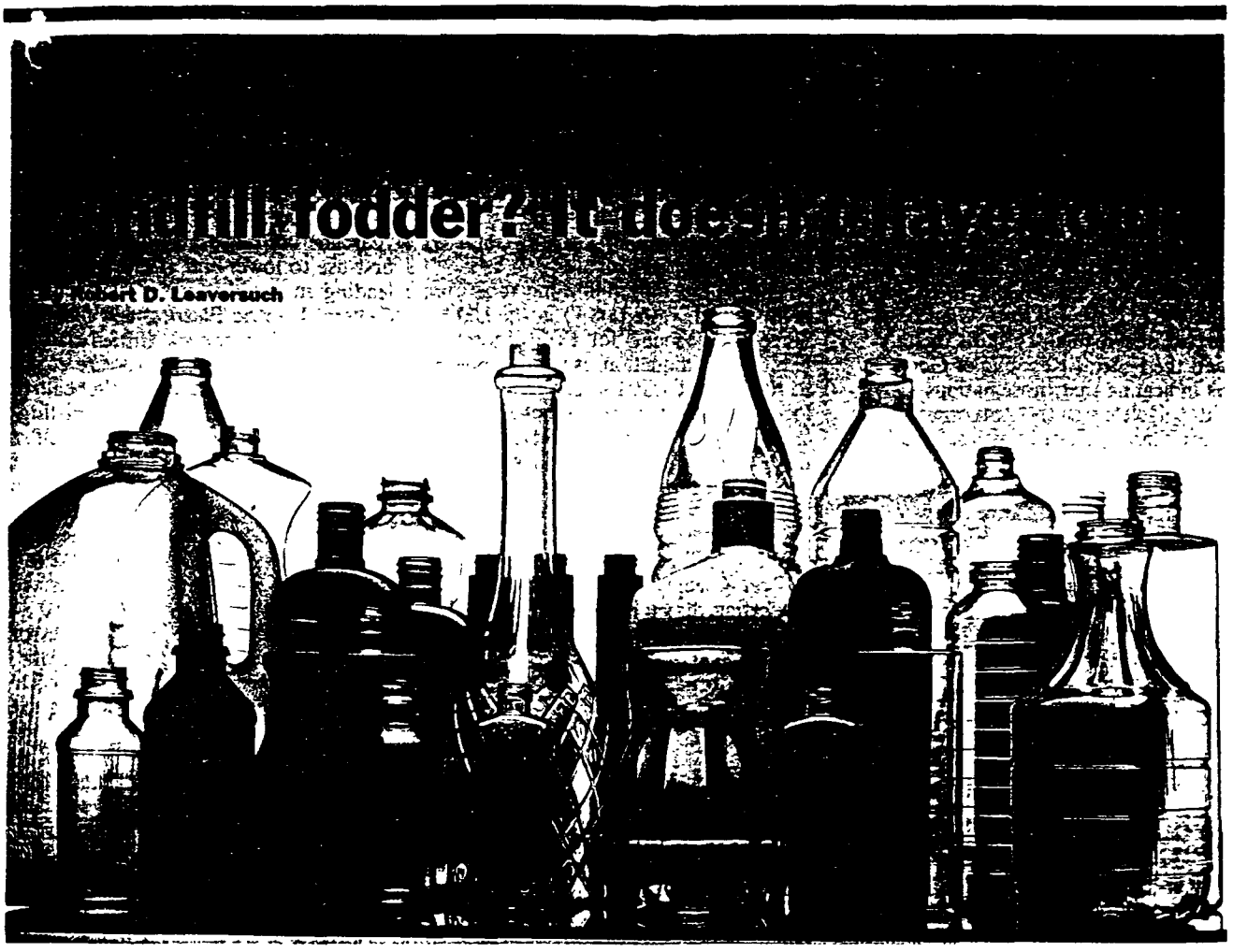


Photo: The Vinyl Institute

Effective reclamation and reuse techniques are emerging to meet the challenge posed by tougher disposability standards. They could also dissipate suspicions that have hampered PVC growth in some markets

THE 1990s are shaping up as an age of garbage glut and diminishing landfills. In such an era, materials choices in packaging, and indeed in all landfill-bound end-uses, are increasingly going to depend on more than just cost and performance. Processors and suppliers of polyvinyl chloride are going to have to convince end-users—and the nation's regulators and lawmakers—that PVC is suited for disposal when a product's useful life ends.

