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Cover: R. T. Martinott

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PVC rolls out of jeopardy, into jubilation

Rapid resurgence of demand shows vinyls are still a bargain in big-volume end-use applications. Confident that growth will continue, producers boost outlays for monomer and polymer plants

Strong demand for polyvinyl chloride in all major markets—especially packaging and textile applications—is leading to new plant commitments and price hikes. Last week, for example, both Firestone and Tenneco unveiled plans to build new PVC units, each with capacity of 200 million lbs./year or more.

Also last week, PPG joined other producers in raising its vinyl chloride monomer (VCM) price to 13.6¢/lb., a 1¢ increment equivalent to nearly 8%. Meanwhile, Diamond Shamrock added 1¢ to its tabs on PVC resins and molding compounds, thereby boosting them to levels previously set by Goodrich. Pipe-grade resin is now quoted at 25¢/lb., general-purpose suspension homopolymer at 26¢/lb.

Clearly, those actions signify U.S. vinyl producers' confidence that they have solved the "OSHA problem" that threatened the viability of their industry less than two years ago. They have installed the equipment needed to meet the worker-exposure requirements set by the Occupational Safety and Health Administration, but without inflating production costs to the point where PVC's growth might be stunted.

No Shortage in Sight: PVC capacity doesn't appear to be a problem this year. The industry has polymerization capability of nearly 6.4 billion lbs./year (see table), and its average operating rate during first-half 1976 was about 73%. Even if producers find it difficult to hold the industry-wide average to more than 80% for an extended period, their potential output would still exceed this year's projected consumption by nearly 500 million lbs. And with process improvements to increase effective capacity, producers believe they'll be able to meet the greater demand that now seems assured for next year.

Furthermore, capacity for the monomer won't be a problem in 1976. VCM producers have nameplate capacity for almost 6.8 billion lbs./year, easily enough to handle this year's probable demand of 5.5 billion lbs. VCM output was depressed earlier this year when operating problems hit some plants, but those problems have been cleared up.

And recent months brought an end to the chlorine shortage that materialized

last spring when chlor-alkali producers lowered their output rates because they were turning out more co-product caustic soda than they could sell. When caustic markets perked up, chlorine output was boosted proportionately, enabling VCM producers to make the monomer at the rate of 6.2 billion lbs./year in June, compared with their average rate of 5.2 billion lbs./year during the first five months.

Lid on '77 Output? Next year, though, VCM capacity could be the limiting factor in U.S. vinyl production. If monomer demand hits 5.5 billion lbs. this year and swells 10% in 1977, VCM producers will have to run their plants at about 85% of capacity to meet demand. That's about the upper limit for equipment utilization,



USE OF PVC, as in Monsanto's rigid vinyl gutters (above), heads for new high in 1976.

even assuming no plant mishaps.

Borden's startup of a 300-million-lbs./year plant at Geismar, La., will lift next year's total name-plate capacity to more than 7 billion lbs./year. Plant improvements may boost that figure slightly, but it's still unlikely that monomer producers will be able to turn out more than 6.3 billion lbs. in 1977.

However, VCM capacity will take a bigger jump late next year when Dow brings onstream a 1-billion-lbs./year addition to its complex at Plaquemine, La. That should enable the industry to handle 1978 demand with ease. And if 1978 ushers in a business slowdown, as some economists have been predicting, U.S. capacity then will be more than ample.

Name-plate capacity of fully 9 billion lbs./year, enough to handle anticipated 1979 demand for nearly 8 billion lbs. of the monomer, will be realized in 1978 when Diamond starts up its 1-billion-lbs./year plant near La Porte, Tex. But if VCM demand keeps on growing at anything like its long-term 12%/year rate during the 1980s, an additional 2 billion lbs./year of capacity will be required every three years. On the other hand, some of the industry's more conservative market researchers say vinyl's growth rate will drop off to 4-5%/year in the coming decade.

Three Coming, One Going? At this point, it appears that there'll be three newcomers on the list of VCM producers during the next few years and that one present producer, Allied Chemical, may leave the club. Allied has been discussing with several prospective buyers the possible sale of its 300-million-lbs./year plant near Geismar. One likely buyer: Robintech, which up to now has had no captive monomer supply for its resin production.

