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PVC: A Vital and Sustainable Resource

special eco issue

Polyvinyl chloride is a vital component of products that raise living standards and maintain the quality of life for end-users around the world. PVC's versatility, performance benefits, low cost, energy efficiency, wide availability, and long service life make it an ideal compound for many applications.

Just how ideal is not commonly appreciated. Vinyl has been so widely used, for so long, and in so many applications forming the background of everyday life, that people take it for granted. Indeed, PVC products have been commercially available since World War II and today account for more annual resin use worldwide than any other plastic except polyethylene. In many applications, it would be difficult to find a substitute material without sacrificing performance, value, or environmental sustainability.

Nevertheless, PVC remains under attack by activists. Anti-PVC campaigns draw on dubious studies, selective data, fabrications, and scare tactics to rally support against the compound and chlorine, its main component. The campaigns, which rely on slick marketing, pseudo-science, and generally uncritical media coverage, have been effective at dissuading some businesses and consumers from using PVC.

'The facts about vinyl undermine anti-PVC activists' claims. PVC exhibits numerous environmental benefits.'

But the facts about PVC undermine activists' claims and show that vinyl poses no danger to the workplace, consumers, or the environment. And as scientists tally up the life-cycle factors that determine the advantages of materials, PVC exhibits numerous environmental benefits.

Vinyl Building Products Are Key to Sustainability

This is especially true in building and construction, the biggest market for PVC, accounting for 76% of demand. Key applications include indoor and outdoor pipes for water, drainage and sewage; geoliners, roofing surfaces and membranes; siding, window lineals, deck and fence materials; floor and wall coverings, and wire and cable coatings.

Studies find that PVC building and construction products are more energy efficient to manufacture and use than those made of competitive materials. It takes 400% more

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PVC pipe has smaller carbon footprint than metal or concrete.

SOLUTIONS

VINYL

TEKNOR APEX

Technical Developments in the World of Custom Compounds

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energy to fabricate concrete pressure pipe than PVC pipe; 280% more energy to make aluminum windows; and twice the energy to produce cast iron pipes. Even products as traditional as wood windows require 50% more energy to produce than PVC windows.

Reflecting the need to consider the full environmental impact of building materials, the U.S. Green Building Council has stated that the elimination of PVC or any other material does not alone qualify for one of its LEED (Leadership in Energy and Environmental Design) credits. A European Commission report, meanwhile, affirms that PVC offers environmental benefits that are equal to or greater than those of other materials in many applications.

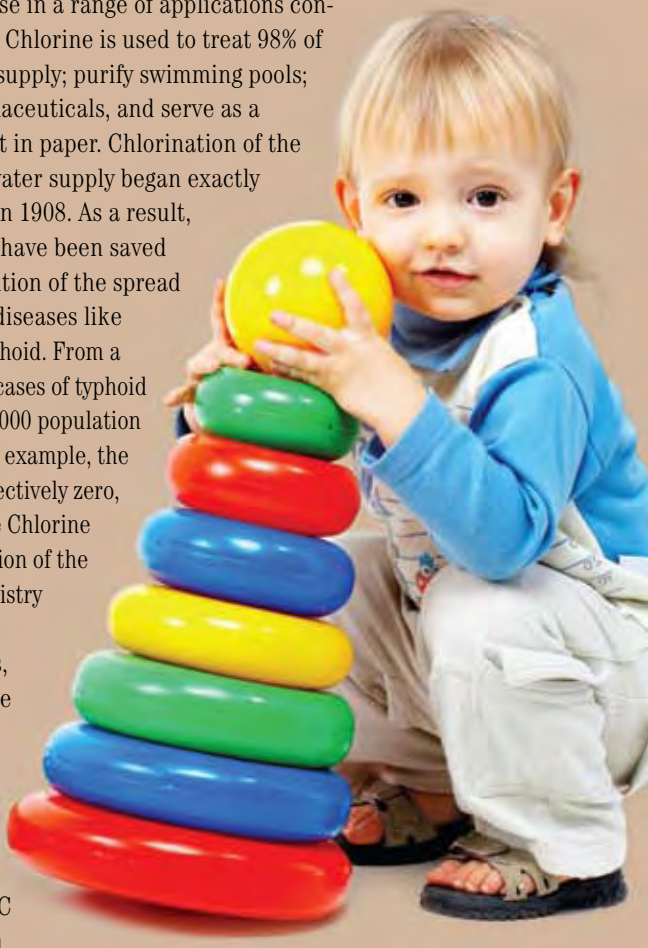
The benefits of PVC don't end with finished products. PVC earns high marks in life-cycle analyses. It has a low environmental footprint during production, especially since ethylene, a fossil-fuel precursor, only accounts for 44% of the basic composition. Studies have found that PVC production is 99% efficient—the process yields almost no waste, and the scrap that's created can be reused in many applications. In-plant recycling has been commonplace for years, and networks have been developed to promote recycling of discarded products.

