MEMORANDUM

ACS CONVENTION - SAN FRANCISCO, CALIFORNIA

SYMPOSIUM ON VINYL CHLORIDE: A CASE HISTORY

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Summary:

The highlights of the symposium on vinyl chloride at the ACS meeting in San Francisco September 1-2, 1976 were:

1.) An excellent paper on Risk-Benefit Analysis for Toxic Chemicals as illustrated by vinyl chloride, by Dr. Richard Wilson of Harvard University. He concluded that "occupational, community and public risks from inhalation and ingestion are small compared with other hazards in life and are small compared to the benefits of vinyl chloride use."

2.) The capital cost of OSHA-type controls in Western Europe has been $50MM compared to $240MM in the U.S. (plus $80MM/yr operating cost), inspite of the fact that total PVC comsumption in Europe is some 50 percent higher than in the U.S. The difference? Most European standards set long-term exposure limits of 5-10 ppm, with excursions to as high as 50 ppm in contrast to the U.S. standards of 1 ppm 8-hr TWA and 5 ppm 15-min TWA.

3.) OSHA and EPA continue to show no appreciation of the difficulties nor concern for the costs involved in meeting the extremely tight restrictions they have (or are about to) imposed versus the minimal additional benefits to be gained compared to the more realistic European standards.

Discussion:

The symposium covered two days, with some fifteen invited speakers, representing academia, industry and governmentent regulatory agencies, each allocated forty-five minutes on the program. The attendance was disappointingly poor, ranging from 10-15 up to a peak of perhaps 30-40. This was in marked contrast to the AIChE meeting in March, 1975, in Houston, which had to move to a larger room because of an overflow crowd of well over 100. Perhaps this says something about a loss of "crisis status" for vinyl chloride now that the OSHA regulation has been upon us for some time and we have more or less learned to live with it.

The most discouraging feature of the program was the evident continued lack of any appreciation on the part of the government representatives of the difficulties faced by the industry in meeting the plethora of regulations nor any concern for the enormous costs involved in meeting additional regulations versus the miniscule additional benefits which might be gained. No consideration of benefit-vs-cost was apparent in any of the three presentations by the representatives of OSHA, EPA , and FDA, i.e., no attempt was made to argue that a demonstrable hazard still exists.

The remainder of the program consisted of papers of representatives from industry (who might be accused of bias) and from the university community (who would generally be considered unbiased). These speakers were unanimous in their appraisal that no significant future hazard could possibly remain at the current level of regulation. Of particular interest was an excellent paper by Dr. Richard Wilson of Harvard University on a Risk-Benefit Analysis for Vinyl Chloride. The author has a copy of this paper which can be made available to interested parties. (Most of the speakers did not have printed handouts at the meeting, but the entire proceedings is expected to be published within the next few months and a copy will then be available.) Comments on individual papers follow.

Risk-Benefit Analysis For Toxic Chemicals: Vinyl Chloride
Dr. Richard Wilson, Harvard University

This was an excellent paper which attempted to make some estimate of the risk involved from continued exposure to vinyl chloride at the low dose levels currently allowed by government regulation and also indicated some of the benefits from continued production of poly(vinyl chloride). It should be noted that Dr. Wilson has no connection with the PVC industry and, therefore, his analysis is free of any bias that might be attributed to an industrial statistician. He utilizes a linear extrapolation from high exposure data to low doses, which he points out is very conservative and may in fact be 100 to 1000 times too high. Even so, he concluded that even this estimate "is adequate to show that we should continue to manufacture vinyl chloride and polyvinyl chloride and that reduction in present concentrations will be more expensive than the risk can justify." Selected Occupational Hazards given for comparison were as follows: (Risk = probability of occurrence, e.g., 1 in 4 coal miners would be expected to contract black lung disease during their lifetime.)

