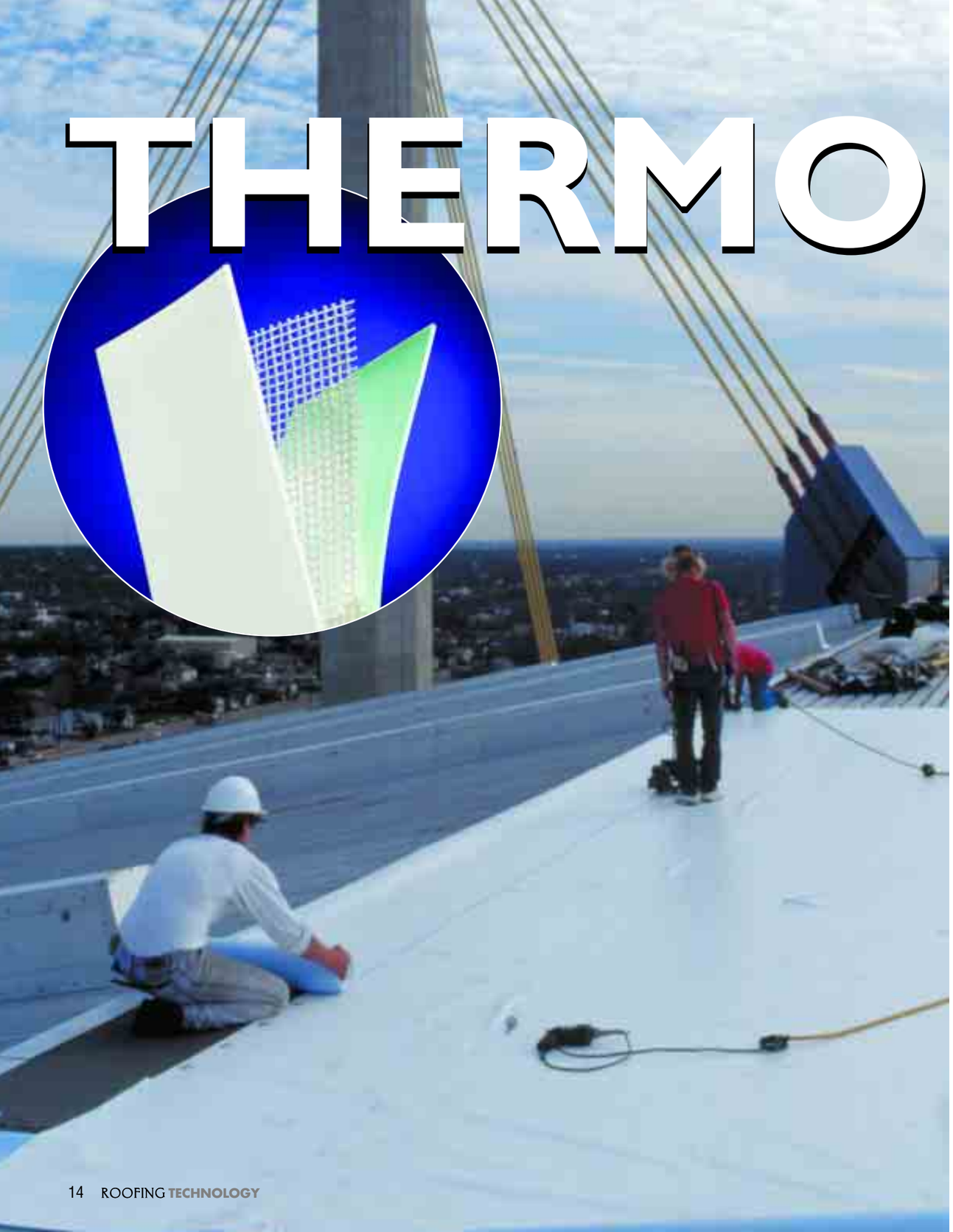

THERMO PLASTICS

Revolutionizing the Single-Ply Market

by Michael Russo
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Thermoplastics are doing the same thing today for single-plies that one plies did when they were first introduced more than 20 years ago — *revolutionizing the roofing market*.

Like it or not, the industry is changing. More and more, building owners are looking for environmental and energy-efficient solutions to their roofing needs.

For example, an estimated 500,000 federal facilities are being required to reduce their energy consumption 35% by the year 2010. Any roofing contractor bidding on government work will be expected to provide energy-conserving technologies with longer life cycles that are installed and maintained in ways that are friendly to the environment.

Architects call it "sustainable" design, and it will be an integral part of roofing specifications in the new millennium.

So how do thermoplastics stack up when it comes to sustainable roof designs? Very well, actually. The hot-air welding application used to install thermoplastics is well within the most stringent VOC tolerances, and the membranes themselves are available in a variety of colors and reflective, energy-saving, white. White membranes can also help ease the growing problems associated with urban heat islands.

What's in it for me?

Fact is, almost every single-ply supplier today is focusing their considerable resources on adding to or improving their existing line of thermoplastic membranes. Competition is fierce, and suppliers are adding new wrinkles (no pun intended) to their membranes and application methods to give them an edge in the marketplace.

The winner in this competition is the building owner. But there's a catch. You need to understand the potential benefits of these new and improved thermoplastic membranes to ensure you get the right roofing product for your installation.

