

Worker Exposure to Vinyl Chloride and Poly(vinyl Chloride)

by James H. Jones*

The National Institute for Occupational Safety and Health (NIOSH) in early 1974 began industrial hygiene studies of vinyl chloride exposed workers. Three VC monomer plants, three VC polymerization plants, and seven PVC fabrication plants were surveyed. VC polymerization plant workers and workers in one job category in VC monomer plants were exposed to average levels above 1 ppm. The highest average exposure was 22 ppm. NIOSH health hazard evaluation studies since these initial surveys have primarily shown nondetectable levels of vinyl chloride. A NIOSH control technology study in 1977 showed that exposure levels in VC polymerization plants had been drastically reduced but exposure levels above 1 ppm were still found in several cases.

Introduction

The National Institute for Occupational Safety and Health (NIOSH) began studies of vinyl chloride (VC) early in 1974 following a report of increased incidence of angiosarcoma of the liver among VC exposed workers. A part of this work included retrospective cohort mortality and industrial hygiene studies of the VC polymerization industry. Also, NIOSH contracted with Bendix Corporation, Launch Support Division, to conduct industrial hygiene studies in the VC monomer production industry and the polyvinyl chloride (PVC) fabrication industry. These industrial hygiene studies were done to document the levels of VC exposure occurring in industry at that time. Three VC monomer plants, three VC polymerization plants and seven PVC fabrication plants were studied. In addition to the VC industry-wide study, NIOSH, through their health hazard evaluation (HHE) program has sampled for PVC at 34 other plants, primarily VC fabrication operations. Also a study to document control methods utilized in the plastics industry was performed under contract by Enviro Control. This study included work at five VC polymerization plants (1-36).

Industry-Wide Study

VC Monomer Plants

One of the VC monomer plants sampled used the acetylene-hydrogen chloride process, the older process for making VC, and the other two used the ethylene dichloride pyrolysis process. It was not possible to assess the difference in worker exposure between the two processes because the plant using the acetylene-hydrogen chloride process was operating at only 10% capacity during the surveys in December 1974.

As can be seen in Figure 1, only the job of loader shows exposure substantially above 1 ppm. VC exposure for this job was being reduced, at the time of the surveys, by the redesign of tank car hookup systems and the use of air-supplied breathing apparatus while the tanks cars were connected or disconnected.

VC Polymerization Plants

Three VC polymerization plants were sampled. Located at these plants were three suspension resin operations, three dispersion resin operations, one mass resin operation and one solvent resin operation. As can be seen in Figure 2, suspension and dispersion resin operations had the highest exposure levels. Within plants the reactor area operators and helpers had the highest exposures.

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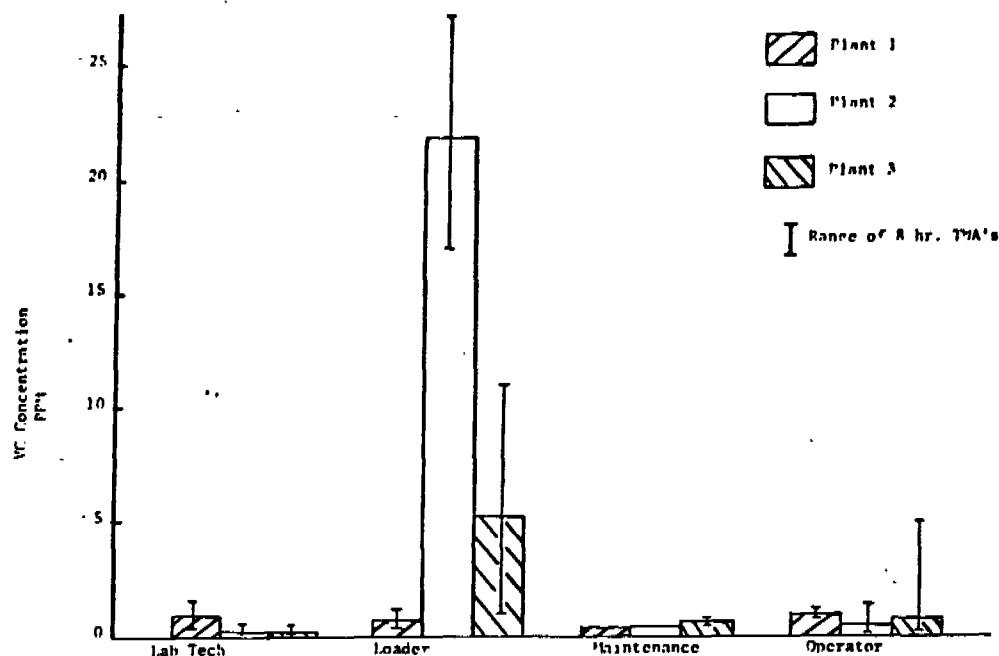