Borden will begin producing VCM under its own name late this year when the company's chemical division starts up its 300-million-lbs./year plant at Geismar. Borden currently gets up to 150 million lbs. of monomer each year through its 50% stake in Monochem, a Borden-Uniroyal joint venture that since 1962 has operated a 300-million-lbs./year plant also located near Geismar. It's the only U.S. VCM plant still using acetylene, rather than ethylene, as feedstock. Borden's polymerization capability is now about 545 million lbs./year, so when the PVC units are running flat-out, Borden will still have to buy monomer at rates up to 100 million lbs./year.

Biggest vertical integration move on the vinyl industry horizon will come about two years from now when Diamond starts producing VCM in the 1-billion-lbs./year plant to be built at La Porte. It's a logical move for Diamond, whose chemical division has large PVC and chlorine plants at Deer Park, Tex., and whose oil and gas division will soon be supplying ethane that will be converted to ethylene in Phillips Petroleum's olefins plant at Sweeny, Tex.—all locations that are within 60 miles of the new

Few vinyl producers are fully integrated

	Raw materials produced	Vinyl chloride capacity at mid-1976 (Million lbs./year)	
		Monomer	Polymer
Air Products		—	200
Allied Chemical	Ethylene, chlorine	300	—
Borden Chemical		(1)	500
Certain-teed		—	200
Continental Oil	Ethylene	700	395
Diamond Shamrock	Ethane, chlorine	(1)	570
Dow Chemical	Ethylene, chlorine	1,400(1)	—
Ethyl Corp.	Chlorine	450	180
Firestone Tire		—	400
General Tire		—	180
Georgia-Pacific	Chlorine	—	220
Goodrich Chemical	Ethylene, chlorine	1,000	1,010
Goodyear Tire		—	250
Hooker Chemical(2)	Chlorine	—	180
Monochem, Inc.(3)		300	—
PPG Industries	Ethylene, chlorine	900	—
Pantasote Co.		—	120
Rico Chemicals		—	150
Robintech Inc.		—	250
Shell Oil	Ethylene, chlorine	1,540	—
Shintech Inc.(4)		—	220
Stauffer Chemical	Chlorine	170	350
Tenneco Chemicals		—	510
Union Carbide	Ethylene	—	400
Others		—	100
Total U.S. capacity:		6,760	6,385

*In joint venture. (1) New monomer capacity due onstream by 1978: Borden, 300 million lbs.; Diamond Shamrock, 1 billion lbs.; Dow, 1 billion lbs. (2) Subsidiary of Occidental Petroleum. (3) Jointly owned by Borden and Uniroyal, Inc. (4) Owned by Shin-Etsu Chemical Industry Co. (Tokyo)

vinyl monomer project at La Porte.

Dow's new 1-billion-lbs. VCM unit under construction at Plaquemine, slated for completion about one year from now, will raise that company's domestic capacity to 2.4 billion lbs./year and strengthen its position as the largest U.S. producer. Along with Shell and PPG, two of the other three major VCM suppliers, Dow is strictly a merchant producer and likes it that way. While shunning forward integration into polymerization, Dow is solidly integrated into the raw materials; it is No. 2 among U.S. producers of ethylene and is the world's No. 1 producer of chlorine.

Polymer Pinch Possible: PVC producers also will need more capacity in 1978 and beyond. Although they can probably meet next year's projected demand of 6 billion lbs. with their current capability plus improvements and expansions now

under way, an additional 600 million lbs. of resin will be needed in 1978, assuming normal growth. A moderate economic downturn in 1978 could shave that year's PVC growth to 5% or less, but markets are likely to be tight unless name-plate capacity is boosted to more than 7 billion lbs./year.

Some half-dozen new units will come onstream during the next two years, but still more expansions will be needed. Prospective PVC demand in 1979 and later years will require new capacity equivalent to at least three new 200-million-lbs./year units each year.

Those new plants, along with the necessary capacity for VCM, will undoubtedly be built. And there will probably be periods of overcapacity. But PVC prices are sure to keep moving up, with only temporary interruptions. Reasons, on a unit-of-capacity basis, new plants for

VCM and PVC alike will be much more expensive than those now in use; and feedstock costs are also headed upward.

Plants Get Bigger and Better: Even during the dark days of 1974-1975 when stringent new safety standards were being drafted for their plants and when the plastics industry was taking an especially severe mauling from the worst recession since the 1930s, PVC makers went ahead with costly construction programs. Last year they added close to 1 billion lbs./year of net capacity. And they're continuing to spend large sums to improve existing operations and build new units.