Why Activists' Anti-PVC Claims Don't Stack Up

PVC compounds formulated to internationally recognized quality standards have never been shown to affect human health, are environmentally benign, and have proven safe in applications ranging from food packaging and transportation to toys, medical devices and commercial and residential building fixtures. Despite activists' claims, regulatory agencies like the U.S. Food and Drug Administration and the European Union Committee on Medicine have never found reasons for concern about the use of PVC in medical and health care products or in packaging. In spite of a recent phthlates ban, the U.S. Consumer Products Safety Commission has also found no health threats to children in PVC toys.

The presence of vinyl chloride monomer (VCM) and dioxin emissions during production of PVC resin are cited by activists as a cause for concern—both are carcinogens and can severely affect health if improperly handled. But these materials have for some time been non-issues during PVC production from the standpoint of worker health and safety. The chloride component in the PVC polymer, the compounds based on it, and subsequent finished products is stable. In fact, this component contributes to fire resistance and is one reason why vinyl wire and cable coatings exhibit better flame properties than competing plastics.

Chlorine's use in a range of applications confirms its safety: Chlorine is used to treat 98% of the U.S. water supply; purify swimming pools; produce pharmaceuticals, and serve as a bleaching agent in paper. Chlorination of the U.S. drinking water supply began exactly 100 years ago, in 1908. As a result, countless lives have been saved through prevention of the spread of waterborne diseases like cholera and typhoid. From a rate of 35 to 40 cases of typhoid disease per 100,000 population in the 1920s, for example, the rate today is effectively zero, according to the Chlorine Chemistry Division of the American Chemistry Council.



In the 1980s, PVC became the largest user of VCM in the U.S. Yet even as production of VCM soared with PVC demand, dioxin

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A Can-Do Approach to the Changing Needs of the Vinyl Market

'Anti-PVC extremists push their agenda of fear using junk science and misinformation. At Teknor Apex we prefer to focus on the facts.'

To many anti-vinyl extremists, nothing will do but to eliminate PVC. Never mind that it is the material of preference in essential applications like medical devices, wire and cable, and pipe. Never mind that it is a building block of modern life and has been used safely for 60 years. And as for the upheaval of replacing PVC in a wealth of good products with materials having far less history and poorer cost-performance—we'll just have to deal with it.

These extremists ignore the benefits of vinyl and years of testing and performance while they push their agenda of fear using junk science and misinformation. At Teknor Apex we prefer to focus on the facts. We use rigorous tests that have been reviewed by scientists to determine the safety of our products and the additives that we use.

Fortunately, the very nature of PVC—its extraordinary versatility—is one key to confronting all-or-nothing activism. While absolutists clamor for the end of PVC, Teknor Apex is using new vinyl chemistry to help customers deal with perceived health and environment issues.

We have addressed the issue of volatile organic compound (VOC) emissions in indoor environments, for example, by developing low-VOC compounds for furniture and furnishings—even though vinyl additives are just a few of the many substances that have been sources of VOCs.