FIGURE 1. Means and ranges of VC exposures in VC monomer production plants.

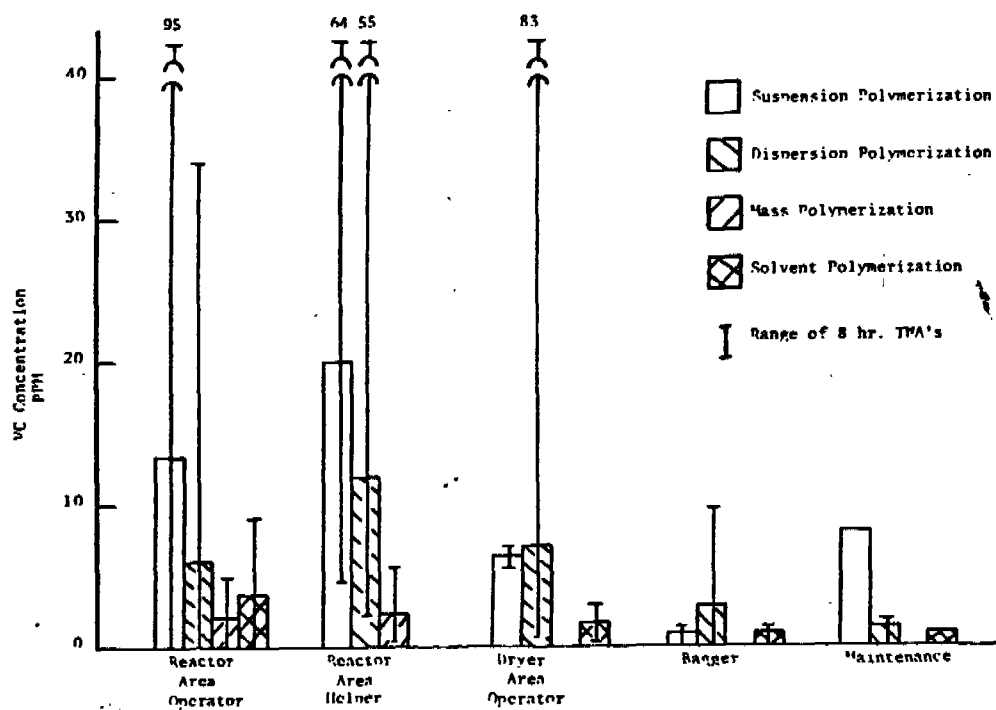


FIGURE 2. Means and ranges of VC exposures in VC polymerization plants.

PVC Fabrication Plants

In the seven PVC fabrication plants samples were collected in calendering, compounding, extrusion, molding, and plastisol operations. All exposures were quite low with calender operators having the only exposures above 1 ppm. Figure 3 shows the relationship of VC exposure between the segments of the PVC industry. As would be expected, VC polymerization had the highest exposures and PVC fabrication the lowest.

Changes in Exposure Since 1974

We have no information generated by NIOSH and know of none in the literature on how VC monomer plant exposures have changed since 1974, although it would be expected that the single "high" exposure category, loader, has had exposure reductions.

