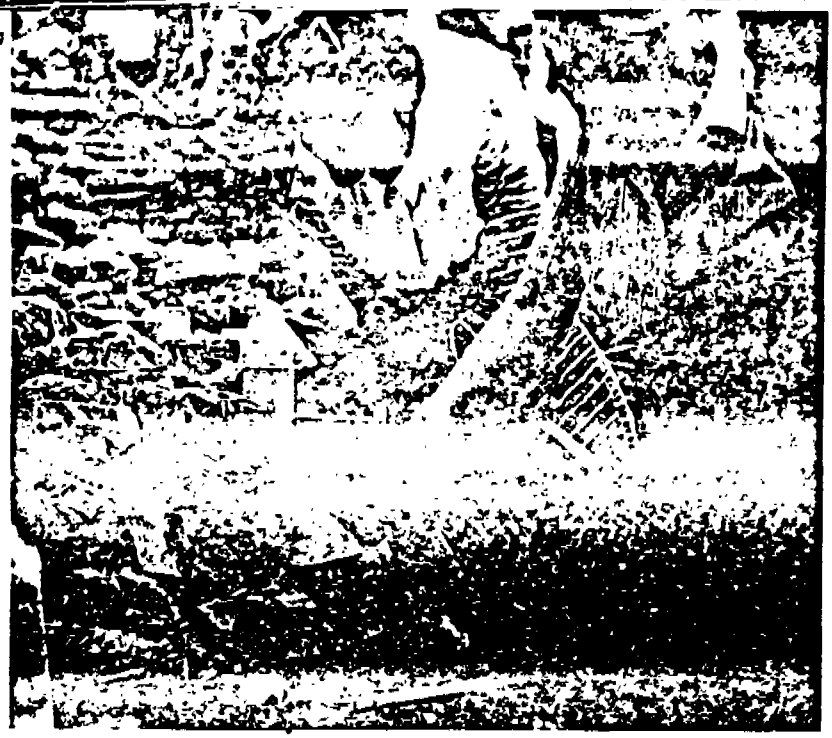

PACKAGING OF FOOD and other products is a major market for polyvinyl chloride.

Second thoughts on using PVC

Packagers stick with PVC, but seek substitute materials for new products and as hedge against possible forced cutbacks

Continued discovery of liver cancer cases among workers in polyvinyl chloride plants is posing a threat to the material's future in the packaging field. Several food manufacturers are dropping plans for packaging new products in the controversial plastic and PVC users are searching for possible substitutes in case federal regulations covering worker exposure force cutbacks in output.

At 325-million-lbs./year consumption, packaging is a major outlet for the 4.6 billion lbs./year of PVC resin produced. And the reluctance of food packagers to use PVC could signal the beginning of harder times ahead for the material.

Reports earlier this month of two cases of angiosarcoma in Czechoslovakian PVC plants has raised the toll to 24. And as those numbers mount, public pressure is building on the Occupational Safety and Health Administration to promulgate its "no detectable level" exposure limit for vinyl chloride monomer in work environments. With the final standard due Oct. 5, OSHA is said to be seeking a compromise position that will avoid lawsuits from industry on the one side and labor and consumer groups on the other. One source tells *Chemical Week* that "trial balloons of 20-25 ppm. have been lofted by the agency."

Industry representatives have been contending that imposition of a no detectable level limit—essentially 1 ppm.—for worker exposure is technically impossible. Enforcement of such a standard, they claim, would cause shutdown of all PVC plants in the U.S., eliminate 1.7-2.2 million jobs in consuming and related industries and result in a loss of domestic production value of $65-90 billion/year.

Manufacturers of substitute materials are not crowing over PVC's setbacks. Most, suffering feedstock shortages, are struggling to satisfy their own markets. Moreover, for many applications, there is no substitute for PVC.

And the vinyl industry's occupational health problems may be precursors of difficulties for other segments of the organic chemical industry. "It's only one tree in the forest," says Cesare Maltoni, of the Institute of Oncology (Bologna, Italy), whose research first predicted the link between VCM exposure and cancer (*CW, July 17, p. 30*).

The National Institute of Occupational Safety and Health has taken on the task of developing work exposure standards for some 400 chemicals by 1976. By November the agency hopes to publish exposure standards it has developed for five ketones—2-butanone; cyclohexanone; 2-pentanone; hexone; and acetone. It had hoped to have 40 chemicals completed, but "underestimated the difficulty."

NIOSH also will be getting approximately 18 standards per month from three consulting groups: Stanford Research Institute, Kaiser Foundation and Arthur D. Little.

Future Unclear: Opposing what he called "blackmail" over the alleged conflict between job losses and worker safety, Peter Bommarito, president of the United Rubber Workers and chairman of AFL-CIO's health and safety committee, says "this country survived for nearly 200 years without PVC and we can survive in the future without it."

