

POLYVINYL CHLORIDE RESIN
ENVIRONMENTAL IMPACT
WHITE PAPER

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BACKGROUND

The PVC Industry

1. Introduction

PVC plastics are among the oldest of the major plastic materials. The first commercial plant to make PVC resin was constructed in 1939. There are currently twenty-one (21) separate producers of PVC resin operating thirty-six (36) plants in the U.S.

PVC resin is a white powdery material which is made from vinyl chloride monomer (VCM--a gas under standard conditions of temperature and pressure and a liquid when transported and stored under pressure). PVC resin, as such, cannot be processed but must be made into a PVC compound which contains several other additives (such as plasticizer, stabilizer, and colorant) in addition to the basic resin, in order to fabricate it into useful product forms. Because they can be compounded to yield a wide range of materials with specific properties, PVC resins are used in more applications than any other type of plastic material.

2. Vinyl Chloride Monomer (VCM)

VCM is the basic feedstock for PVC and the industry is made up of nine (9) producers (see Exhibit I). Four (4) companies (Shell, Dow, PPG, and Allied Chemical) produce VCM for merchant sale only and together they account for over half of the current total VCM capacity. The other five (5) producers make VCM largely or completely for captive use in making PVC resin. (Hooker should also consider VCM production).

In 1973, the U.S. production of VCM was about 5.3 billion lbs. valued at about \$292 million (about 5.5¢/lb. on average). In 1974, VCM production was approximately 5.5 billion lbs., but at about 9¢/lb; the 1974 VCM market value was nearly \$500 million. This production required roughly 2.8 billion lbs. of ethylene and 3.7 billion lbs. of chlorine as raw materials having a combined market value of about \$300 million. Total industry nameplate capacity is now about 6.4 billion lbs. of VCM. When operating rates, losses in polymerization, exports and other uses are applied, there appears to be an actual VCM capacity of 5.3 million lbs. available for PVC conversion. At present, no new VCM capacity is under construction in the United States. Since it takes approximately 2 1/2-3 years to build and start up a VCM plant, decisions on new capacity expansions are needed in the very near future to allow for continued PVC resin growth beyond 1976. In 1974, it is estimated that 940 workers were employed in the VCM industry; 77% were employed in the manufacturing operations.

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3. PVC Resin

The term PVC resin is used to describe a family of synthetic polymers in which the vinyl chloride monomer content is over 50% by weight. In practice, the VCM content is usually 85% or more. Resins which are made from VCM only are called homopolymers and those containing other monomers (such as vinyl acetate) are called copolymers. Homopolymers represent about 85% of total PVC resin output.

The total production of PVC resin in 1973 was about 4.5 billion lbs. valued at about \$550 million (14.5¢/lb.). In 1974 production was 4.6 billion lbs. valued at \$920 million (20¢/lb., on average). About one-quarter of the total world production of PVC resin is made in the United States. The industry rated capacity of the twenty-one (21) existing PVC resin producers is now about 5 billion lbs./yr. (See Exhibit II) However, at least one-third of the existing resin producers are expanding their capacity and at least two (2) new producers are entering the market. By the end of 1975, the total PVC resin capacity will be about 6.4 billion lbs.

PVC is the most versatile type of synthetic resin produced and is used in more individual end products than any other type of plastic material. It is possible to identify over twenty-five (25) individual end use product areas for PVC, each of which accounts for between 1 and 29% of the total PVC resin market. By grouping these products into broad market categories, it is possible to estimate that over half of all PVC resin is used to make products that are classified as building and construction materials. This includes pipe, conduit, flooring, wire and cable insulation, siding, panels, window frames, wall covering, trim, and gaskets and sealing materials. Home furnishing and household goods taken together represent about 12% of the overall PVC resin usage. This broad grouping of products includes furniture upholstery and decorative laminates (using PVC printed films) for furniture and TV cabinets, table covers and shower curtains, garden hose, appliance components (e.g., hoses and gasketing) and window shades. The end-use market called consumer goods, which also represents roughly 12% of PVC resin use contains items such as phonograph records, footwear (e.g., shoes, boots), and athletic goods, luggage, handbags and many other products. Packaging materials, such as flexible and rigid film (used for packing fresh and processed meats, produce, cookies and candy as well as non-food products (e.g., blister packs), bottles and can and closure lining (coating) materials account for about 8% of total PVC resin sales. The transportation equipment industry (mainly motor vehicles) in total represents about 6% of the PVC resin market. The major products include upholstery materials, trim, headliners, wire and cable insulation, floor mats, and external (e.g., Landau-type) tops.