Goodrich, the largest PVC producer, is winding up an expansion in Louisville, Ky., whose main feature is a 250-million-lbs./year polymerization plant with stripping column technology that it is offering for license to other producers.

Goodyear says it's spending "several million dollars" to install Rhone-Poulenc's "microsuspension" polymerization process in its plant at Niagara Falls, N.Y. According to Goodyear, that will be the first use of that technology in the U.S. The unit is rated at 50 million lbs./year.

Union Carbide, whose PVC capacity now stands at 400 million lbs./year, has sold its dispersion resins business to Stauffer and will shut down the 50-million-lbs./year dispersions plant at South Charleston, W.Va. That cutback, however, will be offset by debottlenecking of its plants for other types of resins, and further PVC expansion is on the drawing board.

Also debottlenecking is Georgia-Pacific, which thereby hopes to add modestly to its 220-million-lbs./year capacity at Plaquemine.

New Units Coming: Aside from those modernization projects, at least eight companies are building new PVC units. Two of those expansions will be at Delaware City, Del.; and both are for dispersion resins, sometimes called plastisols. Stauffer is adding an 80-million-lbs./year unit, due onstream within the next few months. And just last week, Diamond's board of directors authorized construction of a 24-million-lbs./year plant at that company's Delaware City complex. The new dispersions unit is scheduled for completion in first-quarter 1978.

At Calvert City, Ky., Air Products is boosting its capacity to 270 million lbs./year, up 35% from the present level there, and plans to add 50 million lbs./year of PVC capacity at Pensacola, Fla., by the end of 1977.

Robintech, which now has a 250-mil-

markets

lion-lbs./year polymer plant at Painesville, O., will raise its capacity to 300 million lbs./year by mid-1977 and to a hefty 500 million by the end of 1979. Shintech, formerly half-owned by Robintech but now wholly owned by Japan's Shin-Etsu, is adding 50% to the 220-million-lbs./year capacity of its PVC plant near Freeport, Tex., with startup slated for mid-1977.

Gulf Coast Favored: Another company selecting a Gulf Coast state for its PVC expansion is Continental Oil, whose chemicals division will add about 165 million lbs./year to the capacity rating of its plant at Aberdeen, Miss. That will hoist Conoco's company-wide capacity to 560 million lbs./year in 1978.

And last week Tenneco Chemicals said it will move ahead on its plan to build an approximately 200-million-lbs./year PVC unit in its complex at Pasadena, Tex. That project, scheduled for completion in mid-1978, will raise Tenneco's total capacity to more than 700 million lbs./year.

Tenneco's move came on the heels of Firestone's decision to build a new plant at a yet unidentified location by mid-1979. That unit, says the company, will have a polymerization capacity of more than 200 million lbs./year, advancing Firestone's domestic total—now about 400 million lbs./year—to a level the company describes as "well above 600 million lbs./year."

Solid Rebound: All of those expansions seem to be well warranted, judging by the robust recovery in virtually all PVC markets so far this year. First-half 1976 data from the Society of the Plastics Industry show that PVC shipments climbed to 2.35 billion lbs., up almost 52% from last year's first-half volume. At that rate, this year's total shipments are likely to come

close to the 4.73-billion-lbs. record high attained in 1973.

Domestic shipments in this year's first six months rose 50.9% to 2.24 billion lbs., while exports mounted 76.3% to 110 million lbs.

Plastic pipe markets, the largest single outlet for PVC, took about 696 million lbs. in the first half, or about 31% of all domestic shipments. Deliveries to pipe fabricators were up about 50% from year-ago levels, and at the current rate will reach a 12-month total of 1.4 billion lbs.

Upbeat Forecasts: This year's rebound is evidence that PVC markets still have a good deal of growth potential. And producers are confident that the uptrend will continue next year. For example, Gerard F. Cohan, a Goodrich product manager for PVC resins, is forecasting that demand will regain its 1974 level this year and thereafter will grow at about 11%/year. More bearish market specialists say not to count on a growth rate of much more than 5%/year.

In support of the more optimistic projections, producers point out that per-capita use of PVC in the U.S. is less than in other developed nations. It's less than half the pounds/consumer ration in West Germany, and somewhat less than the Japanese average.