	Lifetime Risk	Annual Risk
Coal mining		
Black lung disease	0.25	0.01
Accidents	0.08	0.003
Commercial Airline pilots		
Accidents only	0.006	0.0002
Fire fighters	0.03	0.001
Vinyl Chloride worker		
Liver cancer	0.00001	0.000004
All cancers	0.0003	0.00001

He also estimates the possibility of vinyl chloride related cancers or other deaths among the 4.6 million people who live within 5 miles of a VCM or PVC plant at the exposure levels possible under the current regulations. With an upper-limit probability of 10^{-7} , one arrives at the possibility of one VC-related

death in two years, compared to about 25,000 natural cancers per year in the same population. He notes that "there is no medical evidence that there is an unusually large risk for people living near a vinyl chloride plant in spite of several searches for such evidence. Nor at these levels should we expect it. It would not have been possible to detect a risk of the size we estimate here. It is for this reason that our main reliance must be on calculation." In contrast to the 10^{-7} probability/yr of an early fatality calculated for the 5MM population living in the vicinity of a VC plant are $3X10^{-3}$ for cigarette smokers and $3X10^{-4}$ applied to the entire U.S. population for automibile accidents.

Dr. Wilson goes on to develop some of the benefits to society from the use of PVC. Among other points, he cites the use of electrically conducting PVC to replace rubber in conveyor belts in coal mining, thereby reducing the probability of a spark and consequent fire. He estimates this one application could save 10 lives per year, which is many times the projected mortality from future exposure to VCM. In monetary terms the benefits are many thousands of times the values estimated for the risks.

Another important point was made which should be noted. We should expect to continue to see 10 or more cases of liver cancer per year (worldwide) for several years among workers already exposed to high levels of VCM over long periods of time and these should not be cited as evidence that the current levels are still hazardous. Again I qoute Dr. Wilson: "Another 100 to 200 cases might yet appear. It is important to be prepared for this, otherwise vinyl chloride workers may lose confidence in the effect of the presently improved working conditions."

The PVC Industry in Europe
Dr. John Stafford, ICI Plastics Div.

Dr. Stafford reviewed the importance of PVC in Europe (average consumption per capita is slightly higher than in U.S.). He also presented the latest regulations on allowable exposures to VCM in various European countries. Only Sweden has followed the U.S. 1 and 5 ppm standard. The others ranged from 5 ppm TWA (1 week)/ 15 ppm max in France to 10 ppm TWA (8 hr)/30 ppm max in UK and 5 ppm TWA (1 year)/ 15 ppm TWA (1 hour)/50 ppm max in West Germany. Actual area averages were indicated as 1-5 ppm with excursions to 10-15 ppm. He estimated $25MM had been expended in the UK to reduce worker exposures to that level, with another $25MM in the rest of Europe. (This is far less than the increment in annual operating costs in the U.S., let alone the capital costs.)

The Analytical Chemistry of Vinyl Chloride
Dr. Richard Laramie, Continental Oil Co.

Dr. Laramie discussed some of the techniques for determining trace quantities of VCM. Two points of interest were noted. He says head space analysis for VCM in resins is far superior to solution techniques and he described techniques for analysis for VCM in water (e.g., after exposure to PVC pipe) sensitive to 2 parts per billion.

Diffusion of Vinyl Chloride
Dr. A. R. Berens, B. F. Goodrich

He described work measuring diffusion rates in and out of PVC particles and presented equations quantifying their data. (The pace was too fast to obtain notes on the equations but they should appear in the published proceedings.) The general conclusions were much the same as have previously been reached. D (diffusion coefficient in resin) is of the order of 10^{-11}, and influenced substantially by temperature; diffusion rate varies with the square of the particle size; diffusion is very rapid once the VCM gets to a pore. He finds no effect of molecular weight on D over the range of commercial samples he examined. Several references to published papers which cover portions of this data were obtained.

The OSHA Response
Mr. Grover Wrenn

Mr. Wrenn discussed the chronology of the OSHA response to the "VCM problem" leading to the regulation under which we currently are operating. He showed a distressing lack of any accurate knowledge of the effects the regulation has had on capacity and costs for PVC production nor did he show any concern at all for cost/benefit analyses of the type presented earlier by Dr. Wilson. There was no indication of any commendation to industry for an amazingly effective job of reducing worker exposures in a very short period of time, but rather the official attitude seems to be "See, we told you all along you could do it. You just didn't have enough confidence in your own capabilities." He indicated considerable pride that VCM demonstrated that OSHA can be a "technology-forcing" agency and he obviously feels this is a proper role.

