irrespective of their emotional calibre. It does not affect the manufacturing side. There are two possible explanations. The first is that the working population is self-selected and that those nauseated by the smell of paint never attempt to come in at all or promptly leave the industry. The second is that it is a temporary condition and that about a week's exposure under ordinary working conditions is enough to clear most people's symptoms without any medical treatment.

Another type of query comes from industrial customers employing painters, when a new solvent is introduced; that is, a solvent new to them or replacing a solvent well-known to them. Solvent naphtha and butanol are two likely to cause comments from painters. Both have vapours which cause more than average irritation to nose and eyes. Neither is particularly noxious. Probably these queries would not arise if the men were warned frankly in advance, and it was explained to them that the vapour was not unusually toxic.

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Benzene and Methanol

Of all the solvents commonly used in paints, only two, benzene and methanol, are known to be particularly dangerous. By benzene is meant aromatic benzene or benzol, not petroleum benzine. Mistakes have been made; since benzine is non-toxic and benzene can be deadly, this is a serious matter. In 1932, such a mistake was made in a boot factory, as a result[15] of which forty-four workers were taken ill and eight died. The word "benzine" could with advantage be removed from use, but it exists also in French and German and so the task is not simple. Benzene is a notorious blood poison. It contrasts with its hydrocarbon relatives such as toluene and xylenes. The pathological effect of the hydrocarbons themselves is due to solution in fats and absorption from the bloodstream into the central nervous system, producing narcosis or gassing; lesser quantities produce dizziness, headache, drowsiness and very occasionally excitability. These effects are acute, *i.e.* immediate, and pass away completely in time. The pharmacological effects of the phenols (derived from benzene) are capable of permanent damage to the blood-forming organ, either by repeated smaller doses or by a single large dose. The effects of the breakdown products of toluene and xylenes are, however, believed to be harmless. Thus benzene is to be regarded on its own.

Benzene is excreted mainly through the lungs as such, but part is oxidised to phenol, catechol, *etc.*, and, combined with sulphuric and glycuronic acids, these are excreted in the urine. Toluene and xylenes are also exhaled as such, but metabolism in the body converts toluene partly to benzoic acid and then to hippuric acid and xylenes to comparable bodies, toluic acids and their amine derivatives. Benzene exposure of weeks only may cause leukopenia or other blood disease, although generally several months are needed for this to happen. It is absorbed mainly by inhalation, although some may pass through the skin. It has been described as the most dangerous industrial toxic material in use today because of its subtle, insidious attack.

Methanol, or methyl alcohol, also has chronic poisoning effects in man, leading to blindness and death; most of such cases have been due to drinking methanol, but inhalation is a proven route of absorption. Methanol is metabolised in the body to formaldehyde and formic acid. One theory of its action is that it interferes with oxidation processes in the body. It has been said that its danger is over-emphasised. Certainly, the solvent as such has been an attraction to drinking man, but in finished products, such temptations cannot exist; the hazard is less but exists from inhalation, and some warning is needed if more than 15 per cent methanol is present in the product. This is purely an arbitrary standard adopted by the author's company and, if the percentage is exceeded, it is the company's policy to warn the customer.

The use of the word "toxic" needs comment. It means "poisonous", but it is also charged with emotional content and should not be used lightly at all. Most substances are toxic under appropriate conditions, even water. Most men would be shocked to hear their favourite beverage, whether beer, whisky or table wine, described as toxic, yet they accept the use of the words "intoxicating beverages". So the statement that alcoholic beverages contain a toxin must be accepted. Some specifications of the word "toxin" are needed, since its use alone is misleading. Thus to write that *A* is more toxic than *B* is misleading. A reference book writes "in high concentrations toluene is dangerous to life, more so than benzene", but the writer is referring only to the ability to cause gassing, or in medical jargon, narcosis or acute depression of the central nervous system. Any organic solvent that can be vaporised and inhaled will cause gassing if the concentration is high enough. However, benzene is a deadly poison, acting on the blood-forming organ in particular. Another quotation is "methyl alcohol given by injection to animals is less poisonous than ethyl alcohol". This again refers to acute effects. It is well known, however, that wood spirit poisoning and permanent blindness are related, and it is most unwise to drink methanol at all. If the term "toxic" is used it is essential to specify the route of absorption, *i.e.* by eating or drinking, by inhalation or through the skin (percutaneous) or by injection, and also whether the effect is acute (short) or chronic (long term). Each needs separate consideration, so that the answer to the anxious question "Is it toxic?" is liable to be rather long, if dealt with properly. Fortunately, the question is usually asked with one obvious route and effect in mind and can be dealt with briefly, but there is plenty of scope for misunderstanding and confusion if too short an answer is given. The emotional content of the word must be remembered.

