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# THE EVAPORATION OF SOME CARBAMATE INSECTICIDES AT ELEVATED TEMPERATURES[1]

by

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Spray teams applying OMS-15 (3-isopropylphenyl N-methylcarbamate) to houses in Nigeria have developed symptoms of poisoning at a surprising rate and it has been suggested that the insecticide might be vaporized from the hot metal roofs in some sprayed houses. It is noteworthy that symptoms have not developed when the same insecticide was sprayed on the thatched roofs of experimental huts near Arusha, Tanzania. The volatility of OMS-15 has been measured at 25°C and, compared with many standard insecticides, it is a relatively volatile material. However, extrapolation from room temperatures to the values which might be reached on metal roofs is rather too far and actual measurements of evaporation at these higher temperatures would give a better idea as to whether volatilization could generate a high vapour concentration during the time taken for spraying. There is also the possibility of course that evaporation could occur at any later time when the surface temperature was high and would then be a hazard to people living in the houses.

Mr J. W. Vail of the Building Research Station, Garston, United Kingdom, has supplied some references and figures for the temperatures reached by galvanized steel roofs in tropical countries. He concludes that it is reasonable to suppose

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that under the most severe conditions a difference of 100°F (37.8°C) could occur between the internal surface temperature of a dark-coloured galvanized steel roof, and, for instance, a thick thatch. The latter would be close to ambient air temperature. Van Straaten in South Africa has recorded that roof temperatures of over 180°F (82°C) are not uncommon. This suggests that a temperature of 90°C could be taken as an upper limit while temperatures around 70° and 80°C could be fairly common. The evaporation rates of OMS-15 have therefore been measured from surfaces held at 70°, 80° and 90°C and compared with those of OMS-33 (2-isopropoxyphenyl N-methylcarbamate) and OMS-716 (3-isopropyl-5-methylphenyl N-methylcarbamate), two other carbamates which are being used in house-spraying trials in Africa.

EXPERIMENTAL

The normal sample-holder which holds the samples on the spray platform of a Potter tower was replaced by a hollow metal cylinder, 7.25 in diameter and 1 in deep, through which oil from a thermostatted bath could be pumped. The surface temperatures of this disc could be held at any value up to about 95°C. The samples sprayed were 3 in square pieces of duralumin. They were placed on the heated disc, allowed to come to temperature equilibrium and sprayed with a suspension of insecticide wettable powder to give a dosage of 1 $g/m^2$ of active ingredient. The sprayed panels were kept at the same temperature for various times before the insecticide remaining was washed off with 95% ethanol and determined by the 4-amino-antipyrine method. In order to prevent the insecticides from vaporizing into the spray room a gentle movement of air was maintained through the tower. The air-speed over the sprayed plates was 0.1 ft per second.

It was considered that this procedure simulated field conditions more exactly than a technique which involved deposits evaporating into air heated to different temperatures. Another advantage was that the residue reached the required temperature immediately on spraying. This would not have been the case if the metal plates had been sprayed at room temperature and raised to the working temperature afterwards.

RESULTS

1. OMS-15

The insecticide vaporized rapidly from deposits held at 70°, 80° and 90°C. The rates were proportional to the amount remaining and followed first-order kinetics so that the velocity constants could be calculated from the formula,

$$K = \frac{0.693}{\text{half-life}}$$

| Temperature °C | Half-life, mins. | K, mins.$^{-1}$ |
|---|---|---|
| 70 | 37.0 | 0.019 |
| 80 | 12.5 | 0.055 |
| 90 | 4.5 | 0.15 |

The variations of K with temperature show a relationship similar to the Arrhenius equation or to the variation of vapour pressure with temperature and a plot of log K against the reciprocal of the absolute temperature is a straight line. If this graph is extrapolated to 25°C the indicated K is greater by a factor of about 3 than that measured for deposits of OMS-15 on glass-plates stored in constant-temperature rooms. However, ventilation conditions are certainly different in the rooms as compared with the spray tower, the deposit does not have the same distribution when it dries immediately on hitting a hot surface compared with the slow drying on a cool one and finally, of course, the equation may not hold over such a wide temperature range and the extrapolation may be too great.

As surface temperatures of 80-90°C seem feasible for metal roofs in tropical countries these results show that if such roofs are sprayed a large proportion of OMS-15 could have vaporized during the time that the spray team is in the house and support the idea that poisoning could occur by inhalation.

2. OMS-33 and OMS-716

These carbamates are less volatile than OMS-15 at room temperature. Under the conditions of our standard test method OMS-15 evaporates from glass filter-papers at 16% per day compared with 5.0 and 4.4 for OMS-33 and 716 respectively (rates are of zero order in this test). Assuming that the same ratio held at higher temperatures it would be expected that these insecticides would give a lower vapour hazard than OMS-15 in houses with hot sprayed surfaces.

The present method shows that while OMS-33 and OMS-716 continue to have similar volatilities to one another at higher temperatures, they both approach that of OMS-15 as the temperature rises to 90°C. At 70 and 80°C however there are still substantial differences.

| Compound | Temperature °C | Half-life, mins. | K, mins.$^{-1}$ |
|---|---|---|---|
| OMS-716 | 70 | 93.5 | 0.0074 |
| | 80 | 23.5 | 0.030 |
| | 90 | 5.0 | 0.14 |
| OMS-33 | 70 | 108 | 0.0064 |
| | 80 | 26.5 | 0.026 |
| | 90 | 5.5 | 0.13 |

If the vapour toxicities follow the oral toxicities OMS-33 and OMS-716 should be less hazardous than OMS-15 even at the same rate of vaporization and there is this additional benefit of lower rates if temperatures are nearer 70 than 90°C.

CONCLUSIONS

It is possible that metal roofs exposed to tropical sunshine can reach a temperature of 70-90°C. Laboratory experiments show that if these are sprayed with OMS-15 the insecticide would vaporize so rapidly that during the time the spraymen are in the house they could be exposed to a high vapour concentration as well as spray drift. The suggestion that the rapid poisoning observed during house-spraying with OMS-15 could be due to vapour action is feasible.

OMS-33 and OMS-716 evaporate almost as quickly as OMS-15 at the upper end of the temperature range used but, because they are less toxic intrinsically, could be less hazardous. At lower temperatures they are not so volatile.

Apart from possible toxicity hazards the rates of loss of deposits from surfaces at these high temperatures show that there is no likelihood of getting any residual action and insecticide should not be wasted by spraying such materials.