The EPA Response
Miss Susan Wyatt

The planned promulgation date for the EPA standard is October, 1976. The provisions apparently will be very close to those indicated in the proposed regulation we received last spring. EPA projects a 95% reduction in ex-plant exposures from 1974 levels although admitting that the effect of the EPA standard itself will not be that significant. They project a maximum 24 hour TWA outside any plant of 0.30 ppm. Their estimated costs to industry are $183MM capital and $58MM annual operating cost increase and a potential PVC price increase of 7.3%. All of this inspite of the fact that no one has been able to show any adverse health effects from living near a PVC plant even over the many years of admittedly grossly higher emissions than are present now. Dr. Wilson's paper pointed out that the potential risk for the population outside the plants is so small that there is no justification at all for futher expenditures to reduce emission levels below where they currently are. Nevertheless, EPA says they must regulate and thus the PVC industry, and ultimately the consumer, is stuck with another unnecessary multimillion dollar bill.

The FDA Response
Mr. Richard Ronk

Mr. Ronk apparently personally (and unofficially) feels there is a threshold level for VCM carcinogenic properties and therefore PVC packaging made with today's technology is safe. Officially, however, it is impossible to prove absolute safety and therefore it is probable that a regulation will eventually issue calling for no migration to food. He also anticipates that FDA will "avoid like the plague" defining what "no migiation" means.

Suspension and Dispersion Resin Plants
Mr. W. C. Holbrook, B. F. Goodrich

Mr. Holbrook presented some general statistics regarding the suspension and dispersion PVC industries. The bulk of his presentation was spent in praising what a fine job BFG has done in developing and implementing new technology for monomer control and included an extensive commercial for their "Hydraulic Reactor Cleaning System," "Clean Reactor Technology," and "Goodrich Improved Stripping Technology," which just happened to be available for licensing. He neglected to mention that the BFG Louisville plant has experienced the highest number of angiosarcorna deaths of any single plant in the world, and is responsible for over one-half of the U.S. cases. (One could say they needed some improved exposure controls!) Some of the statistics of interest: BFG is the largest producer of PVC in the U.S., with approximately 1 billion lbs capacity in five plants. He indicated > 130 R&D people have been involved and estimates $36-42 million in capital expenditures for compliance with the OSHA and EPA regulations.

Specialty Vinyl Chloride Resin Processes - Effects of Governmental Regulations
Mr. R. N. Wheeler, Union Carbide Corporation

Mr. Wheeler discussed solution, latex and continuous bulk polymerization processes which combined account for < 5 percent of the total PVC industry. He pointed out areas where the existing and pending regulations, written for the other 95 percent, pose special problems for the specialty processes. Mr. Wheeler had printed handouts of his paper at the meeting and a copy is available for loan to anyone who is interested.

Bulk Polymerization Plants
Mr. Ray Abranowitz, Hooker Chemical

Mr. Abranowitz discussed the 2-stage bulk process (sometimes known as Pechiney Saint Gobain or PSG), which has major differences from the UCC continuous bulk process. Four U.S. companies (Certain-Teed, B. F. Goodrich, Goodyear and Hooker) now operate PSG plants with a combined capacity of approximately 650 million lbs. Hooker's Burlington, N.J., plant is approximately eight years old and has a capacity of approximately 180MM lbs/yr. They monitor VCM at 60 remote points with 6 Bendix GC's. Cycle time is 90 sec. per pt which gives a repeat time on each point of 15 minutes (compared with our 40 min). They also have an alarm setting at 5 ppm. Background levels in 1974 were 10-20 ppm, have now been reduced to 0.5-1.0 ppm, with higher "excursions in localized areas." He indicated they expect to use activated carbon for some vent streams. Quoted 1975 efficiency of monomer to polymer was 98.8%. In connection with the EPA regulation, he mentioned they have no aqueous effluents, which indicates they are not slurrying the resin for stripping purposes. They apparently vacuum strip in the 2d stage reactor (to $\lesssim$ 400 ppm in most cases) followed by a "proprietary fluidization process" by which they expect to achieve < 1 ppm in commercial resins.