One key to PVC's prospects is its adaptability. By judicious formulation with plasticizers and other chemical additives, PVC resins can be used to make a wide range of end products, for homes and autos and apparel, with widely varying rigidity and other properties. Recent investment authorizations demonstrate a firm belief that fabricators will continue to find PVC an unbeatable bargain in hundreds of applications for many years ahead.

PVC market growth accelerates

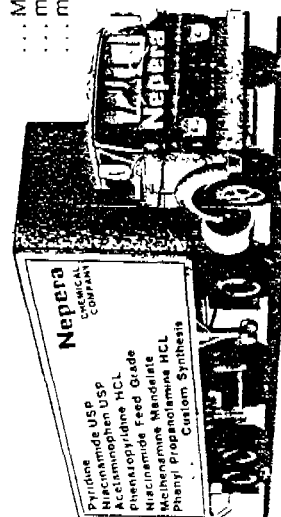
(Billion pounds)	1970	1975	1980
Apparel	0.18	0.18	0.28
Conduit, pipe and fittings	0.48	0.99	2.20
Flooring	0.32	0.29	0.56
Siding, other construction applications	0.20	0.27	0.71
Home furnishings	0.51	0.43	0.71
Wire and cable	0.42	0.28	0.50
Packaging	0.27	0.29	0.42
Records	0.14	0.13	0.22
Transportation	0.22	0.16	0.36
Other	0.24	0.57	1.14
Totals	2.98	3.59	7.10

Source: B.F. Goodrich Chemical Co.

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September 15, 1976 CHEMICAL WEEK 37

COLORITE 007261

Thermal Decomposition of Azobisformamide in High-Density Polyethylene and Poly(vinyl chloride)

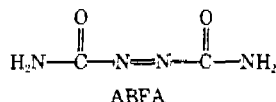
Frederick R. Wight

Bell Telephone Laboratories, Inc., Norcross, Georgia 30071

The thermal decomposition of the chemical blowing agent azobisformamide (ABFA) in high density polyethylene and poly(vinyl chloride) was investigated. The effect of silica modifier in HDPE and lead and tin activator/stabilizers in PVC on the yield and composition of the gaseous products was determined. It was found that in addition to reducing the decomposition temperature of ABFA, silica and lead cause a significant increase in the yield of gas produced. Tin also reduces the decomposition temperature, but does not substantially increase the gas yield. All three additives were found to cause a similar and significant change in the distribution of gaseous products produced; most noticeably the carbon monoxide yield is reduced while the yields of ammonia and carbon dioxide are increased. A common mechanism is proposed to account for the effect of these additives.

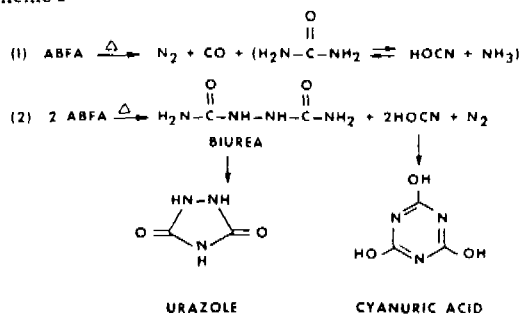
Introduction

Azobisformamide (ABFA) (azodicarbonamide) is one of the most versatile and widely used chemical blowing agents on the market today. Its thermal properties, high gas yield, and low cost make it the choice for such polymers as polyethylene, polypropylene, ABS, polystyrene, and others. Furthermore, Lally (1967) has shown that the decomposition temperature of ABFA can be lowered by the use of certain "activators" such as lead or tin salts, enabling its use in polymers such as PVC and EVA. In addition, azobisformamide can be modified (MABFA) by the addition of 30-35% silica. The silica is said to reduce the concentration of cyanuric acid in the blowing agent residue and thus reduce plate-out which tends to build up on plastics tooling. LaClair (1976) has outlined several areas where ABFA and MABFA have useful applications.