Vinyl products have recently been attacked because of additives such as phthalate plasticizers. Independent organizations and government agencies have undertaken many tests to determine if phthalates are harmful to humans, and time and again the results have found them to be safe when used as intended. It has taken 25 years to demonstrate that test results linking one phthalate, DEHP, to cancer in rodents were not applicable to humans. Teknor Apex and other companies have cooperated in these tests, and the industry proactively stopped using DEHP in teething rings and soft toys while these tests were being completed. We now offer many compounds plasticized with alternatives to phthalates. And we are exploring PVC/elastomer alloys that do not need plasticizers at all to be flexible.

We have eliminated lead stabilizers in our thousands of wire and cable compounds now that there are alternative materials that perform at acceptable levels. This change was made without any evidence that the use of lead stabilizers posed any risks in the applications that used these products, such as wire and cable insulation.

Vinyl is often labeled as difficult to recycle. This is far from the truth. There are tens of millions of pounds of vinyl recycled every year. Most of the vinyl products that are recycled come from industrial sources and therefore do not appear in the public recycling inventories.

It is ironic that, by being singled out for attack and subjected to more testing than many other materials, vinyl has acquired an exceptionally massive body of evidence in favor of its safety and value. The enormous accumulation of evidence makes a strong case against extremists' all-or-nothing demands.

To our customers we say: Teknor Apex is ready to help you deal with any PVC-related issue you are confronted with, from phthalates to lead to VOCs. Give us a specification and we will meet it. We stand ready to develop products that meet your most difficult performance and safety requirements. This is the can-do approach that we always take. There's simply no place for all-or-nothing thinking at a technology company. ◆

Louis R. Cappucci
Vice President, Vinyl Division

Vinyl: an Irreplaceable Benefactor in Healthcare

by Robert S Brookman, Ph.D.,
Vice President, Teknor Apex Company

Medical uses of PVC include tubing, bulbs, masks, and many other devices where replacement by other materials would sacrifice performance, economy, or both.

Amid the controversies raised by anti-PVC activists, it is easy for ordinary citizens to overlook the benefits of vinyl in medical applications. Virtually no clinical or hospital environment can do without vinyl medical devices. Each year in the U.S. alone, healthcare professionals use well over half a billion pounds (225,000 metric tons) of flexible PVC products to treat patients. Vinyl devices help to heal, bring comfort, prevent the spread of disease, and save lives.

Today medical manufacturers face demands that they "de-select" vinyl in favor of other plastic materials, but replacing vinyl would not be easy—or desirable. No other plastics can match PVC for its combination of value, wide range of properties specific to medical uses, ease and versatility of fabrication, and availability.

Then there is the vinyl track record in medical devices—more than 60 years of safe use in applications for which compounds are subject to stringent regulation. Medical devices were one of the first uses of flexible PVC. During World War II, vinyl components were used in blood transfusion and IV sets for treatment of U.S. forces in the field. After the war, demand for vinyl in medical applications grew steadily, and today it continues to expand rapidly worldwide.

Vinyl Is Uniquely Versatile

No other plastic meets such a wide range of the performance requirements encountered in medical applications. Vinyl can be transparent, opaque, rigid, flexible, or even elastomeric. Teknor Apex can formulate vinyl to be tough at very low temperatures, stable at elevated temperatures, resistant to lipids, electrically conductive, opaque to X-rays, or sterilizable by any standard method, including gamma irradiation. If a customer asks for an alternative to phthalate plasticizers, Teknor Apex offers several choices.

Also diverse are processing alternatives. Depending on the form in which it is supplied, vinyl is readily injection molded, extruded, thermoformed, blow molded, rotationally molded, slush molded, calendered, applied by various coating methods, or cast—probably the broadest range of processes for any thermoplastic. It can be bonded or sealed using thermal, radio frequency, or solvent techniques. In tubing—its most common medical application—vinyl resists kinking far more than any plastic suggested as an alternative.

Vinyl also provides unique price/supply advantages. PVC is one of the world's most widely produced and highest-volume resins and differs from all other commodity polymers in not being 100%

derived from petrochemicals—more than half of the PVC molecule is chlorine from sea water. Thus, even after the PVC has been compounded with plasticizer and other additives, it is less expensive than alternative materials. This is an important advantage, since most plastic medical devices are for one-time use.

