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- Electrical Materials Council
- Pipe Resources Council
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66A-420 PLASTICS WORLD

MONTHLY 63,500

APRIL 1990

3274

The pipe business will be 9.7-billion ft strong by the year 2000, and plastic will have a 60% share of the market—worth some $7.6 billion. That's the prediction of Leading Edge Reports, a Cleveland-based market-research company. In 1988, the total pipe market was about 6.6 billion ft, and plastic had roughly 56% of the business, which translated to about $3 billion.

There are several factors contributing to plastics' dominating presence in the pipe business. The big one is cost; plastic continues to have economic advantages over other materials, despite relatively violent price swings for pipe resin, particularly polyvinyl chloride.

A copy of the report sells for $1,700 and may be obtained by calling Karyn Thomas at (216) 791-5500.

56B-700 JOURNAL AMERICAN WATER WORKS ASSOCIATION
MONTHLY 44,000

APRIL 1990

3274

The Vinyl Institute, headquartered in Wayne, N.J., has formed the **Pipe Resource Organization** (PRO) to promote the use of PVC in water and sewer pipe applications. PRO will sponsor research on the use of PVC in pipe applications, serve as a clearinghouse for product information, and work with other organizations that can influence PVC's position in the pipe market. □

56B-1060 SOLID WASTE & POWER

BI-MONTHLY 16,000

APRIL 1990

Corrugated Steel Pipe Performs Well in California

In recent years, there has been a change in the pipe used for new construction of buried methane gas collector lines in Los Angeles County landfills. Polymer-coated, corrugated steel pipe (CSP) is now specified for use by the county's districts for certain purposes. Polyvinyl chloride pipe (PVC) is still used to meet other needs.

This use of polymer-coated CSP in landfill gas-to-energy operations was a first for California and the U.S., says Boral Cascade Culvert, a supplier of CSP headquartered in Escondido, Calif.

Orange County, Calif., has also shared in this change-over. Since 1986, CSP has replaced PVC for gas collectors in that county's landfills. Recently, Orange County also installed poly-coated smooth-wall steel pipe for the above-ground "header" lines that transport the trash-generated gases, the supplier said.

John Cosulich, supervising engineer for the Los Angeles County Sanitation Districts, said his county uses the CSP for landfill trenches but not for above ground applications because it is difficult to seal. L.A. County still uses PVC above ground.

The change to CSP for some landfill uses began about 5 years ago, when operators discovered that a number of PVC gas collector lines in landfills were not performing as expected. Probes placed inside those lines pinpointed failures in the pipe's ability to permit a flow of gas.

Engineers turned to polymer-coated CSP for its strength (usually of 14-gauge steel, in 12- to 18-inch diameters). The pipe resists crushing from trash loads and heavy equipment. It is resistant to high heat or melt-down, and the pipe resists corrosion.

FEBRUARY 1990

MIXED VIEWS ON SUITABILITY OF PLASTIC PIPE FOR DISTRIBUTION SYSTEMS

While trade publications, bulletins and talks point out the suitability of plastic pipe for many utility applications, the industry is still suffering from past improper installation and the use of unsuitable materials and/or extrusion practices in making pipe from 10 years ago. With the adoption of standards by the American Water Works Association (AWWA) during 1989, together with further standards being prepared, plastic pipe may be on the road to recovery from the bad press which occurred as a result of the failures allegedly caused by the reported deficiencies. But those in the plastics industry, who are asked to comment on these failures, should readily acknowledge that they did occur and be able to show that steps are being taken so that they will not happen in the future.

The failures in the past have included polybutylene (PB) pipe in several places where it was used for water service lines. The main cause of failures in these installations was kinking of the thin-walled tubing where the pipe was bent during installation. In other cases the pipe was buried in rocky soil without using suitable soft soil around the pipe to protect it from cutting by the sharp rocks. In San Antonio, the result was a settlement of several million dollars paid by material suppliers and the manufacturers of the tubing.