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The remaining 9% of the domestic PVC resin market is composed of a miscellaneous products category containing hundreds of individual applications. Among the most significant are: medical products (e.g., tubing, blood bags), stationery supplies, book covers, and bindings, conveyor belting, credit cards, tools and hardware (e.g., handles), agricultural products (e.g., reservoir liners), and novelties. Exhibit III presents an approximate end-use breakdown of the PVC resin market.

PVC is produced in sixteen (16) states, as shown in Exhibit IV. Production is close to raw material supply (VCM) or near resin market centers.

- Over 50% of PVC resin capacity is concentrated in five (5) states - Ohio, New Jersey, Texas, Massachusetts, and California.
- Within these five (5) states are located eighteen (18) producing plants.
- Only ten (10) plants are located in warm climates where open structures are possible; the remaining twenty-six (26) plants are situated in states having moderate to cold temperatures.
- The PVC manufacturing industry has approximately 5000 plant employees. Estimates were developed based on the 1974 production level.
- Approximately 3,100 workers identified with suspension processes represent 62% of industry employment; while emulsion process workers represent 26%; bulk and solution process workers represent 12%.
- 55% of PVC plant employment is represented by production workers, while 24% by maintenance personnel. The remaining force consists mostly of management personnel.

DISCUSSION

Vinyl chloride monomer (VCM) has always been known to be a hazardous material due to its high flammability. Recently, however, it has been determined that VCM is highly suspect as a carcinogen. This has been confirmed for high levels of concentration both on rats and by human experience.

In early 1973, B. F. Goodrich announced that several workers in their PVC operations had died from a rare form of liver cancer

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(angiosarcoma) which they believed to be associated with massive exposures to VCM over a period of years.

These findings have resulted in a flood of new and/or proposed legislation by the various environmental agencies that have legislative control over the manufacture and sale of PVC materials. These agencies are:

Occupational Safety & Health Administration - OSHA (Labor Dept.)
Environmental Protection Agency - EPA
Food & Drug Administration - FDA (HEW)

Each agency's impact on the industry is assessed below.

OSHA

The Occupational Safety & Health Administration is primarily concerned with controlling the manufacturing environment with the basic goal of protecting the workers in the plants.

OSHA has issued a standard for vinyl chloride monomer; 1910.93q, effective on April 1, 1975 that calls for the following actions by industry and Ruco.

1. Monitoring the plant environment for VCM level.
2. *Any exposure to VCM above 1ppm (parts per million) is prohibited and engineering changes must be instituted to try to get the work environment below 1ppm. Until the VCM exposure is reduced to 1ppm, all workers exposed must wear fully contained air breathing respirators.
3. All workers must be given certain medical tests at six (6) month and one (1) year intervals.
4. Extensive record keeping is required.

*Until April 1, 1976, a worker can elect not to wear a respirator provided the VCM level is below 25ppm.

So far, the OSHA regulation has not resulted in any major PVC plant shutdowns; primarily, because the worker is exercising his right not to wear respirators below 25ppm.

There have been several small PVC operations that have announced shutdown of either all or part of their plants as follows:

<u>COMPANY</u>	<u>LOCATION</u>	<u>CAPACITY</u>
Uniroyal	Painesville, Ohio	120 mm lbs.
Olin	Assonet, Mass.	150 mm lbs.
Goodyear	Niagara Falls, N.Y.	60 mm lbs.
Ruco	Hicksville, N.Y.	12 mm lbs.