One controversial aspect of this issue is vinyl's impact when fed into an incinerator. Even more pressing (due to the top billing accorded to recycling in the hierarchy of waste disposal goals adopted by the U.S. Environmental Protection Agency) is vinyl's viability in reuse. PVC, long subject to attack on grounds of safety and health, now confronts the challenge of meeting ever-tougher disposal standards.

"Vinyl can be safely disposed of by any currently proposed waste management method—recycling, landfill or incineration," declares Roy Gottesman, executive director of the Vinyl Institute, a division of the Society of the Plastics Industry. A recent ruling by the U.S. Food & Drug Administration suggests that some of the nation's regulators have yet to be convinced. The FDA case involves a petition seeking approval for PVC use in liquor bottles.

Last November, FDA responded by ordering its staff to prepare an environmental impact statement covering many aspects of PVC's role in solid waste. One doubt cited by FDA concerns PVC's efficacy in reuse; the agency has plied its investigators with questions covering the current methods and scope of PVC recycling, possible emissions of hydrochloric acid during PVC incineration and even recycling, and the effects that the adoption of vinyl might have on reuse programs for other materials. The FDA move permits all current PVC uses to continue, but postpones a final decision on PVC use in liquor bottles for perhaps as long as five years.

FDA also cited research that it says shows possible links between the burning of PVC and a recognized health threat: increased emission of dioxins and furans. In response, industry sources insist that vinyl is as safe when incinerated under proper combustion conditions as is any other plastic or competitive material. They point to research purported to substantiate this claim (Sep 87 MP, 12).

FDA's decision leaves a cloud over PVC's future as a packaging material. The industry's fate rests in part on its ability to gain *political* recognition of its safety record in incinerators. From a pragmatic view, its success in getting a viable post-consumer recycling pro-

gram off the ground could counter much criticism. Should current efforts in both spheres fail, then angry citizens, draconian regulations, and adverse decisions by PVC's major end-users could threaten a slowdown, or even decline, in existing markets as well as dim prospects in such emerging markets as the water bottle.

Competitors are anticipating PVC's dilemma. In a recent speech, Himont Inc.'s CEO, Alexander J. Giacco, interpreted new regulatory shifts in Italy and the Federal Republic of Germany as indicating that those nations view the polyolefins as the "environmentally clean" large-volume plastics. This shift favors material substitutions away from PVC and polystyrene and in favor of polypropylene over the next few years, in Giacco's view (see p. 10).

Part of the solution?

"PVC, a thermoplastic, is an eminently recyclable material," Gottesman says, voicing industry optimism about the potential for PVC recycling. The practice of post-consumer PVC reuse, however, is in its infancy. The little that is recycled in the U.S. goes into mixed, or commingled, scrap plastics where, in the view of some, it can be a nuisance.

Spokesmen for BFGoodrich's Geon Vinyl Div., a major PVC supplier, note some of the ironies in PVC's portrayal by environmentalists as "*bête noire*" in the solid waste crisis. One is vinyl's truly minuscule contribution to the municipal waste stream. In 1987, all polymers contributed just over 7% by weight to the 160-million-ton total municipal solid waste (MSW) in the U.S. Since PVC accounts for 12% of total U.S. resin production, it would appear to represent about 1% of the total load. In fact, PVC's role is relatively small in short-lived packaging and relatively greater in durable goods that stay out of the waste stream longer. BFGoodrich sources estimate that PVC actually contributes no more than 0.2 to 0.3% to the landfill-bound MSW.

Don Knechtges, BFGoodrich's vinyl marketing director, suggests also that the existing PVC market structure is perfectly suited for recycling. Vinyl markets form a pyramid in which a narrow apex of short-life, demanding, higher-cost materials (bottles, film, window profiles and blister packs) sit atop a broad base of long-life, less demanding, lower-cost markets (including drainage pipe, conduit, and a host of smaller applications). The most logical recycling scenario calls for a simple "cascade" of reuse from higher-end, first-use to lower-end aftermarkets. A leading engineering resins supplier, General Electric Plastics, was first to theorize such a system. Critics claim GE's proposed low-end uses are currently little more than hypothetical. In contrast, Knechtges notes the existing structure of PVC markets lends itself well to recycling.