Information on how well VC polymerization plants were able to reduce exposures since 1974 was obtained during the control technology study. This information is in the form of company personnel sampling data for VC over a period of time. At the first plant, a mass polymerization plant, the percentage of personnel samples below 1 ppm has gone from 2% in 1974 to 73% in 1976 (Fig. 4). At the second plant, a suspension and dispersion polymerization plant, the percentage of personnel samples

below 1 ppm has gone from 0% in 1974 to 65% in 1977 (Fig. 5). At the third plant, a mass polymerization plant, VC exposures are given by job for the period October 1974 to May 1975 and then for January 1977. In Figure 6, it can be seen that exposures dropped substantially, in most cases by a factor of almost 10. VC exposures at the fourth plant, a suspension polymerization plant, are given for both 1975 and 1976. As seen in Figure 7, in most cases a two-fold drop in exposure levels occurred. Although the percentage drop is lower than the third plant, the final exposures are about the same. At the fifth plant, a dispersion polymerization plant (Fig. 8), VC exposures are given by job for the period May 1975 to December 1975 and then for January 1976 to September 1976. Again reductions were sufficient to bring exposure averages to the same approximate level (less than 1 ppm) as the preceding two plants.

PVC fabrication plants had exposures predominantly below 1 ppm in early 1975 when the industry-wide study was done. In addition to this work, HHE's have been conducted at 26 PVC fabrication plants beginning May 1974 and ending in April 1978. Detectable levels of VC were found in only 10 plants with only 1 plant of the 15 sampled since April, 1975 having detectable levels. At that plant sampled in March, 1976, the highest level found was 0.38 ppm.

PVC dust exposures were also briefly examined

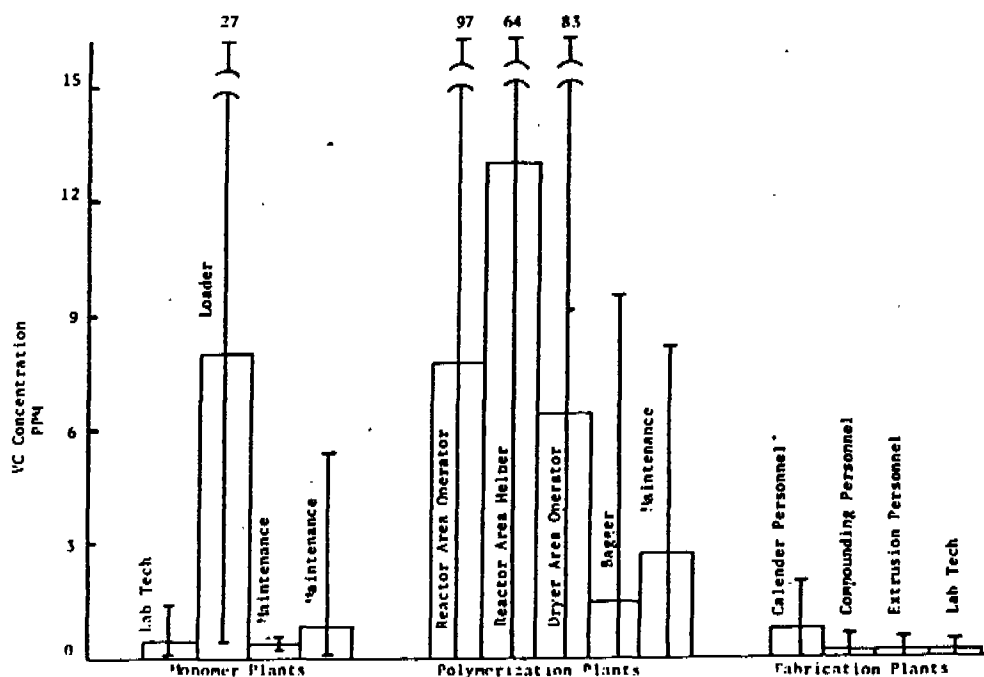


FIGURE 3. Means and ranges of VC exposures in VC related industries.