There have been many reports of failures of polyethylene (PE) pipe where it was used for water service lines. It appears that most or all of these installations were made by one manufacturer who used inferior PE and/or did not extrude it properly. The most reported that commercial PE pipes had not exhibited any degradation of chemical, mechanical, or physical properties while being used in underground service for Chris Panetta, the utilities superintendent of Peoria AZ, disclosed that they were requiring that copper tubing be inserted in the lines of the houses which had developed leaks. He noted that some developments were much more prone to having failures than others. It was felt that some of this might have been due to poor installation practices such as improper laying of the service line in rocky soil and improper connections during installations, which led to stresses that accentuated the slow micro crack growth due to the water pressure (60–90 psi).

Panetta noted that Peoria did not experience such failures until after 8–12 years, while many other Arizona localities experienced failures within 3–10 years. It is felt that this might have been due to the fact that Peoria pumps its water from deep wells while the other localities used canal water which had been stored in reservoirs and thus was much warmer when it entered the distribution system. Since the service lines are typically only one foot deep, they can get very warm in an area where it is frequently over 100°F in the shade for more than 100 days a year. Although one might expect that the pipes would not receive much of that heat because of dry soil, most residents soak their lawns several times a week and thus the soil is a fairly good conductor of heat. Indeed, some residences hardly need to use a hot water heater in the summer—and a cold shower is impossible—since the entering water is over 110°F for much of the time. Since tests have indicated that PE develops microcracks much more rapidly at higher temperatures (at 140° vs. 72°F), it is probable that these conditions accentuated the use of inadequate pipe.

A Gas Research Institute *Bulletin* of December 1989 reported that commercial PE pipes had not exhibited any degradation of chemical, mechanical, or physical properties while being used in underground service for periods up to 20 years. This was based on two reports on research studies by Battelle Institute and L. J. Broutman & Associates. In the Battelle test, PE pipe was buried in the service yard of Columbia Gas in Mount Vernon, Ohio with 50 psi gas pressure for up to 20 years starting in 1963. The pipe showed no significant changes from tensile samples of unexposed pipe.

The Broutman project used pipe samples exposed for 1–20 years from all over the US. The tensile tests showed that there was no apparent change in the yield stress or energy-to-yield of the specimens during the various time periods, although there was a scatter of lower values in energy-to-break values within the age distribution of the sample. The bulletin did not indicate any determination of the causes of such discrepancies. Furthermore, carbonyl index measurements did not indicate any trends for oxidative degradation and for the few pipes with any effects of oxidation on the outer surface it was felt that this might have been due to outdoor storage of the pipes before installation. The oxidation induction time (OIT) and percent of crystallinity were also measured to give indications that after periods of up to 20 years antioxidant was still present.

Both research evaluations were conducted with compressed-ring environmental stress crack resistance tests; they showed that there were only small differences. In addition, Broutman squeezed PE pipes in elevated temperature stress-rupture tests and found that the aged pipes had no significant decrease of their stress-rupture values. These results indicate that PE pipe should continue to be the preferred material for gas service lines.

Although there are some installations of PE pipe for water transmission of up to 54 inches diameter—and new standards should be available soon for up to 63

Cont.

inches – PVC remains the major plastic pipe material, mainly due to its higher hydrostatic design basis and its chemical resistance. Additi nally, there have been no reports of failure of PVC pipe; e.g., Panetta volunteered that "the C900 pipes of PVC are great!" These and other successes form a good base upon which to promote even greater use of plastic pipe in the future, while providing better assurance that the standards will prevent failures.

For further information contact: Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631 (312/399-8100); Stanley A. Mruk, Plastics Pipe Institute, Wayne Interchnage Plaza II, 155 Route 46 West, Wayne, NJ 07470 (201/812-9076); and AWWA. 11 p. 3

By Julio Coto, P.E.
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Fatigue Failure Of PVC Pipe

Pipe materials can experience fatigue failure when exposed to severe cyclic surging. Cyclic surging, which is caused by pump starts and shutoff, valve operation, gas entrapment, etc., results in non-steady state conditions common in piping systems. These conditions tend to develop cyclic pressure variations within the piping system and it is the magnitude and frequency of these variations which cause fatigue failure in the piping system. The design of the piping system, therefore, should consider these factors in order to avoid premature pipe failure due to fatigue.