Stringent Regulation of Medical Devices

In the United States, vinyl medical devices are subject to regulation by the U.S. Food & Drug Administration (FDA). Extensive information on the FDA's programs for medical devices is available at http://www.fda.gov/CDRH/. The standards applied by the FDA are detailed and exacting, and they exert a strong influence on medical device manufacture around the world.

Consider the example of the blood bag. The FDA assumes that the components of the bag will migrate into the blood and thus be infused into the human body. Therefore, the blood bag is considered a "drug" and cannot be used until the FDA approves a "New Drug Application" (NDA) whose subject is the blood bag as produced by a given manufacturer. Once the NDA is issued, the components in the blood bag and its method of manufacture are fixed as described in the NDA. Even a change of supplier involving a chemically identical compound ingredient must go through rigorous testing as described by the NDA.

More Vinyl Medical Devices Needed

The need for vinyl medical devices is actually growing. In the U.S., the market for medical and other "regulated" applications of flexible vinyl (such as food-contact and potable-water products) expands at 5% per year, and the rate is considerably higher in China, India, and other developing countries.

There are strong forces creating new demand for vinyl medical devices:

Aging Population. As life expectancy steadily increases in developed countries, the growing elderly population requires more medical care.

Infectious Diseases. The discovery that diseases like AIDS and hepatitis are transmitted by transfer of bodily fluids dictates greater usage of disposable devices. In addition, methicillin-resistant staphylococcus aureus (MRSA) bacteria is now a major source of cross-infection in hospitals and clinics.

Healthcare Cost Containment. Strong pressure from government and insurers to drive healthcare costs down has shortened hospital stays and increased reliance on home health care; as a result, demand grows for sterile, disposable devices.

Dialysis. More than 600,000 patients undergo dialysis therapy worldwide, and this number increases by 6% every year. Since a patient is subjected to three treatments every week, about 93 million devices are consumed per year. On this basis the demand for PVC tubing for hemodialysis is about 370 million meters per year, growing at a rate of 6%. In addition the employment of dialysis to treat trauma patients is growing.

Even as activists call for reduced use of PVC, the advantages of vinyl for medical manufacturers and its benefits for patients continue to drive the medical device market in the opposite direction—greater need for PVC. Medical-grade vinyl is one of the most important benefactors developed by the plastics industry. Teknor Apex is proud to be a longtime participant in an industry that does so much good.

Vinyl Is Ubiquitous in Healthcare

Because of its versatility and cost-performance ratio, vinyl has many medical applications. Here is a partial listing:

- Blood transfusion sets (blood bags, tubing, and connectors)
- IV sets (storage bags, tubing, drip chambers, and connectors)
- Dialysis tubing
- Endotracheal tubes (used during surgical procedures)
- Radio opaque devices (catheters, surgical threads) that can be monitored by X-ray
- Inhalation therapies (oxygen masks)
- Catheters for open heart surgery
- Drainage tubing
- Peristaltic pump tubing and syringe bulbs
- Specially formulated wire and cable insulation and jacketing for EKG machines, X-ray devices, and other diagnostic equipment
- Non-toxic, anti-static floor covering and wall covering products
- Operating room drapes and sheetings

Still Essential for Wire and Cable, Vinyl Is Now Lead-Free

by Mike Patel, Industry Manager, Teknor Apex Company

Few people appreciate how much modern life has benefited from the use of vinyl in wire and cable. More than 60 years ago, when vinyl began to replace rubber insulation and textile jacketing, it vastly increased the safety and efficiency of wire and cable and helped make possible the massive expansion of the world's electrical power and communications infrastructure. Today nearly two-thirds of all wire and cable manufacture involves some use of vinyl, as does production of associated components like conduit, raceways, fittings, and outlet and switch boxes.

Teknor Apex was one of the pioneering suppliers of the flexible PVC compounds that made this revolution possible, and in 2008 the company has continued in its leadership role by becoming the first compounder to completely eliminate lead stabilizers from its product range, which includes more than 3,000 wire and cable compounds. Since July 31, 2008, the company supplies only non-lead stabilized (NLS) compounds for wire and cable.