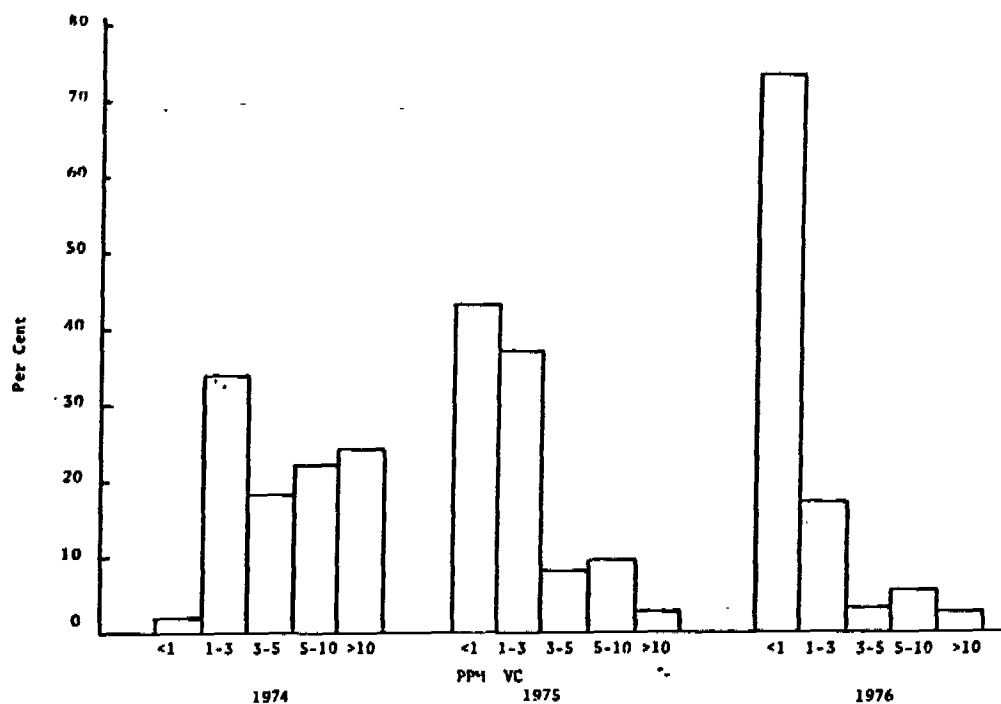


FIGURE 4. Distribution of VC exposures at a mass polymerization plant.