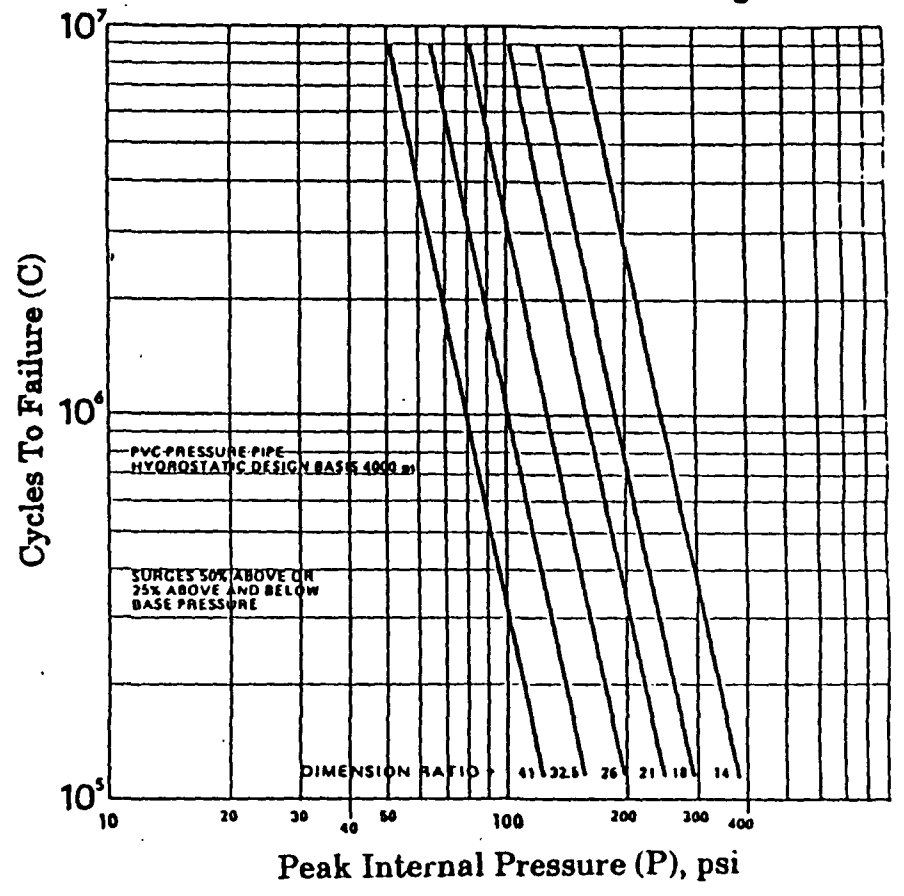
Fatigue pipe failure becomes significant in piping systems where the pressure variations equal or exceed 50% of the system working pressure. Piping systems which typically experience high frequencies and magnitudes of cyclic surging are sanitary sewer force mains, transmission mains, irrigation piping systems and frost control systems.

Practical design limits for the determination of the PVC piping system's capacity for cyclic surging can be determined by using empirical equations developed by H.W. Vinson[1]. These equations predict the number of surge cycles to failure. Therefore, by determining the expected number of cycles and the magnitude of the pressure variations per cycle, one can estimate the life of the pipe before it fails through fatigue (see Figure 1).

The values obtained in this fashion are conservative because the empirical relationships were obtained by subjecting the PVC pipe to large pressure surges at frequencies not typically encountered in municipal sanitary sewer force main systems, transmission mains or irrigations systems. Furthermore, the equations do not take into account the stress relaxation capacity of PVC pipe. Sustained surge cycles in excess of those predicted by these equations have been cited for C900 PVC pipe.

The cyclic surge fatigue phenomena should be considered in the design of municipal PVC piping systems especially where cyclic surge fatigue becomes the critical design parameter. The Vinson relationships provide the designer with a conservative estimate of the PVC piping system's capacity for cyclic surge fatigue.