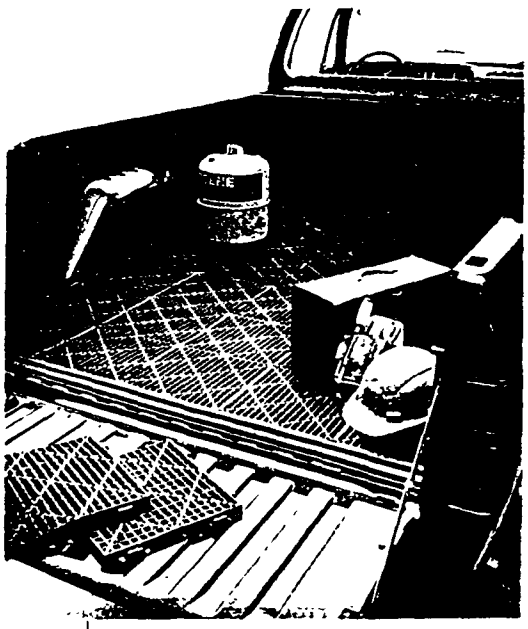
Chuck Gruber, market manager for Rohm & Haas, supplier of additives for PVC, describes vinyl as one of the most versatile of materials. He says PVC is rarely used neat; formulation gives vinyl its utility. Since its inception 50 years ago, compounders and processors have perfected this art. "The PVC industry can draw on a broad base of knowhow and a wide array of additives of all types for use in doctoring polymer in myriad ways," Gruber says.

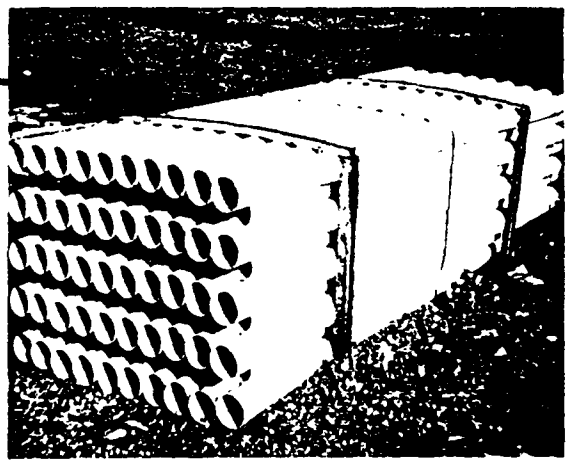
While PVC's "additives feast" is clearly an advantage in some cases, in others it creates problems. An example is the use of lead-based additives by some makers of wire-and-cable jacketing. Concerns about lead's safety in the environment make the notion of regrinding materials containing it problematic. Another heavy metal, cadmium, is used in certain stabilizers and pigments for PVC and other plastics. According to a recent EPA report, 8661 tons of lead stabilizer were used in the U.S. in 1986 (200 tons of which was thought to have entered MSW) and 711 tons of cadmium (with 500 tons going to landfill). Much of this was in plastics use, especially PVC. A soon-to-be-published SPI report is said to show that plastics use of these metals plays a minor role in the overall problem.

Progress is being made in solving problems associated with the use of heavy metals in PVC. The European PVC industry has already developed and is using alternatives to cadmium. A push to replace it in additives for PVC is under way in the U.S.

Lead use is a more intractable problem because no effective substitutes for its use in wire-and-cable have appeared as yet. An apparently fruitful ap-

RECLAIMED VINYL FINDS A UTILITARIAN SECOND LIFE





Existing reuse outlets for PVC pre- and post-consumer regrind are non-specified drainage pipe (extruded by TBA Inc.) and molded floor tile grids (designed by Turtle Plastics). In numerous other existing markets, such as PVC fences (PVC compound supplied by BFGoodrich), there is considerable potential for reuse.

proach, however, is that of Reclaimers, Inc. Kendallsville, IN, one of about 100 copper reclaimers operating in the U.S. This company employs a mechanical system that removes copper from vinyl and other plastics used in wire jacketing. Vinyl is cleaned to 99.6% purity and rerouted by the firm for use in sheet and molding applications.

Stirrings of success

D'Lane Wisner, BFGoodrich's Geon vinyl marketing manager, packaging, suggests that the PVC industry has already mastered many technical aspects of the challenges of recycling *clean* regrind via the internal reuse operations employed in many vinyl market segments. In pipe, extruded film and blow molding, for example, the great majority of internally generated scrap is looped back into production.

Efforts to reclaim large pockets of *contaminated*, pre-consumer waste not reusable in internal operations have been only partly successful. This source totals at least 400 million lb. annually, and industry estimates are that about three-fourths of it currently goes to landfill. Although this is less than 5% of all the PVC used in the U.S., it is a significant flow. The remainder of this contaminated vinyl stream feeds a surprisingly virile PVC reuse industry. The dream of one participant, Tom Norton, president of Turtle Plastics, Cleveland, OH, is to find a useful outlet for every last pound of it.