The full extent of lost productive capacity in both industry and Ruco will not be known until we observe the operations after next April 1 when respirators for all personnel will be mandatory. We believe there will be a slight reduction in productive capacity (less than 15%) for at least the first year and then each year thereafter will see improvements until the industry is again at 100% capacity.

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We do know that the OSHA ruling has caused industry and Ruco to spend money for equipment and process changes in an attempt to reduce worker exposure to below 1ppm. We ourselves have appropriated to date, \$960,000 of engineering and/or plant changes. In addition, the use of air mask cannisters, uniform changes (\$1.50/day/man), medical costs (140-160 \$/year/man), monitoring costs and increased utility costs have been estimated to increase the industrys' operating costs between 1¢ and 2¢ per lb. (including added depreciation).

We believe that once the PVC industry recovers from the current recession that we will be able to pass these costs on to the consumer.

In the future, we can continue to look forward to capital expenditures as OSHA keeps the pressure on industry to reduce VCM exposure of industry workers. In addition, the need to keep the plastic fabricators from not being controlled (less than 0.5ppm) is causing a complete change in the PVC resin manufacturing process to provide the market with low residual VCM in the base PVC resin as shipped. We are responding to these market changes and expect to be able to keep abreast of our competitors; providing of course, that capital will be made available to support Ruco in this endeavor. We will soon submit an AFE to purchase and install a post stripper that will permit us to get down below 5ppm residual VCM in the resin. The original pilot operation will cover 25% of the plant and is expected to cost \$800,000.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency has proposed to establish a national air standard for public exposure to VCM under the premise that VCM has been proven to be a hazardous material. This proposed rule is expected to be issued within the next sixty (60) days.

The PVC industry through the Society of the Plastics Industry, Inc. has hired the former head of EPA, William Ruckelshaus, to represent the VCM/PVC industry in this EPA area. The industry has had a meaningful dialogue with the EPA staff and many changes have been introduced in the latest EPA draft document that reflect some of the industry's concern about the original draft. We do not foresee the EPA ruling having any significant effect on the industry's ability to produce PVC resin except in the area of capital spending. In this regard, the EPA estimates that the cost of the compliance could add 20% to the cost of making PVC resin. Basically, the EPA is proposing to limit plant emission points to be lower than 10ppm. This control is to be either carbon absorption and/or incineration.

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Until the EPA standard becomes final, we have no real basis for assessing the actual impact of this standard. We do know, however, that the Ruco bulk PVC plant is, in the eyes of the EPA staff, the third best plant in the country to-date as far as VCM emissions are concerned. This is mainly due to the fact that the bulk process has no water pollution problem when compared to the standard suspension PVC process.

FOOD & DRUG ADMINISTRATION

The Food & Drug Administration has responsibility for protecting the public from impure foods and/or from toxic substances that could enter the food as additives, such as might migrate from a food package. They also control the use of cosmetics, drug, toiletries, and potable water.

FDA has expressed a sharp interest in all uses of PVC in packages that might cause VCM to migrate into food. A three tier approach to the control of VCM was proposed on September 3, 1975 as follows:

1. The first part of the proposal reaffirms the prior sanctioned status of PVC as a food contact material if used in "flexible" applications. The FDA position here is that the compounding (adding plasticizer), and fabrication techniques release residual VCM so that there is no likelihood of VCM becoming a food additive due to migration. This ruling essentially OK's the use of PVC meat and produce wrap, can coatings, bottle cap liners, etc.
2. The second part of the proposal states that the FDA believes that PVC pipe for carrying potable water is OK because there is no reasonable chance for VCM to get into the water due to the continuous nature of water flow. Industry has sixty (60) days to set up programs to confirm the FDA position.
3. The third part of the proposal is to withdraw the prior sanctioned status of PVC as a food package in PVC bottles and rigid packages (e.g., pre-packaged luncheon meat). In the proposal, the FDA invites food petitions by industry to show no "reasonable" expectation of VCM becoming a food additive. This ruling, if upheld, could cause a loss of sales at Ruco of from 2% to 20% depending on whether the FDA considers mouthwash as a food. Most PVC food grade bottle compounds are not really for food, but for toiletries and cosmetics. If only PVC food packaging was eliminated, it would mean a 2-5% reduction. If, however, mouthwash is included, the impact could be 20% loss of sales (immediate) which represents lost sales revenue of \$3,000,000, and income reduction