Figure 1
PVC Pipe Cyclic Fatigue Life When Subjected To Large Pressure Surg s



From: Handbook of PVC Pipe Design and Construction, Uni-Bell PVC Pipe Association, Uni-Bell Plastic Pipe Association, Dallas, Texas, 1982.

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1) Handbook of PVC Pipe Design and Construction, Uni-Bell PVC Pipe Association, Uni-Bell Plastic Pipe Association, Dallas, Texas, 1982

56A-440 THE FLORIDA SPECIFIER
MONTHLY 37,385

MARCH 1990

SPECIAL REPORT

Plastic to remain leading pipe material

By Bill Bregar
PLASTICS NEWS STAFF

Led by a resurgent domestic energy industry, plastic pipe is expected to continue its dominance over steel, copper and other materials in the United States through the 1990s, two market studies report.

Plastic was the leading pipe material, as well as the fastest-growing, from 1977 to 1988, according to a new study from Leading Edge Reports, a market research company in Cleveland. Plastic pipe sustained an average annual growth rate of 7.3 percent in terms of feet produced during the period. That compares with only 2.7 percent for the total pipe market. Leading Edge predicts growth in plastic pipe demand in the 1990s will slow to 3.8 percent a year from 1988 to 2000.

Polyvinyl chloride, which controlled 73 percent of the plastic pipe market in 1988, will lose market share as other resins continue to gain acceptance as competing materials, Leading Edge said. But PVC pipe in the year 2000 still will hold a strong lead, consuming more than three times the volume of resin used for polyethylene, the No. 2 type of plastic pipe.

PE is one of the fastest-growing types of plastic pipe, boosting its share of plastic pipe from 8.5 percent in 1977 to 13 percent in 1988 and a projected 17 percent in 2000. PE pipe growth will continue at nearly 6.5 percent per year in the 1990s, Leading Edge said.

Meanwhile, steel pipe, the No. 2 material in terms of volume, should rebound to annual growth of 4.3 percent during the period of 1988-2000—following its decline of 1.6 percent annually from 1977 to 1988, the study said. By year 2000, plastic pipe's volume should be triple that of steel and four times that of copper, according to Leading Edge.

Another study, released last year by Freedonia Group Inc. of Cleveland, gives a much lower rate of annual growth—4.4 percent—for plastic pipe during the 1977-88 period. The Freedonia study predicts that growth will slightly to 4.1 percent through 1993, the last year for which it gives annual growth projections.

The Freedonia study also gives somewhat lower volume amounts for plastic pipe than the Leading Edge report.

Though the construction market is by far the largest user of pipe, both studies point to the energy sector as a particularly fast-growing pipe market. Polyethylene, in particular, will benefit from a healthy gas and oil industry. PE pipe now dominates the market for local gas distribution lines. In the oil industry, PE has become a popular, economical alternative to steel for applications at the drilling site, such as gathering lines, downhole tubing and water supply and disposal lines.

Freedonia said construction growth will be slow through 1993 because of maturing markets and the fact that pipe systems with improved durability and corrosion resistance are already in use. Infrastructure projects, previously postponed by local governments, will help stimulate construction's demand for pipe, Freedonia said.

Overall, improvements in processing technology and material properties will propel the continued growth of plastic pipe, according to Freedonia. Further penetrations into markets such as sewer mains and chemical process piping can come from making pipe with greater strength and better tolerance to temperature extremes, pressure and corrosion.

The Freedonia study also said that plastic conduit applications will grow at the expense of steel, owing to plastic's smooth bore, sealing properties and ease of installation.

By the year 2000, the plastic pipe industry will consume more than 7.2 billion pounds of thermoplastic and thermosetting resin and materials, Leading Edge predicts.

The Leading Edge study offers these projections of plastic pipe by type of resin:

■ **Polyvinyl chloride**—Potable water pipes will remain the biggest pipe market for PVC resin, but growth of PVC usage in this application is expected to increase by less than 2 percent annually in the 1990s, much slower than before. The report cites three reasons for this: PVC penetration already is highly mature in service and distribution applications; other resins will give PVC increased competition; and acceptance of PVC is likely to move slowly in municipal water applications requiring larger-diameter pipe.