PVC Processing Plants
Mr. Bob Rehall, Diamond Shamrock

Mr. Rehall reported data which indicate processing plants have very few problems with current low VCM resins, and in fact had only minor problems in 1974 when RVCM levels in resin ran several hundred to a few thousand ppm. Processors are generally below 0.5 ppm (OSHA action level) in all areas except, in some cases, resin storage areas. These can be cured by ventilation. He cited one measurement of 150 ppm in a resin silo 1 ft above the resin surface, with the resin containing 50 ppm. Human exposure at such a location would not be expected.

Moderator's Remarks
Dr. Si Gilbert, Rutgers University

Dr. Gilbert works in the area of safety of food packaging and has developed techniques for measuring VCM down to the parts per billion range. He was very forceful in his views that PVC food packaging poses no health hazard. He is opposed to undue haste in banning use of VC-based resins for packaging applications (many times there is no acceptable substitute), and urges a more rational approach to the use of resources - financial and personnel - to problems of most importance, rather than the "blind panic" crash approach which has characterized the VCM situation.

The PVC Pipe Industry
Mr. Randy Prust, Johns-Manville

Studies were described leading to a mathematical model to predict the maximum concentration of VCM which could diffuse into water from pipe with a specified RVCM. Static extraction for seven days could give approximately 0.005 ppm from pipe with 150 ppm. Field tests in five communities on samples of water drawn through 6000-66000 ft of pipe produced in 1969-1974 (RVCM level unknown, but likely > 200 ppm) gave no detectable VCM with analytical methods sensitive to 0.002 ppm. Figures were cited showing the major drop in RVCM in pipe over the past three years until in April of '76, 90% of pipe and 50% of fittings were < 10 ppm. The National Sanitation Foundation Industrial Advisory Board has proposed, effective February 1, 1977:

1) RVCM level must not exceed 10 ppm in PVC pipe or fittings (for potable water service).
2) RVCM level in PVC resin or compound must be low enough to allow preparation of pipe and fittings < 10 ppm.

(Editorial comment: At that level, one would drown long before you could drink enough water to get a significant dose of VCM!)

The PVC Bottle Industry
Dr. Albert Haefner, Ethyl Corp.

The data presented was addressed to the use of PVC bottles for liquor. The maximum concentration of VCM which could be extracted into the liquor is a function of the VCM in the bottle compound and reaches a maximum 3-4 years after filling. In the spring of 1973 up to 7 ppm of VCM was found in liquor which had been bottled in PVC for two years. In retrospect, the resin probably contained up to 3100 ppm and the compound approximately 250 ppm. Current compound is now < 1 ppm. From his data, Dr. Haefner calculates a "worst case" of 50% ethanol, 16 oz bottle, 1 ppm VCM in the compound might reach a maximum of

~ 25 ppb in 3-4 years after filling and storage at 72°F.

The PVC Rigid and Semi-Rigid Sheet Industry
Mr. Mike Saggese, Tenneco

Mr. Saggese was not present at the meeting. His paper was read by the moderator, Dr. Gilbert. The proposed FDA ban on use of PVC for food packaging would require showing < 1-2 ppb could migrate to food. (Saggese's conclusion; Mr. Ronk of FDA indicated they would not define a limit for "no migration.") Tenneco proposed satisfying that requirement by starting with resin ≤ 3 ppm, reduced via sheet processing to < 350 ppb.

Prior Sanctioned PVC Plastics-Flexible
Dr. Eugene Skeist, Borden Chemical Co.

400MM lbs of PVC will be used in food packaging and medical applications in 1976. There is no possibility of VCM migration into food at detectable levels. Calculations can demonstrate < 1-2 ppb to < 40 ppt (parts per trillion) for most types.

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