But Arthur D. Little (Cambridge, Mass.), in its examination of the possible demise of the PVC industry for the Society of the Plastics Industry says: "It would not be possible to duplicate the exact properties of vinyl plastic products by using substitute raw materials." And even if it were possible to find a product with the exact or equivalent properties, says ADL, cost of production would probably price the substitute out of the market.

"Choice of a packaging material is a series of complex considerations," says an industry observer. For many applications it's difficult, if not impossible, to find a material that fits the bill exactly. PVC has clarity and excellent oxygen and carbon dioxide barrier qualities. Polypropylene does not. On the other hand, polypropylene is a tough construction material.

According to *Modern Plastics'* 1973 survey on plastics production, some 79 million lbs. of PVC were used for bottles, compared with only 19.8 million lbs. of polpropylene for the same purpose. And while polypropylene is more available than PVC, a Phillips Petroleum spokesman says, "We don't have that much."

Search for Substitutes: There was an earlier spur to the search for PVC substitutes when a problem arose with the test marketing of half-gallon PVC bottles for liquor in 1973. Alarmed by reports of VCM migration into the liquor, the Food and Drug Administration proposed to drop to zero the allowable VCM migration into food, drugs and cosmetics on May 9, 1973. Almost immediately, the Bureau of Alcohol, Tobacco and Firearms cancelled its approval for the test marketing of the half-gallon PVC liquor bottles. (Final FDA decision on VCM migration limits is still pending.)

According to one packaging supplier, "We lost some business in PVC over the liquor decision, and it was picked up by our glass operation."

Glass is probably the best qualified al-

ternative across the board, but it, too, is in tight supply.

For certain film applications, polyvinylidene chloride could benefit. For example, Dow notes that for odd shapes and barrier packs, such as for cheeses, it is "ideal." But a spokesman notes, it is more difficult to handle than PVC in machines, and it is more costly.

Other packagers report little if any increase in interest from marketers anxious to switch. But most agree that the PVC problem is influencing new-product introduction. Case in point: Borden's RealLemon Subsidiary, which was test marketing a line of cocktail mixes called On the Rocks in PVC containers. The PVC packaging idea has been dropped. "We're exploring a number of alternatives," a spokesman reports.

Opinion seems unanimous that large market shifts from PVC would be impossible to soak up. Construction is the largest consumer of PVC resins. Last year, for example, 1.34 billion lbs. of PVC were used to make pipe and fittings. That's more than 25% of total PVC consumption, estimated by the SPI to be 4.6 billion lbs. in 1973. An additional 464 million lbs. went into flooring. And siding use as well as miscellaneous construction applications pushed total construction markets for PVC well over 2 billion lbs. in 1973. Auto upholstery, seat covers, mats and decorative tops accounted for 256 million lbs.

PVC output has risen about 70% during the past five years, for a compound growth rate of about 11%/year from 1968 to 1973. This year's growth, however, is likely to be much slower. Output during the first five months of 1974 was up only 1.7%, according to data compiled by the Tariff Commission. That's partly an indication of slackening growth in demand but also reflects shortages of capacity.

Reactor Role: Of the 24 reported cases of angiosarcoma linked to VCM exposure, only one, in Sweden, involved a worker at a monomer plant. Of the rest, 20 were in PVC plants, two among compounders and fabricators (one wire extrusion plant, one plastic-fabric plant) and one West German worker engaged in filling aerosol pesticide containers with a VCM propellant.

Because vinyl chloride plants are generally automated they can be built without enclosures. But PVC production is labor-intensive, and in the colder climates it's necessary to enclose the plants. "Less than half are open," estimated one company spokesman. Goodrich has announced that it plans to build an "outdoor" PVC plant alongside its Louisville plant, where the VCM-angiosarcoma link was first reported last January.

Four basic polymerization processes are used for PVC production—suspension (which accounts for more than 75% of the tonnage), emulsion, solution and bulk. The reactor or autoclave, where polymerization takes place, is the key piece of equipment in each. Conversion of 85% of the monomer is considered high. Unreacted monomer is removed from the unit by vacuum for recycle to the process before the polymer is fed into a drying tower or storage tank.

Moreover, some polymer sticks to the reactor sides, hardens and accumulates, lowering the heat transfer in the units. When the heat transfer becomes too low, or a different resin is produced, it becomes necessary to clean the reactors.

High-pressure water jets are used primarily to do the bulk of the cleaning. But in some older plants, the ports in small kettles are positioned so that water jets can't be used. Some efforts are under way

It will be impossible to duplicate exact properties of vinyl

to develop new monomer-absorption, hardened resin removal methods. For example, GAF has patented a solvent addition method.