The sheer number of compounds offered by Teknor Apex points up one of the important advantages of PVC in wire and cable: its versatility. More than any other widely used polymeric material, vinyl can be compounded to yield a wide range of grades for specific application requirements. But vinyl offers other critical advantages as well, including strength, durability, flexibility, good electrical properties, and low cost relative to most competing materials. Since more than half of the PVC polymer consists of chlorine, vinyl is inherently more flame-resistant. In fact, vinyl performs exceptionally well in stringent Underwriters Laboratories (UL) fire tests.

Use of vinyl in wire and cable has been an important factor in the rapid spread of electrical and communications infrastructure.

Losing the Lead—but Keeping the Performance

For decades, most of the vinyl compounds used by manufacturers of wire and cable have contained lead stabilizers, but now that era is ending. Mandates to eliminate lead in a wide range of products—not just wire and cable—have arisen in Europe, Asia, and the United States, the most notable being the European Union's RoHS Directive. In response, Teknor Apex has developed NLS compounds that entail no compromise in physical and electrical properties and are comparable in price to the lead-stabilized products. In some cases, reformulation has actually improved certain properties.

The main reason why getting the lead out has posed such a challenge is that, until recently, lead sulfate and other lead-based stabilizers have been the most efficient and cost-effective additives available for rendering the PVC polymer in vinyl resistant to thermal degradation. Polymer degradation causes deterioration of the mechanical properties of vinyl and compromises its electrical properties.

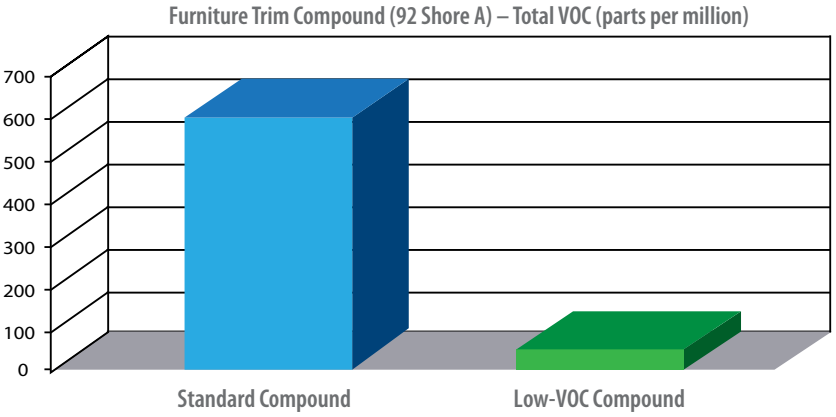
The key to replacing lead stabilizers was the development by additive companies of new "mixed-metal" (calcium-zinc and barium-zinc) stabilizers that are more efficient than previous mixed-metal formulations. These new stabilizers alone, however, were no "magic bullet" for eliminating lead. The next step was for Teknor Apex to develop formulations in which the new stabilizers function in concert with all the other ingredients that make up so complex a product as flexible vinyl. Unlike many other commonly used polymers, PVC itself has no commercial value unless it is compounded with plasticizers, lubricants, heat stabilizers, and other additives. A formulation change involving any one of these components may affect the functioning of the others, which in turn can affect processability, mechanical and electrical properties, or the cost of the compound

The NLS compounds from Teknor Apex include Apex® flexible vinyl formulations, Flexalloy® vinyl elastomers, and Fireguard® low-flame, low-smoke vinyl compounds for plenum cable.

Low-VOC Vinyl Helps Improve Indoor Air Quality in Homes and Offices

As part of a wide-ranging program to expand options for customers looking to address environmental issues, Teknor Apex has developed vinyl compounds that help reduce the amount of volatile organic compounds (VOCs) in indoor environments—a concern among architects, designers, and builders.

Innovative formulation technology now enables Teknor Apex to manufacture flexible vinyl compounds that reduce emission of VOCs from furniture and furnishings by 80% or more in comparison with conventional vinyl counterparts.



These low-VOC versions of the company's Apex® compounds are for use in profiles and molded items, extrusion coated fabrics, and extruded and calendered sheet used in residential and institutional applications. Some examples are wall coverings, window treatments, office partitions, baseboards, and furniture trim profiles (like those shown in the photo). Supplied on a custom basis, the new compounds exhibit the same processing and end-use properties as similar conventional products and are comparably priced, according to Phil Morin, industry manager of consumer and industrial markets.