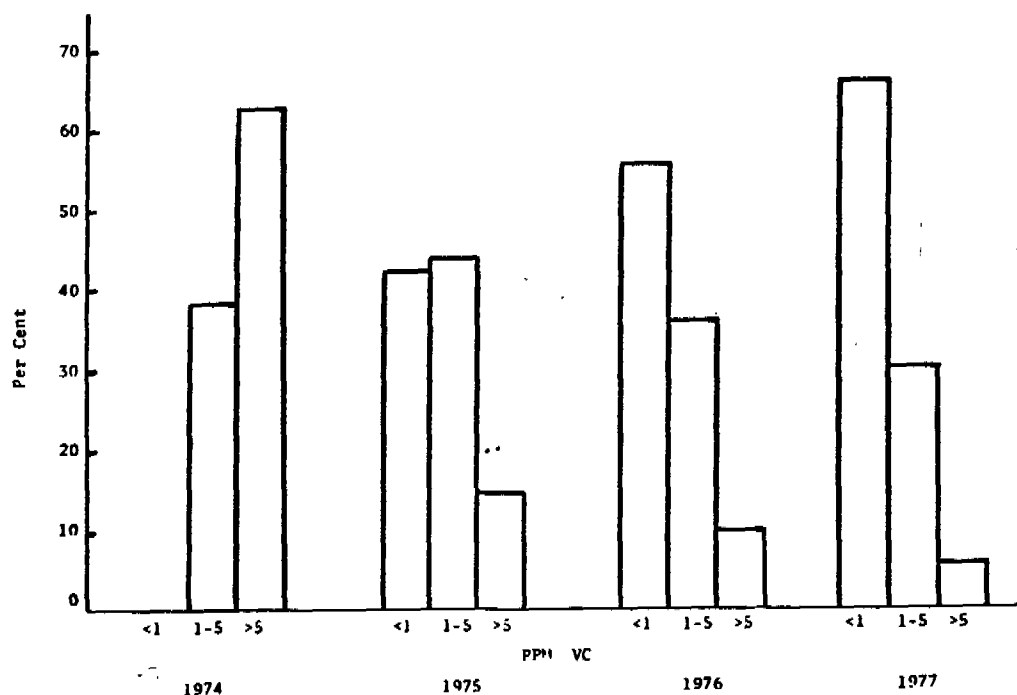


FIGURE 5. Distribution of VC exposures at a suspension and dispersion polymerization plant.

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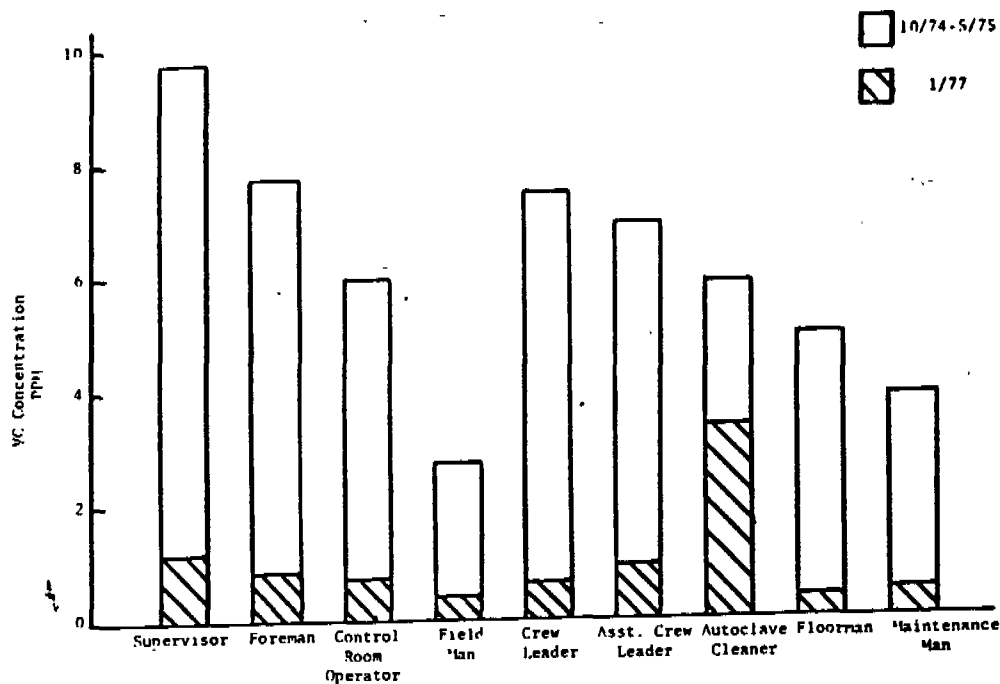


FIGURE 6. Change in VC exposures at a mass polymerization plant.