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of \$500,000 for Ruco. In the bottle area, we are a dominant factor and we would be hurt along with Ethyl and B. F. Goodrich. The rigid meat wrap producers (Tenneco and American Hoescht) would also be seriously affected by a complete ban of PVC used for luncheon meats.

Industry (SPI) is forming small select committees to present comments to the FDA proposal by November 3, 1975, the end of the sixty (60) day comment period. Industry hopes to show that new technology is such that there is "no reasonable expectation" of VCM migration from food packages made of rigid PVC. The question is largely political inasmuch as we have practically no VCM migrating from food containers (less than 50ppb(part per billion)) at this time.

CONCLUSION

It's much too early to draw precise conclusions regarding the total impact of all of the regulatory bodies, but it appears that it will be significant at least in the area of capital expenditures.

We, as well as the suspension PVC people, expect to be able to adequately resolve the technical issues that arise. Ruco expects to remain a viable PVC supplier.

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EXHIBIT I

PRODUCTION, PRICE, VALUE, PRODUCERS AND USES OF
VINYL CHLORIDE MONOMER

Production, Price, and Market Value

<u>Year</u>	<u>Production</u> (billion lbs)	<u>Average Price</u> (¢/lb)	<u>Market Value</u> (\$ million)
1962	1.3	7.5	98
1967	2.4	5.3	127
1972	5.2	4.2	218
1973	5.3	5.5	292
1974	5.5	9.0	495

Producers and Capacity

<u>Producer</u>	<u>Annual Rated Capacity (million lbs)</u> (at August, 1974)
Shell - Texas, Louisiana	1,500
Dow - Texas, Louisiana	1,200
Goodrich - Kentucky	1,000
PPG - Puerto Rico, Louisiana	800
Continental Oil - Louisiana	625
Ethyl - Louisiana	420
Monochem (Borden & Uniroyal) - Louisiana	350
Allied Chemical - Louisiana	300
American Chemical (Stauffer & Atlantic Richfield) - California	170
Total	6,365

End-Use Pattern - 1973

<u>Use</u>	<u>Approximate Percent of Market</u>
PVC Resin	88
Export and Other	12
Total	100

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EXHIBIT II

PRODUCTION, PRICE, VALUE AND PRODUCERS OF
POLYVINYL CHLORIDE RESIN

Production, Price and Market Value

<u>Year</u>	<u>Production</u> (billion lbs.)	<u>Average Price</u> (\$/lb.)	<u>Market Value</u> (million)
1962	1.2	17.6	212
1967	2.1	15.6	327
1972	4.3	13.6	585
1973	4.5	14.5	650
1974	4.6	20.0	920

Producers and Capacity

<u>Producer</u>	<u>Annual Capacity (million lbs.)</u> <u>by December 1975</u>
Goodrich	950
Borden	545
Tenneco	480
Robintech	470
Continental Oil	430
Firestone Tire & Rubber	400
Diamond Shamrock	360
Union Carbide	350
Goodyear	300
Stauffer	300
Georgia Pacific	220
Certain-Teed	200
Air Products	190
Ethyl	180
Hooker (Ruco)	170
General Tire	165
Pantasote	85
Great American	55
Keysor	50
	<u>5,900</u>

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EXHIBIT III

END USE BREAKDOWN OF PVC RESIN

End Use and Product

% of Market Million Lbs
(Approximate)