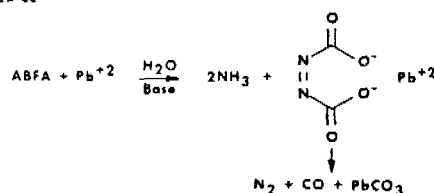


Relatively little exists in the literature on the chemistry of azobisformamide in polymer systems. Independent work by Reed (1969) and by Saunders and Hansen (1972) has been widely referenced on the mechanism of ABFA decomposition. Scheme I is the mechanism put forth by Reed (1969) for the decomposition of ABFA in mineral oil where biurea, urazole, and cyanuric acid are the principal residues, and nitrogen and carbon monoxide are the principal gases produced. Ammonia and carbon dioxide are produced to a lesser extent. The mechanism for the activated decomposition of ABFA by compounds such as tribasic lead sulfate has been postulated by Nass (1963) to involve a basic hydrolysis of ABFA to pro-

Scheme I



Scheme II



duce an azodicarboxylate, which readily decomposes to nitrogen, carbon monoxide and metal carbonate (Scheme II).

One aspect of the decomposition process which has not been reported but which is of importance not only in interpreting the mechanism of decomposition but is of practical importance as well is the yield and composition of gases produced by decomposition of ABFA in the presence of activators and modifiers. Reed (1969) reported the gaseous yield from ABFA as 220 cm³/g(STP) consisting of 62% nitrogen, 35% carbon monoxide, and 3% of a mixture of carbon dioxide and ammonia. LaClair (1976) has indicated that MABFA also produces gas yields in excess of 200 cm³/g. We have investigated the yield and composition of gases produced by modified and activated ABFA in a polymer matrix and our results bear directly on the mechanism of ABFA decomposition.

Experimental Section

The gas evolution of ABFA and MABFA consisting of 66% ABFA and 34% silica was measured in high-density polyethylene (HDPE) at a concentration of 0.85%. Additionally, the gas evolution of ABFA at a concentration of 0.5% was measured in a semirigid PVC formulation containing 7.0 phr tri-basic lead sulfate stabilizer/activator or 3.0 phr of the dibutyl tin type stabilizer/activator di-*n*-butyltin bis(*n*-dodecylmercaptide). The blowing agent was compounded into HDPE by means of a two-roll mill whereas the PVC formulation was dry blended in a high-speed mixer. Gas yields were determined by placing a weighed sample of each material in a small tube which was attached to a vacuum pump and mercury manometer. After evacuating the system to a pressure of ca. 0.1 Torr, the pump was closed off, the sample tube was heated to the desired temperature in a thermostated oil bath, and the pressure change was measured with time until no further gas had evolved. The sample was then cooled to room temperature and the final pressure was recorded. No changes were observed in the pressure on standing for extended periods, indicating the evolved gases were stable to the conditions of the apparatus. The vacuum system was calibrated as follows. Neat

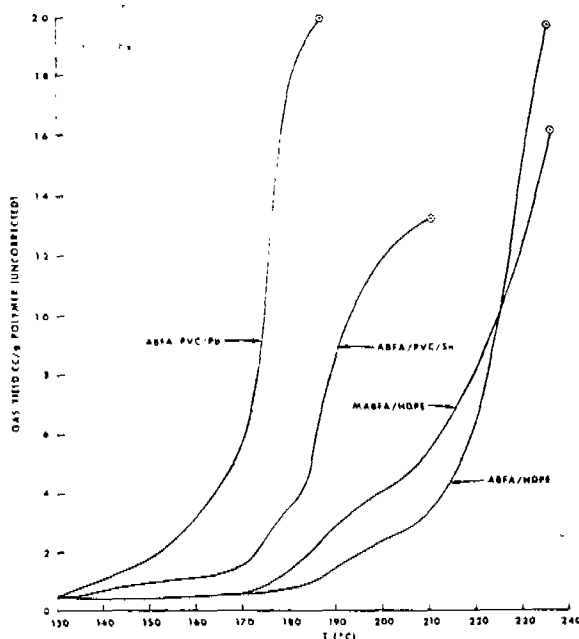


Figure 1. Gas evolution from ABFA and MABFA expandable polyethylene and poly(vinyl chloride). Heating rate, 5 °C/min.

ABFA was decomposed at atmospheric pressure by connecting the sample tube to a gas buret and mercury leveling bulb. An identical quantity of neat ABFA was then decomposed in the apparatus under vacuum. The volume of gas evolved in the first measurement was then correlated to the pressure change observed in the second run. All samples were recorded in triplicate and the data presented here represent the average of the three runs.