Spray Painting

Another problem is spray painting. A spray will do several things; it will splash back especially in tiny droplets and produce skin contamination. The solvent will readily evaporate, and the spray droplets may themselves be inhaled. Thus with spray painting exist the hazards already mentioned and also that particulate matter may enter the painter's breathing passages.

Polyurethane surface coatings are employed to an increasing extent in several different fields, as floor lacquers, marine and maintenance finishes and chemical resisting finishes. They are based on diisocyanates and not to be accepted lightly as innocuous, since many are based on tolylene 2,4-diisocyanate (TDI), which may exist as free monomer in the final coating in small amounts. First, TDI is irritant on contact to skin, eye and mucous membranes; secondly, it is an allergen, *i.e.* may produce sensitisation in those who become allergic to it. The common form of allergic response is a sudden pneumonia-like or asthma-like attack; once attacked the patient is liable to further attacks on exposure to very small concentrations. The condition is serious, although the patient usually recovers. There must, however, be some reservation about this since experience with these materials is relatively limited on any industrial scale. However, in his joint address[16] to this Association, with Dr. Walpole in 1959, the late Dr. Williams stated that the diisocyanates were not believed to possess any carcinogenic properties.

In large industrial undertakings brushing of articles is easy to control by routine methods, such as suitable buildings and plant, protective clothing and medical supervision. However, with spray painting two separate aspects require consideration; the concentration of TDI vapour breathed in by the user and the possible inhalation of droplets. The first is the known cause of the allergic respiratory response referred to above, while the inhalation of droplets or particles will add to this the direct irritative effect of TDI on mucous membranes, probably of larynx and trachea and possibly of bronchi and bronchioles. It is

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therefore imperative that additional care be taken to protect spray painters from both dangers.

Home Decoration

The last aspect is the "do-it-yourself" home decorator, over whom control is impossible: he does not in general read warning labels nor follow instructions accurately. He must not therefore be allowed access to a means of poisoning himself, his children and his friends. He cannot be trusted not to spray a finish labelled "not to be sprayed"; he will probably use a gauze dust mask, which is useless, if he heeds the warning at all. Similarly, it would be wrong to include materials such as could be consumed accidentally, which could cause harm in small quantities. In any resin for household paint, TDI must be suppressed satisfactorily.

In 1959, when Dr. Williams discussed this matter before, he quoted Zapp[17] as suggesting a maximum allowable concentration (M.A.C.) of 0.1 p.p.m. for TDI. Now the Factory Department's latest list of M.A.C.s has laid down 0.02 p.p.m. for TDI. It means that technologists must now work to an even stricter standard than before. However, when the vapour problem is controlled, there is still danger from spray dust or droplets, if they should be inhaled; in other words, the suppression of vapour levels is not enough. It will not be enough to state there is no vapour pressure, unless it is also possible to say this liquid or solid will not irritate mucous membranes on contact. The first of the problems, the suppression of vapour, may now have been achieved by the reaction of the isocyanate with suitable agents in several recent products.

Good exhaust directional ventilation, facial protection, *etc.*, are all strongly desirable, and formulations have to be most carefully devised to comply with what good sense decrees to protect the customers' men. However, many problems still remain, especially in the spray painting of large objects such as aircraft which are not amenable to directional exhaust ventilation in the accepted sense.

Children

Every year many children are poisoned and die; in 1953 Jakobziner[18] reported 400 deaths in the United States among children, 80 from lead poisoning, while another report[19] from Baltimore gave 293 cases of plumbism in children between 1931 and 1951, with 83 deaths. Another worker in 1956 reported 197 children with 89 brain conditions, all from ingestion of lead paint flakes. Cases have been reported from Australia, an epidemic outbreak once, and in the United Kingdom the *Lancet* reported a case in 1952, describing how "Lead paint in the nursery is the commonest cause of lead poisoning in children in this country". The City of Baltimore has laid down the byelaw that "no paint shall be used for interior painting of any dwelling . . . unless the paint is free from lead pigment." This does not exclude paint containing lead driers, nor pigments with only traces of lead. Most of these cases of poisoning have arisen, it is hoped, from "do-it-yourself" painters, and there is evidence of this to be found in some reports of cases. It is unlikely that toys or childrens' furniture made in this country would be painted with lead paints, but the manufacture of imported toys, *etc.*, is often not so strictly supervised.