Norton estimates that some 70-80 million lb. of contaminated PVC is copper-contaminated wire-and-cable scrap. At least 100 million lb. more is automotive scrap; another 15 million lb. is protective auto rub stripping. By Norton's estimate, the calendering industry yields an additional 70 million lb. The following examples further illustrate some of the strengths (and limits) of existing PVC recycling efforts.

□ Drainage pipe. Vermont Republic Industries (VRI), St. Albans, VT, cleans and regrinds landfill-bound PVC from several sources. One is a nearby factory that discards PVC devices used to ship computer chips. Trim is also generated by an adjacent Eveready Battery Co. plant that displays its flashlights in PVC clamshell blister-packs. A third source is Aim Packaging, Pt. Clinton, OH, a PVC blow molder, which seeks an aftermarket for bottle rejects contaminated by paper labels.

VRI routes these feedstocks to TBA Inc., Louisville, KY, a PVC drainage pipe extruder. There, the regrind is fed into 600-lb./hr. extruders that make 6-in.-diameter pipe designed for a 50-year underground work life. Pipe is nonspecified, as current National Sanitation Foundation codes require that regrind be used only in the specific plant and formulation in which it was originally used. Regrind, however, is useable in large segments of the drain pipe market that often do not require NSF and other approvals. TBA's vp. Tom Brooks says the additives-rich regrind PVC material is used in letdown as concentrate to make pipe that is tougher than virgin pipe by virtue of a high impact modifier content.

□ Consumer items. The U.S. auto industry uses about 150 million lb. of

Sampler of U.S. efforts to recycle landfill-bound PVC

Company/location	Role[a]	Materials source[b]	Remarks
AIM Packaging, Port Clinton, OH	Source of merchant scrap	2	Sends bottles for which label choice precludes internal recycling to makers of drainage pipe and of molded packaging for auto windshields.
APV, Inc., South Plainfield, NJ	Machinery builder	—	Plans to introduce cascade extruder designed to handle light, hard-to-process scrap PVC and other materials.
Cleveland Reclaim/ Turtle Plastics, Cleveland, OH	Compounder, reclaimer, processor	1,2,3,4, 7	Claims to have pioneered reclaim of contaminated auto rub strips for reuse in urinal screens, floor mats, handles. Latest products—auto traction pads and wheel chocks.
Plascal, Inc., Farmingdale, MA	Reclaimer, processor	3	Reprocesses tailings of virgin-only calenders for use by heat sealers in low-end book and check covers, infant seats, ladies' handbags.
Plastic Compounders, Inc., Haverhill, MA	Compounder	6	Compounds copper-free 'transition' scrap engendered in wire-coating operations on toll basis for reuse in low-voltage cords and molded insert plugs.
Recoverable Resources (R2B2), Bronx, NY	Reclaimer	1,2,4, 7	PVC reclaim routes: blister packs to aquarium tubing; auto strips to floor mats; pool liners to urinal screens.
TBA, Inc., Louisville, KY	Processor	1,2,3,4	Draws on bottle, credit card, blister pack, circuit board carrier feedstock to produce non-NSF drainpipe.
TH International, New York, NY	Exporter	1,2,3, 4,5,6	Purchases reclaimable vinyl for export to Pacific Rim.
Vermont Republic Industries, Inc., St. Albans, VT	Reclaimer	1,2,3,4	Reprocesses extruded circuit board holders and other scrap for drainage tile.
Reclaimers, Inc., Kendallsville, IN	Reclaimer	5	Uses mechanical recovery method to yield 99 6% copper-free vinyl for sale into sheet and molding applications.

a In this column *reclaimer* refers to a company that separates cleans and regrinds scrap but does not repelletize or compound it

b PVC reclaim sources classified as follows 1 = curbside-collected scrap, 2 = pre-consumer bottles 3 = pre-consumer calendered film or sheet 4 = post-user extruded profiles (siding packaging) 5 = post-consumer copper bearing wire and cable cladding, 6 = industrial copper-free wire and cable cladding, 7 = decorative and protective automobile stripping

PVC shipping devices for re-use in pipe are inspected by Albin Voegele of Vermont Republic. [Photo, Oxychem]

PVC annually as protective stripping to which adhesive and decorative film is applied as profile exits the extruder. Given a 10% downstream scrap rate, this produces about 15 million lb. of contaminated PVC that was, until four years ago, landfill-bound. Today, Turtle Plastics cleans, regrinds and molds it into various useful items. The major established application is a floor tile used in light trucks and workshops.