Results and Discussion

The degree of activation of ABFA can be seen in the curves in Figure 1, which were obtained by heating the samples under vacuum at approximately 5 °C/min up to the temperature indicated by the termination of each curve. Heating beyond this point was not attempted due to the onset of polymer degradation at these temperatures. The gas yields shown are uncorrected for the change in pressure produced by the increasing temperature. The lead stabilizer in PVC can be seen to have the strongest activating effect followed by the tin stabilizer. Note that silica in MABFA also appears to have a slight activating effect on the decomposition of ABFA.

Table I shows the room temperature gas yields obtained from each of the compounds. Note that silica and even more significantly lead produce an increase in the total gas yield in cm³/g of ABFA. Tin appears to have a negligible effect on the total gas yield, however. As a consequence, less ABFA is required in lead stabilized PVC compounds vs. tin stabilized PVC to achieve comparable expansion.

Finally, Table II shows the composition of the gases evolved from each sample. The presence of silica in HDPE or lead in PVC was found to increase the nitrogen yield, while tin had no apparent effect. Except for lead, there is a decrease in the carbon monoxide yield, but most apparent is the fact that significant increases in the carbon dioxide and ammonia yields are observed in the presence of all three additives.

The close similarities in the changes in the gaseous yield and composition produced by the three activators suggest a common mechanism by which each of these compounds interacts with ABFA. However, Scheme II (which incidentally requires thermodynamically less stable cis configuration of

Table I. Gas Yields from ABFA Expandable Polymers

Polymer composition	Polymer, cm ³ /g	ABFA, cm ³ /g
0.85% ABFA/HDPE	1.68	197
0.85% MABFA/HDPE	1.48	264
0.5% ABFA/PVC/Pb ^a	1.70	340
0.5% ABFA/PVC/Sn ^b	1.03	206

^a Semirigid PVC stabilized with 7.0 phr tribasic lead sulfate.

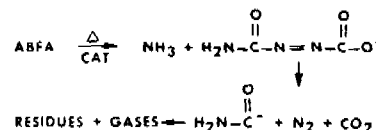
^b Semirigid PVC stabilized with 3.0 phr di-*n*-butyl tin bis(*n*-dodecylmercaptide).

Table II. Gaseous Composition from ABFA Expandable Polymers

Sample	cm ³ of gas/g of ABFA (%)			
	N ₂	CO	CO ₂	NH ₃
ABFA/HDPE	121.9 (61.9)	69.0 (35.0)	3.9 (2.0)	2.2 (1.1)
MABFA/HDPE	148.1 (56.1)	47.5 (18.0)	58.3 (22.0)	10.3 (3.9)
ABFA/PVC/Pb	153.4 (45.1)	71.7 (21.1)	83.3 (24.5)	31.6 (9.3)
ABFA/PVC/Sn	121.1 (58.5)	56.7 (27.4)	22.6 (10.9)	6.6 (3.2)

ABFA) is clearly not consistent with the data presented here. If Scheme II were a significant pathway to decomposition of ABFA, the carbon monoxide yield would be expected to increase significantly while the carbon dioxide yield would be expected to remain quite small. An alternative mechanism, more consistent with the observed results, would be the catalytic hydrolysis of one amide function by the activator to give ammonia, followed by rapid decarboxylation to give nitrogen and carbon dioxide (Scheme III). It is quite likely that this is

Scheme III



not the sole pathway to the decomposition of ABFA. In all probability, a combination of free radical and ionic pathways is contributing to the decomposition of ABFA.

Summary and Conclusions

The decomposition of azobisformamide in HDPE and PVC has been investigated. Results show that modifiers or activators, such as silica and lead or tin salts, in addition to reducing the decomposition temperature of ABFA, also increase the gas yield and alter the composition of the gases produced. The similarities in the changes in the gaseous composition produced by each additive suggest that a common mechanism occurs with the presence of each activator. The mechanism proposed involves catalytic hydrolysis of one amide function of ABFA to yield ammonia and a species which decarboxylates to produce nitrogen and carbon dioxide as the principal gases.