One producer's engineer, who has worked around PVC plants and been exposed to the monomer for over 20 years, thinks companies will have to "sharpen up polymerization techniques and methods of stripping free monomer."

He would like to see free-monomer concentrations in the dryer reduced to 500 ppm., claiming they are now up to 3,000-4,000 ppm. on resin leaving the plant. "The plant of the future—if we have one—will be able to strip most of the free monomer," he says.

Meeting Standards: Acknowledging that the 1-ppm. standards are "going to be tough to achieve," Daniel Boyd, director of OSHA's standards development office, says a combination of engineering controls, work practice methods and respirators could be used.

A spokesman for one manufacturer says he fears "we'll be hung with hose-fed positive pressure masks." All sources agree that self-contained supply packs, similar to those used by astronauts, couldn't be used because the workers couldn't function. In fact, labor sources oppose use of respirators, too. "Have you ever tried working all day with a respirator on?" asks Tony Mazzochi of the Oil, Chemical and Atomic Workers union.

One possible answer is to collect the escaping monomer and vent it to the atmosphere. But the Environmental Protection Agency, concerned about escaping monomer, has been monitoring the air around 10 PVC plants. "When OSHA gets through EPA will move in and won't want monomer going out the stack," says a Union Carbide spokesman. EPA contends that there are 6% VCM losses from PVC plants and concentrations of 1-2 ppm. in air outside plants.

Another possibility: absorbing the monomer in the vent gases on activated carbon. Calgon has reported successful laboratory studies of the technique and is installing a system for the effluent from the vent condensers at a southwest PVC plant. The company says the monomer can be regenerated with steam.

But other companies are skeptical, saying relatively concentrated streams of inert gases with relatively small amounts of oxygen are needed for activated carbon absorption. One company reports its estimated cost for activated carbon scrubbing in its resin-drying operation at $500,000 per stack.

Chemical Carcinogens: Maltoni is already looking for other chemical carcinogens, based on evidence supporting his predictive cancer techniques. He is suspicious of all carbon-chloride groups. Maltoni is also doing more work on VCM, studying inhalation doses of 25 ppm. down to 1 ppm. and doing tests on the effect of ingestion.

"I'm sure 25 ppm. will show cancer, too," says Joseph Wagoner, chairman of NIOSH's occupational carcinogen committee.

"There's no way to demonstrate the safe level of a carcinogen," he warns. Wagoner is also concerned that other diseases may be caused by worker exposure to VCM. While critical of the "serious limitations" of the Tabershaw-Cooper epidemiological studies sponsored by the Manufacturing Chemists Assn., he notes that they demonstrated brain and lung damage linked to VCM exposure.

Occupational health standards may be one of the greatest problems the chemical industry has faced. But great optimism and faith in the industry has been expressed in some unexpected quarters. "The ingenuity of American industry never fails to surprise me," says NIOSH's Wagoner. "Somehow, surprising things can be done."

BUDGET ANALYSIS AND PRODUCT COST

PROFIT CENTER 381

SOLVENT VINYLS - TEXAS CITY

SYSTEM 08310 (Dry Resin)

	M $					
Budgeted Cost	1970 Actual	1971 Actual	1972 Actual	1973 Actual	1974 Plan	1974 Estimated
Source	512	534	582	635	706	700
Maintenance (repair)	736	849	720	950	861	1,050
Maintenance (rearrange.)	103	77	97	52	98	150
Total Budgeted Cost	1,351	1,460	1,399	1,637	1,665	1,900
Apportioned & Assigned						
Insurance & Taxes	211	212	200	215	243	243
Maintenance overhead	197	200	185	206	215	275
Laboratory	115	123	123	118	120	142
All Others	-	-	184	129	109	100
Total Apport. & Assigned	523	535	692	668	687	760
Allocated	232	277	223	269	288	325
Environmental	-	-	-	32	56	52
Blending (Texas City only)	221	195	234	236	217	210
Refrigeration & Water	*	*	*	241	349	240
TOTAL PERIOD COST	2,327	2,467	2,728	3,083	3,262	3,487
Total Production (MM Lbs.)	80.9	73.0	81.0	89.0	90.0	93.0
Average Period Cost ¢/Lb.	2.88	3.38	3.36	3.46	3.62	3.76
Utilities Cost ¢/Lb.	1.16	1.30	1.48	1.20	1.47	1.30
Raw Materials Cost ¢/Lb.	6.22	5.82	5.84	5.84	6.26	6.44*
Total Product Cost ¢/Lb.	10.26	10.50	10.68	10.40	11.35	11.50

* Included with Utilities

* USING 1974 STANDARD TRANSFER PRICES

K. E. Ross - May 28, 1974

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006752