□Aquarium tubing. Recoverable Resources Inc. (R2B2), Bronx, NY, aims to tap independent pickup networks as a way to revive industry and create jobs in some of New York's most deteriorated neighborhoods. One of its successes involves a local firm that packages hardware items in calendered PVC blister packs that generate large volumes of trim. This had previously been sent at high cost to a landfill, but a year ago the landfill operators declined to take it any more. Now, R2B2 separates, cleans and sells it to a local processor who in turn extrudes the material into aquarium tubing.

□Post-consumer recycling. The items best suited to getting the reuse of curbside-collected PVC under way are bottles, which use some 230 million lb. of PVC annually in the U.S. Obstacles are that the bottles go into diverse end-markets (shampoo, vegetable and salad oil, creamer, peanut butter, water); the rate of turnover of bottles in PVC markets tends to be low; and none are easily recognized by the public (as are the clear PET soda bottle and the translucent HDPE milk jug).

Industry leaders are finding new ways to reuse PVC bottles. To this end, a consortium of six major PVC bottle compounders and additive suppliers has been set up. Efforts by individual companies, including Rohm & Haas, Oxychem, Georgia-Gulf Corp. and BFGoodrich are also under way. BFGoodrich is testing the properties of PVC regrind. Research shows that additives-rich PVC bottle compounds retain sufficient properties to be viable in such aftermarkets as nonfood bottles, pipe fittings, and drainage pipe. And work is being done to improve vinyl labels as a way of fostering reuse.

An important step forward in separating curbside-collected PVC bottles is the adoption by SPI in mid-1988 of a voluntary recycling code. One of the first U.S. blow molders to adopt the code, which involves a mold change to include the letters PVC and numeral 3 inside a reuse logo, is Schoeneck Containers, Inc., New Berlin, WI. "I like the idea that the bottle we make today could end up as a fencepost, pipe, or possibly even a welcome mat tomorrow," remarks Bill Smith, president. A more radical approach (and one that is likely to affect U.S. recycling in the next few years) is being taken by a European joint venture project. The operation, formed by three West European resin suppliers, has a plant in Ferrara, Italy, that employs an electromagnetic scanning technique, tradenamed Technoplast, to identify and separate polyethylene terephthalate from PVC bottles automatically. The 10,000-lb./day facility reuses PVC in tubing and pipe.

"The greatest potential for post-consumer PVC bottle reuse is in the noncarbonated water bottle market," remarks Bill Carroll, Jr., technology director at Occidental Chemical Corp., a PVC supplier. He says prospects for PVC capturing a big share of this market are excellent, due to vinyl's clarity, low-cost, and the low odor and taste transfer of recent compound offerings.

"It's the perfect candidate for recycling," adds Richard LaRue, Oxychem's market development manager for water bottles. He says PVC water bottles are distinctive. They are, moreover, unpigmented, and the mode of their use probably means that little or no washing will be required.

Experience in France, where the PVC bottle dominates the estimated 100-million-lb. bottled water market, demonstrates that efficient recycling of PVC water bottles is practical. Solvay, a leading Belgian PVC supplier, reports that nation's PVC bottle reuse system a success. The reclaimed powder is used by some end-users in the foamed inner-layer of drain pipe. PVC regrind also is used to make vine stakes and (in granular form) as a soil reinforcer.

Prospects for PVC reuse are also being pursued in siding and window-profile markets. The Vinyl Institute recently signed a contract with Vermont Republic Industries to identify recoverable PVC sources in this and other markets. BFGoodrich suggests that a trend in siding (to coextrusion of a weatherable, additives-rich cap over a lower-cost, low-additives-package substrate) could lend itself well to reclaimed material use in substrates. Turtle's Norton sees considerable potential in buyback of profile regrind from construction industry networks.

Performance of PVC in commingled waste recycling is another area of interest. Current practitioners are Polymer Products, Iowa Falls, IA (using a proprietary system), and New England CRInc., N. Bellerica, MA, Process Plastics, Ionia, MI, and The Center for Plastics Recycling at Rutgers Universi-

PVC water bottles: a perfect recycling candidate? [Photo, Indian Springs]

ty, NJ (which use the licensed ET1 system). These turn commingled waste into plastic lumber.

Experimental work on PVC in commingled waste is being conducted at the center by Dr. Tom Nosker. In a first step, PET and HDPE milk bottles are removed from the stream, leaving a mixture that includes PVC. Nosker says the goal is to determine how different polymer mixtures affect properties of the residual stream. He claims research has shown no evidence of problems associated with PVC use in commingled streams. However, the presence of PVC and PS, which have lower melt temperatures than other large-volume resins, means the ET1 process must be run at temperatures low enough to prevent offgassing or degradation. ■