The latest (1961) B.S.I. Code for Children's Toys and Playthings[20] states that they "shall not include in their composition any dyes, plasticisers and

other ingredients known to be injurious . . ." and "shall not contain lead compounds of which the lead content is in excess of 1 per cent of the contained solids, including pigments and drier". In a footnote, it states "it may be dangerous for coatings to contain more than slight traces of compounds of such materials as arsenic, cadmium, mercury, beryllium, selenium and barium", and an addendum on them is promised. Another interesting point under "construction" is given that "manufacturers shall give adequate instructions for erection, *etc.*" and also ". . . instructions for the handling of chemicals. . . ."

Lead is a poison with a varied form of attack. More is known of its effect in detail than that of any other poison used in paint. It affects muscle and produces a weakness, *e.g.* wrist-drop in fatigue when excess lactic acid changes to lead lactate, which is soluble. This passes to the surface of muscle cells and is then reprecipitated as insoluble lead phosphate altering thus the surface permeability of the cells. Lead affects the brain directly and produces colic and constipation by action on the autonomic nerves which control the bowel. It also directly poisons kidney cells during excretion.

When a young child-- say, under three-- is poisoned, it is extremely difficult to ascertain the true course of events. Babies who chew their cot sides, may have a firm history given by the mother; others, however, give none and the child cannot help. However, there is a belief in informed medical circles that some of the mentally defective or deranged children encountered in hospital, may be the late results of lead absorbed earlier, as one result of lead poisoning is an encephalopathy which may cause permanent damage to the brain. Evidence is difficult to collect—the damage to the brain is permanent, but the lead content of the patient is not and may well have greatly diminished by excretion by the time the patient goes to hospital. Opinion is generally that the lead often comes from paint but that it is only occasionally the connection can be found.

The purpose in describing this matter is to emphasise the danger so that these tragic cases might be avoided. Is better labelling an answer? How can one get at the "do-it-yourself" man and persuade him to think before applying to his child's cot the rest of that old tin of paint he has left over? Farmers do exactly the same, and periodic deaths of young calves are reported from chewing the paint on their stalls. One reason for its happening may well be that white lead is rather sweet to taste and this makes it attractive to young children and calves.

Late Sequalae

Lead poisoning in adults in factories is still reported regularly by the Chief Inspector of Factories in his Annual Report. Some come from other industries, some from colour making works, but paint appears regularly among shipbreakers as the ultimate cause. The cutting of steel with oxy-acetylene burners vapourises the lead primers, *etc.*, and lead fumes are given off; in 1959 five oxy-acetylene burner operatives suffered this way when cutting girders. Other cases included that of two young women scraping paint off glass tubes--the paint having a white lead base; there was a lesson to be learnt from this, since the trouble arose only when the job was moved away from its original site where exhaust ventilating plant was provided. Now it is difficult for the manufacturer of paint to feel he has responsibility about these late results of using his product. Their importance is to provide warning of what does happen already with lead and what might occur if some highly noxious material were introduced afresh into certain types of finishes.

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Other Toxic Ingredients

Organic mercurials are used in fungus resisting paints. Such mercurials are already used in seed dressings and fungicides. In very small concentrations phenyl mercuric acetate (PMA) has been used in a fungicidal preparation for the treatment of "foot rot", but it is not without danger.

Mercury may produce effects differing according to its chemistry. Metallic or inorganic compounds produce no apparent damage to brain except a curious temperament change called "Erethism," as well as the well known tremor or "hatters' shakes". Alkyl compounds produce focal brain damage with severe effects such as ataxia, dysanthria and restrictions of visual fields; the difference appears to be that the alkyl compounds both penetrate the blood brain barrier better than inorganic ones and are firmly fixed after absorption. Aryl compounds probably approximate more to the inorganic types in their effects. It has been shown that preparations of PMA applied to the skin of rabbits results in much of its being absorbed through the skin. Mercurialism might well arise from paints containing a substantial proportion of mercurials if they were allowed to fall regularly on the skin, as might well happen in painting ships' bottoms. Again, what will happen at the ship-breaking end? Will there be sufficient mercury to burn off under oxy-acetylene burning to cause poisoning? Surprisingly no case has occurred from the use of mercury oxide for over fifty years, but this is believed to be because it is so quickly leached out by sea water under normal shipping conditions, so possibly there remains no mercury to vaporise.

Triortho cresyl phosphate (TOCP), sometimes used as a plasticiser, can produce a severe paralysis. Most known cases have been reported from its consumption by mouth, the material being present as an adulterent. Two major disasters recall themselves—the "Jake Paralysis" story from the United States, when the TOCP was taken in Jamaica ginger; and the other recently due to cooking oil in North Africa. However, TOCP can be absorbed through the skin or by inhalation. This is a danger that, if recognised, can be simply dealt with by avoiding both contact and inhalation.