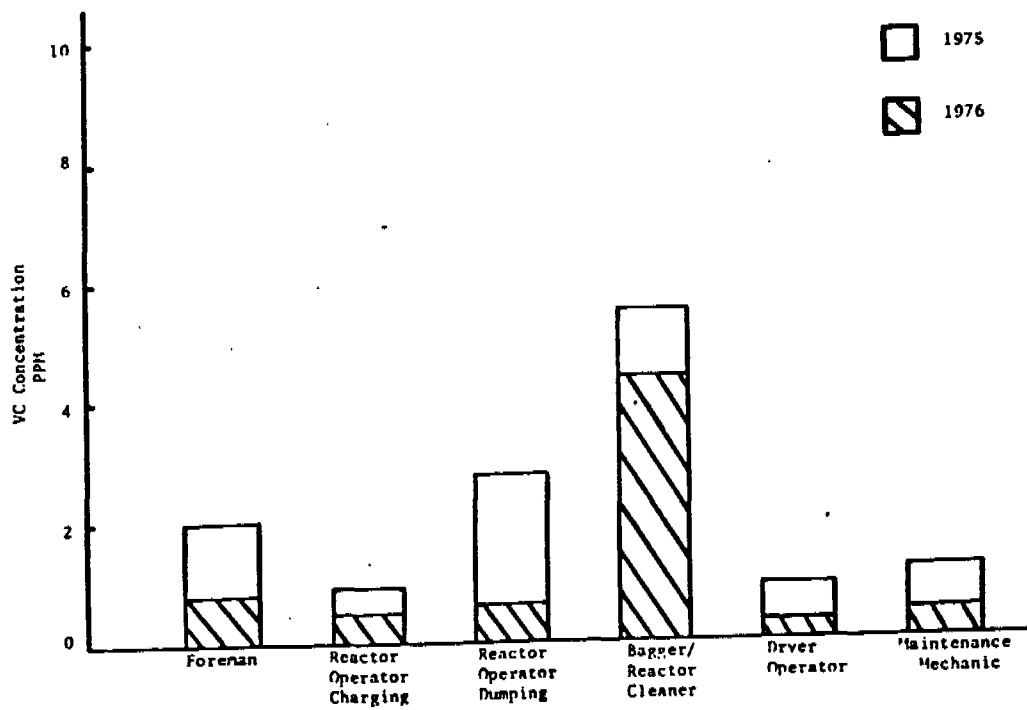


FIGURE 7. Change in VC exposures at a suspension polymerization plant.

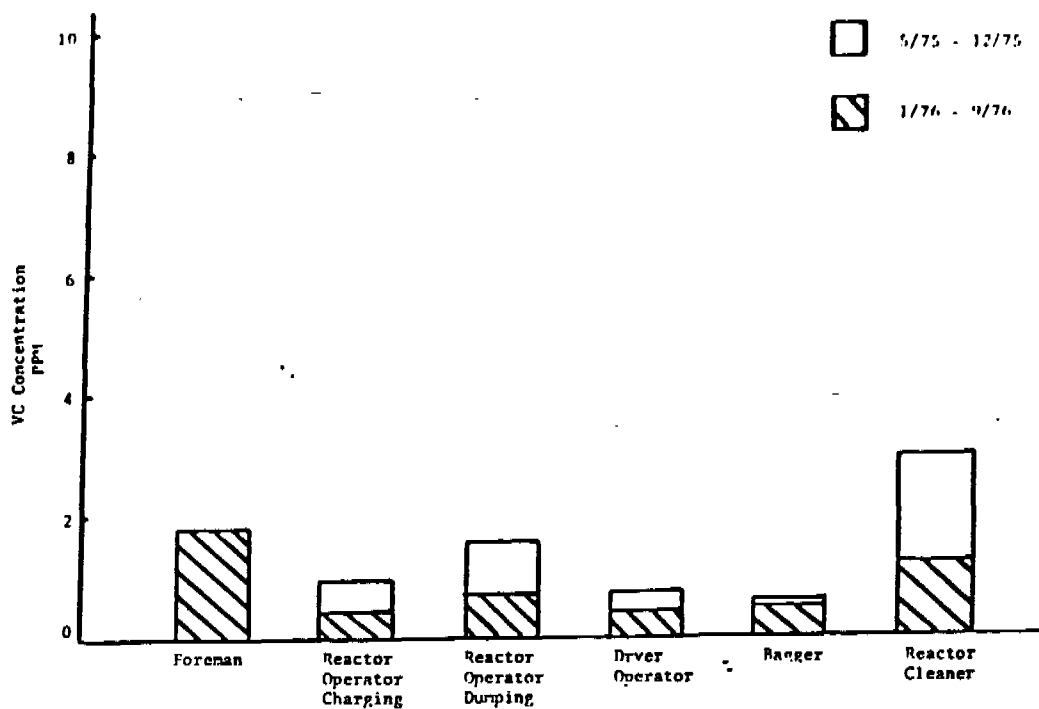


FIGURE 8. Change in VC exposures at a dispersion polymerization plant.