Building and Construction

Pipe, conduit and fittings	29	1,345
Flooring	9	440
Wire and Cable Insulation (a)	8	365
Siding, panels	2	90
Wall covering	2	90
Other (window frames, trim, gasketing, sealants, miscellaneous)	2	90
Sub Totals	52	2,420

Home Furnishing and Household Goods

Furniture (mainly upholstery)	7	320
Shower curtains, table covers, etc.	2	105
Appliance parts (including hoses, gaskets)	1	40
Garden hose	1	35
Other (e.g., window shades)	1	45
Sub Totals	12	545

Consumer Goods

Phonograph Records	3	145
Footwear (shoes, rainwear)	3	140
Toys, dolls, and games	2	75
Outerwear (e.g., apparel)	2	70
Sporting and Athletic Goods (e.g., balls, bicycle grips, miscellaneous)	1	65
Other (including handbags, wallets, luggage)	1	55
Sub Totals	12	550

Transportation Equipment (mainly motor vehicles)

Upholstery and Seat Covers	4	180
Wire and Cable Insulation	1	50
Auto Tops, headliners, trim, floor mats, other	1	45
Sub Totals	6	275

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EXHIBIT III (Cont'd.)

END USE BREAKDOWN OF PVC RESIN

<u>End Use and Product</u>	<u>% of Market</u> (Approximate)	<u>Million Lb</u>
<u>Packaging</u>		
Flexible film (for fresh meats & produce)	3	135
Rigid Sheet (for cookies and candy, unit packs, blister packs)	2	105
Coatings (e.g., can linings, cap liners, gaskets)	1	50
Bottles, other	<u>2</u>	<u>85</u>
Sub Totals	8	375
<u>All Other Uses</u>		
Medical Products (e.g., tubing, blood bags)	1	45
Stationery Supplies	1	35
Agricultural Products (e.g., reservoir liners, tubing)	1	30
Novelties (including advertisement items)	1	30
Conveyor Belting	1	30
Miscellaneous (tools and hardware, credit cards, book binders and covers, other)	<u>4</u>	<u>265</u>
Sub Totals	9	435
Grand Totals	<u>99</u>	<u>4,600</u> (b)

- (a) Includes some wire and cable used in communications equipment.
(b) Domestic use only; excludes exports of about 145 million lbs.

Source: The Society of the Plastics Industry and
Arthur D. Little, Inc., estimates.

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EXHIBIT IV

GEOGRAPHIC DISTRIBUTION OF POLYVINYL CHLORIDE PLANTS

<u>States</u>	<u>Number of Plants</u>	<u>Production Capacity (million lbs.)</u>	<u>Share of Total Capacity (percent)</u>	<u>Accumulated Percent</u>
Ohio (1)	4	810	14.9	14.9
New Jersey (1)	5	635	11.7	26.6
Texas (2)	2	490	9.0	35.6
Massachusetts (1)	4	480	8.8	44.4
California (2)	3	385	7.1	51.5
Illinois (1)	3	370	6.8	58.3
Maryland (1)	1	315	5.8	64.1
Kentucky (1)	2	305	5.6	69.7
Louisiana (2)	2	280	5.2	74.9
Delaware	2	260	4.8	79.7
West Virginia (1)	2	255	4.7	84.4
Mississippi (2)	1	250	4.6	89.0
Oklahoma (2)	1	215	4.0	93.0
Pennsylvania (1)	1	190	3.5	96.5
New York (1)	2	115	2.1	98.6
Florida (2)	<u>1</u>	<u>80</u>	<u>1.5</u>	<u>100.1 (3)</u>
TOTAL	<u>36</u>	<u>5,435</u>	<u>100.1 (3)</u>	

Notes: (1) Sited in
moderate to cold climate
26

3,735

68.7

(2) Sited in
warm climate

10

1,700

31.4

36

5,435

100.1 (3)

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