

THE TOXICITY OF VINYL CHLORIDE MONOMER (VCM)

The VCM story started in 1966 when Lefevre of Solvay in Belgium described a condition which has since become known as 'Acro-osteolysis', which had occurred in men cleaning out autoclaves used in the polymerisation of VCM in the manufacture of polyvinylchloride.

Very briefly, the process takes place in three stages.

(a) Vinyl Chloride Monomer is made by the chlorination of ethylene to form ethylene dichloride and this is then cracked to give Vinyl Chloride Monomer and Hydrochloric Acid.

(b) The Vinyl Chloride Monomer, which is a gas, then passes into a large autoclave where it is reacted under pressure with water, a plasticiser and a catalyst to form a slurry of polyvinylchloride (PVC).

(c) This PVC slurry then passes to a drying plant and is then further processed to a powder.

In the first stage of the process, i.e. the manufacture of the monomer, the background levels of VCM in the atmosphere are of the order of ten parts per million.

On the autoclave floor the levels of VCM in the atmosphere are in the range of 50 to 100 parts per million.

During the polymerisation, PVC powder tends to stick to the side of the autoclave and it is necessary therefore that they should be cleaned, and until recent years this had to be done by hand and men going into the autoclaves with scrapers after the autoclave had been evacuated and purged of any gases. There are difficulties in getting rid of all the gas before opening the manhole at the top of the autoclave with the result that a puff of un-reacted Vinyl Chloride Monomer, albeit it momentarily, is given off to plant atmosphere and the concentration of VCM at this particular point of time is of the order of one thousand parts per million.

It should be noted therefore that it is at this stage of the operation that the highest exposure to VCM is experienced and it is also possible that in the process of scraping off the PVC powder from the side of the autoclave, that further exposure also occurs to pockets of VCM trapped behind the powder.

Since Lefevre published his account of Acro-osteolysis many other cases have occurred throughout the world and I believe I am correct in saying that almost without exception the condition has only affected autoclave men.

The main features of 'Acro-osteolysis' are bony changes which typically involve the terminal phalanges of the fingers, but changes in other parts of the skeleton, such as the sacro-iliac joints, the patella and the toes have been noted. These bony changes are often preceded by Raynaud's phenomenon and are associated with scleroderma. It is apparent therefore that Acro-osteolysis is a systemic disease.

- i) He was trying to pinpoint more accurately the no effect level in rats by exposing them to levels of 200, 150 and 100 parts per million.
- ii) He was exposing rats to concentrations of 10,000 down to 50 parts per million for four months only as this was considered to be equivalent to the working life of an average man.
- iii) He was also carrying out a quick test on pregnant female rats to see if he could produce any ill effects in their offspring.
- iv) He was also repeating his original experiment in the rat on hamsters and exposing them to levels of VCM of 10,000 down to 50 parts per million.

By this time the Manufacturing Chemists Association in the USA had become interested in this problem and were doing similar work on the rat, mouse and hamster.

The MCA also commissioned a firm called Tabershaw Cooper to carry out a survey of causes of death which involved the examination of records of approximately 4,000 VCM operators.

The situation at Christmas therefore was as follows:-

- 1) Professor Maltoni had produced evidence that Vinyl Chloride Monomer was carcinogenic to the rat.
- 2) There was no evidence whatever at that time of any carcinogenic effect in man and indeed the survey carried out at ICI Hillhouse complex had been reassuring.
- 3) The Tabershaw Cooper investigation was well under way and the results were expected at the end of February and it seemed reasonable to await these results before taking any further action.

On Boxing Day however Dr Johnson of B F Goodrich contacted ICI by telephone and reported that he had found two suspected cases of death from angiosarcomata of the liver in men who had worked on their Louisville Plant and had been exposed to VCM. In the next few weeks he reported two further cases from the same plant.

It was of course very necessary to validate the histological findings. All VCM exposed employees on both manufacturing sites were informed of the position and a few days later detailed discussions, in which Dr Murray took part, were held with the shop stewards and supervisors involved in the process.

Our customers, the Ministry of Agriculture, Fisheries and Food, and the DHSS, who had been generally in the picture for some time, were brought up to date. The TUC and the Factory Inspectorate were informed of the facts on the 22nd and the 23rd January, 1974 respectively.

A press statement was put out by the Company.

During these few weeks ICI was busy up-dating its examination of causes of death at its Hillhouse Factory and it was during this process that one case of angiosarcoma of the liver was found. This concerned a pensioner, aged 71, who had worked on the

Employees on the effected plant were seen by plant management and told of the situation.

Tahershaw-Cooper were brought in to carry out an in-depth investigation into the records of all VCM/PVC employees - past and present - including a plant at Niagara, which although now closed was their first plant.

An account was given at this meeting of the work being carried out by Tahershaw-Cooper. To date 4, 400 records have been examined. So far 122 deaths have been identified and 102 death certificates obtained. A further 1, 600 to 1, 800 records are outstanding with an expected 30 to 40 more deaths to be investigated. It is now known that this work is not likely to be completed before April.

No death suspected as being due to angiosarcoma of the liver has been identified although it is admitted that the remaining 1, 600 to 1, 800 records will cover the older plants.

The Manufacturing Chemists Association decided to set up immediately a number of Committees.

- 1) A Medical Committee with a broad remit to investigate any possible means of applying meaningful surveillance.
- 2) A committee to study work practices (including transport) with the broad remit to reduce exposure.
- 3) A committee to study methods of analysis and monitoring.

The UK has two representatives (Dr Duck of BP and Dr Duffield of ICI) on the Medical Committee. ICI also has a representative on each of the two other committees.

At a meeting in the States on the 14th February Professor Maltoni reported that in the rats that had now been exposed to VCM for 12 months he had found a subcutaneous angiosarcoma of neck, 2 angiosarcomata of peritoneum, 1 angiosarcoma of uterus and 1 angiosarcoma of lung.

2 subcutaneous angiosarcomata had also been discovered in the twenty week offspring of the pregnant rats which had been exposed to VCM.

On the 15th February a meeting was held in the States of the Medical Committee to consider possible methods of health surveillance. The following suggestions were put forward:-

- i) A full medical history
- ii) A full occupational history
- iii) A cancer background history
- iv) A physical examination, including x-ray of both hands and chest.