Other materials that have been considered and may possibly be used by paint companies somewhere include pentachlorphenol and its sodium derivative and organic tin compounds, all of which need careful assessment before utilisation. It is essential with new ingredients to assess their toxicity just as their other technical qualities are assessed. Many have some small hazard, but it is not justifiable to pass on a hazard to an unsuspecting customer. If a hazardous material is to be used, it is necessary to consider whether it will be present free at all in the final product and even more so in the dried film or whether it will be modified and so rendered harmless.

Carcinogens

There is one other subject which is the difficult one of carcinogens or cancer-producing substances. It is a subject not entirely new to the Association and only a little concerns paint manufacturing companies at present, but there is a growing number of potential carcinogens known and a growing public awareness of their existence. It would be wise at this stage to consider this whole problem and decide on a course of action. The particular group of concern at the moment is the bis-epoxide resin group. It has now been established fairly

clearly that those based on diphenylol propane diglycidyl ether, which fortunately accounts for most of those sold under trade names, are non-carcinogenic, but there are a few others which may be animal carcinogens, and some which certainly are. Some manufacturers of these materials have included such information in the technical literature they send to us as customers, and should not be disregarded. There may well be place for these carcinogens as intermediates, but not to be passed on to either workers or customers. No doubt in a few years' time the problem of handling more and more carcinogens will be routine. One point which must not now be neglected is that with any substance, a search of the literature is essential to clear it of this hazard before embarking on its use. Unfortunately, there is a vast literature and no central authority to advise. However, the Factory Inspectorate are always willing to help, if asked, and they have a great deal of useful information.

Prevention

In the rather diffuse selection of hazards to paint users, certain aspects are exceptionally important and an attempt is made here to suggest remedies.

Dermatitis

Industrial dermatitis is by far the commonest condition causing complaint, and it can be prevented. As the author had said on a previous occasion to the Association, there is a simple enough system of prevention, which takes good management and supervision to carry out. The system consists of

(*i*) Good housekeeping generally and good supervision of work;
(*ii*) Avoidance of unnecessary contact with paints;
(*iii*) Skin care, *i.e.* impervious gloves where needed, good skin cleansers provided in the workshop near at hand with abundant clean rags to wipe off, barrier cream and lanolin after-work cream in suitable places, and the usual supply of hot water, soap, towels as laid down in the Factory Regulations; also training and supervision in their use;
(*iv*) Not to use paint thinners to wash the skin;
(*v*) The Shop Foreman should personally be held responsible if any case of dermatitis occurs and given full training and authority in hand care.

There is one other point—the provision of a trained and experienced industrial nurse or attendance of an industrial doctor, so that each case is seen immediately, is a more certain way of coping with all the above, owing to the availability of detailed on-the-spot advice, and the climate for such appointments on a nation-wide scale has improved during the last few years. Users of paint should be encouraged to devise the most effective way of obtaining such services.

Industrial Hazards

The formulation of paint products changes so frequently that it is important to keep the confidence of user firms by giving all available information and advice. It may then be discussed with them whether a particular hazardous material should be included or not, or whether special plant is needed to control a hazard. At present there seems to be considerably more fear by user firms than actual hazard, but that is as it should be.

Some of the hazards have been mentioned already, and some manufacturing firms have facilities for checking and examining hazards. It is certainly not

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true that such facilities are widely available. There is a need for a central body or bodies to provide these services; no doubt the reader will think of one or two possible arrangements. In general, there is needed a central library service; then much more research into hazards is needed, and animal work will be part of it. Thirdly, a more systematic investigation on all the doubtful human causes of poisoning might well be included. At present any doctor or hospital anywhere may be responsible for some of the more erudite investigations; their task is impaired by lack of knowledge of plants and processes, and decisions have to be taken on inadequate knowledge.

Children

Problems about the hazard of the chewing child and lead have been discussed, and it is necessary only to remind the reader to think of ways of preventing this trouble.

The Home Decorator

Today and in the future increasing care will be needed to avoid unsuitable paint products falling into his hands. Do-it-yourself men are increasing in number, are ingenious and often clever at their work, but they spray when they should not and transfer products to unlabelled cans. Every care must be taken before supplying finishes to the retail trade that these finishes are harmless.

As a generalisation, it is only fair to supply the retail trade with products which have no serious inhalation hazard and no major ingestion hazard. If a man with paint-contaminated hands can poison himself eating a sandwich, the risk is too high—the old lead paint worker took months or years to do so with lead. It is desirable to build up the confidence of paint users, whether industrial or domestic, so that they will trust paint manufacturers. At present there seems to be an increasing awareness by the public that hazards of all types exist and to suspect that its interests are not always so well protected as they should be. The Association can do a considerable amount to allay such worry.

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