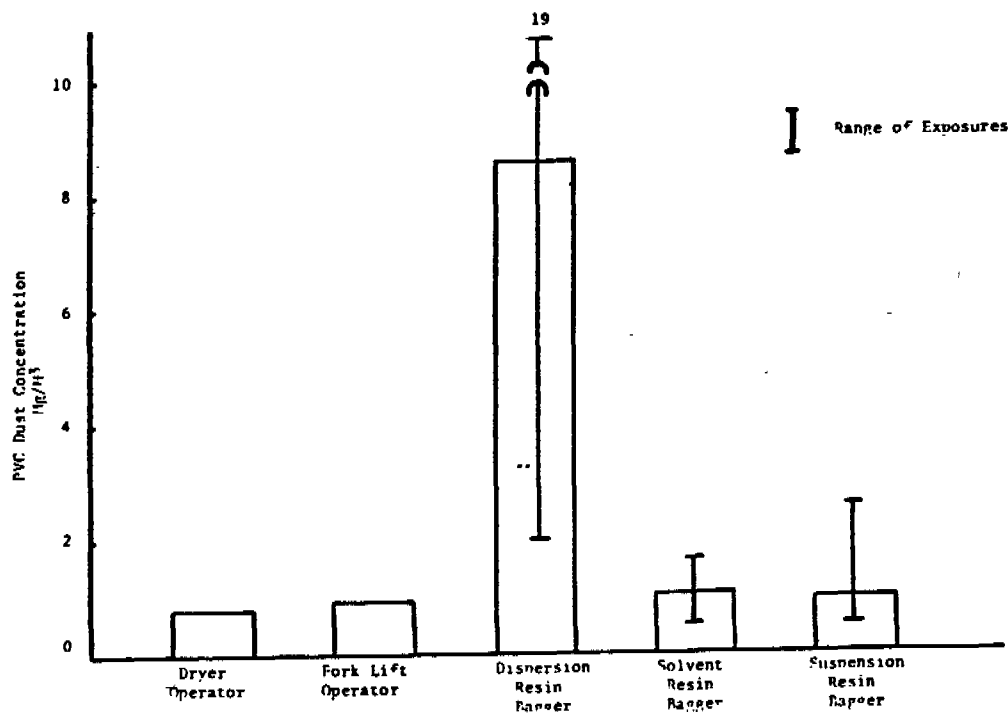


FIGURE 9. PVC dust exposures at VC polymerization plants.

uring the industry-wide study. Total dust concentrations were determined. Because it was felt that VC would be the primary constituent of the dust, no analysis for PVC was performed. Respirable samples were not collected because it was felt that the static charge on PVC particles would cause malfunctioning of the normally used sampling equipment, such as nylon cyclones. A few samples were examined by optical microscopy. In these samples all particles had diameters less than 7 μm , and 90% of the particles had diameters less than 2.5 μm . The samples examined were from dispersion resin operations.

This result was expected, since dispersion resins generally are in the range of 2-10 μm in diameter. Suspension resins, the major resins in terms of production, are generally much larger, about 100 μm in diameter. The sampling results displayed in Figure 9 show that dispersion resin bagging had by far the highest exposure, averaging 8.6 mg/m^3 . We have no information on whether PVC dust exposures have been reduced since 1974.

It appears, based on the information that we currently have that the PVC fabrication industry has achieved good control of VC exposures. The VC polymerization industry was making big strides in controlling exposures, but we have no information at all if they have continued to lower exposures since 1977. We have no information on exposure reductions in the VC monomer production industry, but it appeared that only one job category was significantly above the standard in 1974.

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