PVC pipe consumption is expected to grow most quickly in the process industries, such as chemicals, petroleum refining and waste processing, because of major expansion and modernization plans of large companies and the increasing substitution of plastic in low-temperature, low-pressure applications.

■ **Polyethylene**—PE, the second most widely used pipe resin, made big gains in the 1980s in oil and gas pipe applications. Energy industries consumed 40 percent of all extruded PE pipe in 1988.

Demand for PE grew by 22.7 percent a year from 1977-88 in the catch-all structural, mechanical and miscellaneous category. The study looked at the overall PE segment. It did not break out various types of PE.

In potable water applications, high and volatile polyethylene prices helped PVC increase its edge over PE during much of the mid- to late 1980s. But as new PE capacity begins production, prices should soften and stabilize, according to Leading Edge.

Strong PE growth also is expected in conduit, drain and sewer, drainage and irrigation. Total PE used in pipe applications should enjoy an annual growth rate well

Cont.

U.S. Pipe Market

(milli n feet)

By Application

ITEM	1977	1988	2000	% Annual Growth 1977-88	% Annual Growth 1988-2000
Total Pipe Market	4,888	6,575	9,784	2.7	3.4
Potable Water Pipe	1,850	2,781	3,845	3.8	2.7
Drain & Sewer Pipe	501	624	825	2.0	2.4
Drain, Waste & Vent Pipe	537	648	850	1.7	2.3
Conduit	444	780	1,335	5.3	4.6
Drainage & Irrigation Pipe	253	247	320	(0.2)	2.2
Oil & Gas Pipe	853	630	1,184	(2.7)	5.4
Process Pipe	69	69	115	—	4.3
Structural, Mechanical & Miscellaneous	381	796	1,310	6.9	4.2

By Material

ITEM	1977	1988	2000	% Annual Growth 1977-88	% Annual Growth 1988-2000
Total Pipe Market	4,888	6,575	9,784	2.7	3.4
Plastic	1660	3,600	5,643	7.3	3.8
Steel	1,224	1,027	1,695	(1.6)	4.3
Copper	1,018	1,002	1,342	(0.1)	2.5
Concrete	372	476	599	(2.3)	1.9
Cast Iron	348	273	245	(2.2)	(0.9)
Aluminum	101	157	253	4.1	3.7
Clay	97	30	17	(10.1)	(4.6)
Asbestos/Cement	68	10	—	(16.0)	—

Source: Leading Edge Reports

above 6 percent, Leading Edge said.

■ **Reinforced Thermosets** —Most commonly using polyester resin, these materials will lead growth of all plastic pipe through the 1990s, with an annual rate exceeding 7 percent. Process markets are the top users of reinforced thermoset pipe because of the material's corrosion resistance and strength.

By 1995, the conduit market will have overtaken the drain and sewer market as the No. 2 consumer of reinforced thermoset pipe. Annual growth rates will settle from the thriving 19.2 percent seen during 1977-88 to a "more sustainable" 7 percent throughout the 1990s, Leading Edge said.

■ **ABS** —ABS is a potential competitor in plastic sewer and drain applications, with projected annual growth of more than 6.5 percent. The material's wide operating temperature range should help it move into non-standard service and distribution, as well as municipal water pipe applications at 10 percent a year.

Overall, however, ABS should average slightly below 3 percent annual growth.

■ **Non-traditional resins** —Some resins not generally associated with this sector should make inroads into unique market niches unfilled by the traditional pipe resins. Overall growth for non-traditional resins is expected to climb about 7 percent a year in the 1990s.

In conduit applications, polypropylene's initial quick growth during the 1970s cooled as less-expensive, traditional pipe resins gained ground. Demand will remain strong at nearly 4.5 percent as PP enters the potable water market, substituting for PVC in some applications, according to Leading Edge.

Chlorinated polyvinyl chloride (CPVC), with good high-temperature properties and flame retardance, has helped plastic penetrate process industries and specialty applications such as fire sprinkler systems. Potable water applications should remain the leading market for CPVC pipe, however.

Typical uses for polybutylene pipe have expanded from hot- and cold-water applications and oilfield downhole tubing into process and other specialty applications.