"Teknor Apex has developed its low-VOC formulation technology to help manufacturers achieve certification under voluntary air-quality standards developed by industry groups for a wide range of substances, including vinyl," said Morin. "These industry standards are being used as a reference by green building guideline organizations such as the United States Green Building Council (USGBC) and Leadership for Energy and Environmental Design (LEED)." ◆

Spread the Good Word about PVC

A wealth of information about PVC, its chemical precursors, and phthalate plasticizers is now readily available on websites sponsored by key industry groups. More than just defending these materials against activist attacks, the online resources emphasize the positive benefits of the materials for society. They are useful tools for anyone seeking to enlighten communities about the benefits of vinyl and the misconceptions surrounding it.

Important online resources are available from these associations:

The Vinyl Institute

The Vinyl Institute:
www.vinylinfo.com
This site provides extensive information on PVC as a material and as an industry, shows the importance of vinyl in addressing issues affecting the environment, recycling, and energy conservation.

Vinyl News Service:
www.vinylnewsservice.net
Another resource developed by the Vinyl Institute, this timely website gives access to current case histories showing the value contributed by vinyl in a wide array of applications.

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The Good Word

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Phthalate Ester Panel of the American Chemical Council:
www.phthalates.org
Phthalate plasticizers are the sole focus of this website, which provides news, technical information, and links to important government and industry documents.

Phthalate Information Centre Europe:
www.phthalates.com
The emphasis of this website is on current European Union developments relating to phthalate plasticizers, including EU risk assessments.

Chlorine Chemistry Division, American Chemistry Council:
www.dioxinfacts.org
This site provides access to factual backgrounders, technical studies, regulatory documents, news articles, and expert commentary relevant to dioxins.

Chlorine Chemistry Division, American Chemistry Council:
www.americanchemistry.com/chlorine
An extensive resource on the practical benefits of chlorine and the issues surrounding its use.

Vinyl in Design:
www.vinylindesign.com
This site highlights new and innovative applications using PVC as well as provides information on existing PVC applications.

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PVC: A Vital Resource

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emissions plummeted. In one period, 2000-03, emissions from PVC production declined 70% from an already low level, a trend that reflects ongoing developments in process efficiency and safety standards. PVC manufacturing, in fact, accounts for only about 0.4% of annual U.S. dioxin emissions, a negligible amount when compared to forest fires (61% of dioxin emissions every year); landfill fires (14%); land-clearing (7%); waste incineration (6%), and backyard burning (6%).

PVC's Long Track Record: Value Rather then Harm

Activist groups base anti-vinyl campaigns on the claim that vinyl and its components—chlorine, plasticizers, stabilizers and phthalates—are harmful to human health and to the environment. Yet no credible scientific studies have shown any dangers to humans from exposure to these materials, either during PVC production or in products, providing, of course, that internationally recognized safety procedures are in place, a given for any reputable manufacturer.

Experts are at a loss to explain why PVC provokes fury among activists, especially since none of their claims withstands scrutiny. Some believe that anti-PVC campaigns are really directed at chlorine, which, like many chemicals, is dangerous when improperly handled.

In 1999, the former U.S. Surgeon General, C. Everett Koop, reported that a commission he headed failed to find problems with DEHP, a phthalate used in PVC toys and medical devices, and one that activists claim should be banned for health and safety reasons. Koop advised that it was not only unnecessary to eliminate DEHP (and PVC products containing it), but doing so in medical applications could pose a "significant health risk to some individuals."

PVC is one of the materials on which modern societies depend for utility, reliability and economy in the products they produce. As businesses and consumers better understand the life-cycle relationship of chemicals to the environment, PVC will increasingly be recognized as a material with green benefits, one whose use substantially reduces the carbon footprint associated with manufacturing, distribution, and consumption of many products.

Efforts to ban PVC are, consequently, bad science, bad policy and bad for the markets and consumers that benefit from its properties and product-enabling performance.