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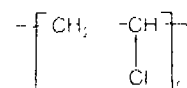
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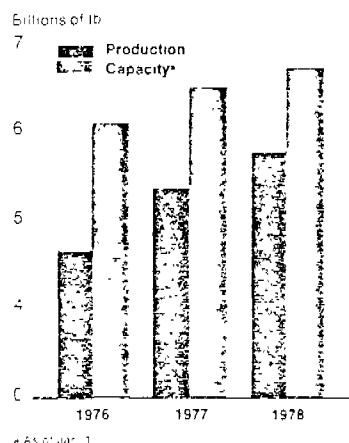
Key Polymers

Polyvinyl chloride



- Demand good
- Capacity rising
- Pricing unstable

PRODUCTION/CAPACITY



HOW MADE

Free radical polymerization of vinyl chloride using an initiator such as a peroxide

MAJOR FABRICATED FORMS

Pipe and fittings 35%, film and sheet 15%, flooring materials 10%, wire and cable insulation 5%, automotive parts 5%, adhesives and coatings 5%

FOREIGN TRADE

Exports—declining this year to about 250 million lb or less, imports—negligible

PRICES

25 to 27 cents a lb, depending on type, with discounts

COMMERCIAL VALUE

\$1.5 billion for total production, 1978

Polyvinyl chloride will have a good year in 1978, probably better than next year. U.S. production will be up nearly 8% in 1978 over 1977. Selling prices generally have firmed and are likely to go up, although pricing has been a series of ups and downs with a real trend difficult to discern. Plant capacity expansions are beginning again, too.

As with many other chemical products, demand for polyvinyl chloride boomed surprisingly as the second quarter unfolded. Price increases soon came along. PVC producers began pushing to meet demand without letting inventories of certain kinds of resins get out of line. This upsurge led to optimistic forecasts by some PVC producers that there might even be a 10% production gain for the year.

The summer doldrums arrived to temper this optimism and bring price discounts midway through the third quarter. Current thinking as a result is that a further slacking is due in demand growth later in the year. One forecast is that 1979 demand growth will be in the 5 to 7% range. There are predictions that price increases will be made before year's end that will hold into 1979 unless the economy falters badly.

Part of the reason for differences in opinion on PVC's future comes from PVC's consumption pattern. Alone among the big thermoplastics, PVC has markets dominated by durable uses. Some of these uses have cycles somewhat different from the main business cycle.

A big part, now estimated at more than a third of all domestic U.S. consumption of PVC, goes to make pipe and fittings. Most of these fabricated products go into housing. Other large volumes go into agriculture as irrigation pipe and into conduit for electric power and telephone cables.

Except for the irrigation outlet, much of the market for pipe resins depends on how well home, apartment, and commercial construction goes. So far this year, some choppiness has shown up in the high level of housing demand, but even soaring interest rates haven't dampened demand much yet. This demand alone keeps PVC pipe moving well.

Currently, the majority of PVC pipe and conduit carries either wastewater, vent gases, or cables. Changes in building codes provide good increases for these uses alone.

However, increased future use of PVC pipe in carrying potable water could keep demand for the pipe on a strongly rising curve. Estimates of the market penetration potential for this use vary widely but are very large. On balance, it appears that the shift to PVC pipe for water supplies in housing and commercial buildings will continue over a long period, a decade or more. This shift will provide substantial outlets for PVC production capacity not yet on the drawing boards. This new area, plus PVC use in conduit, some industrial piping and drain, waste, and vent piping should make the share of PVC going to pipe ever larger.

Unfortunately, the other main uses of PVC are not having such a strong year. Most, such as film and sheet, including automotive uses, have much lower growth rates. The reason is that much of the potential market penetration has been accomplished. In some instances of automotive uses, such as "vinyl tops," demand actually has disappeared under the vagaries of consumer fashion desires.

Other housing-related uses of PVC also have slackened their growth rates because of changing fashion. Furniture uses of films are now rising very slowly if at all. Flooring, even with good development in roll forms in addition to tile, has settled into a low growth rate.

The vinyl siding market is cited by some industry sources as the next "pipe" market in growth for PVC. As yet vinyl siding takes a relatively small share of PVC consumption. However, this use could grow rapidly as did the pipe and conduit market when these caught hold after long efforts to gain acceptance from building authorities. Estimates are that use of PVC for siding could reach 200 million lb in 1980, double the 1977 use of under 100 million lb.

Producers also are coping with pricing problems by shifting to larger reactors, particularly for suspension polymerization, and to computer control to gain uniformity and production cost savings. The larger reactors for which computer control can be justified could cause a shift to larger capacity plants. In this case, many of the smaller units could be shut down.

Hence, plenty of change may yet be due for PVC, an old-line polymer. Current trends make for a good 1978, a slightly slower 1979, and some big new markets later.