Here's a list of the benefits that thermoplastic membranes offer building owners:

1. The use of membrane reinforcements and increased thickness of materials (more polymer) have dramatically improved the performance of thermoplastics.

2. Light-colored thermoplastics can boost the solar reflectance of a building's exterior and reduce heat transfer to the building's interior — potentially decreasing energy demands and the use of fossil fuels polluting our environment.

3. Thermoplastic hot-air welded seams are up to eight times stronger than butyl adhesive seams and three times stronger than butyl tape seams. Heat-welded peel strengths are 25 pounds or greater, compared to 3 pounds for liquid adhesive seams and 8 pounds for taped seams.

4. Thermoplastics are either inherently fire resistant or can be made fire retardant.

5. Significant labor savings are achieved with hot-air welded seams compared to adhesive or taped seams.

6. Thermoplastics can be specified with varying degrees of chemical resistance to fats, acids, oils and microbial attack. Hypalon-based membranes are probably the most chemical resistant.

7. Installation flexibility. Thermoplastics can be mechanically attached, fully adhered, ballasted or installed as part of a "vented" roof system or protected membrane roof. There are also fleece-backed systems that can be installed using several methods.

8. Some thermoplastics are available in extra-wide, 8-, 10- and 12-foot sheets that can save on cost and labor (less fasteners and seams).

Where does your TPO supplier stand?

There are essentially three different types of TPO suppliers in the market: chemists, converters and private labelers. It may be important to know where your current roofing supplier stands in this matrix.

Chemists — Defined as manufacturers that fully compound their own membranes and have a full understanding of all the intricacies of the chemical formulation of their TPO products.

Converters — Companies that process or convert pre-compounded materials into sheet form without having a direct impact on the initial material formulation.

Private Labelers — As the name implies, these firms are re-sellers of membrane made by another company. As such, private labelers may not have an intimate knowledge of the product's chemical formulation and make-up.

Other suppliers' membranes can be prefabricated for easy installation.

9. TPO thermoplastics are chlorine and bromine-free and are available with reduced levels of halogenated fire retardant, or halogen-free formulations, to avoid creation of environmentally harmful acid gases when incinerated.

10. Higher molecular weight plasticizers and improved manufacturing techniques have successfully addressed past problems with plasticizer loss in some PVC-based membranes.

11. Thermoplastics achieve UL and FM Class A and B fire ratings over substrates including polyiso, extruded polystyrene, wood fiber and gypsum.

12. Prefabricated flashing provides error-free installation and savings in terms of labor and materials.

Steep growth curve

With advantages like those listed above, it's not surprising that thermoplastic single-plies have experienced healthy growth over the last several years.

For example, in 1990, thermoplastic single-plies accounted for 9% of the average contractor's annual dollar volume, according to RSI's State of the Industry Report. Today, thermoplastics account for 13% of the average installer's volume — up 44% over the last decade. TPO shipments alone are showing double-digit increases over the past year.

"While single-plies are on cruise control, TPOs are full speed ahead," said one well-respected industry observer.

With the trend toward "green" buildings and energy-saving, environmentally friendly roofing systems, thermoplastics have strong selling points. While more expensive than unreinforced EPDM, in terms of membrane price per square foot, the labor savings associated with thermoplastics go a long way toward closing the "installed" price gap.

However, there are still a vast number of options within the thermoplastic category, including CPA, CSPE, EIP, NBP, PVC and TPO. In the TPO category alone, there are a wide variety of choices and there can be significant differences between manufacturer's products. Add to this other proprietary thermoplastic membranes, with varying reinforcements and fire/UV resistance packages and the building owner's membrane choices become a little more complex to say the least.

It's not surprising, then, that building owners, architects, roof consultants, and even roofing contractors all need help differentiating between available membranes.

While the information presented here is non-proprietary, it should help those who are unfamiliar with certain manufacturers' membrane make a more educated buying decision.

How thermoplastics stack up

An experienced roofing applicator can often tell the difference between two white, thermoplastic sheets by their handling or welding characteristics.

Membrane surface patterns and colors will also vary from manufacturer to manufacturer.

However, making direct product comparisons of single-ply membranes in the fiercely competitive thermoplastics segment can be a dangerous business. While there are certain material characteristics common to all thermoplastics, such as hot-air welded seams, other performance attributes can vary widely.

The product summaries listed below were compiled from a variety of sources, including manufacturers' product literature.

1. CPA — The Co-Polymer Alloys
Co-Polymer Alloy (CPA) thermoplastics are "modified" PVCs or plasticized vinyl membranes with base resins primarily made of PVC. However, other polymers besides PVC are used in their formulation.

All CPAs are polyester reinforced, offering 25-40% elongation depending on the test method used. Depending on the amount of PVC in the formulation, chlorine gives these membranes some inherent fire resistance, although all manufacturers add additional fire retardant. The chemical resistance of these membranes is generally greater than standard PVC and EPDM. However, like PVC, if EPS insulation without a fiberglass or foil facer is used under a CPA membrane, a separation sheet is required.

High molecular weight plasticizers are also used to keep the materials flexible. For one membrane, the polymer is applied to both sides of a non-woven polyester fabric. The membrane is then put through a laminator and formed into a composite sheet. This particular membrane can also be custom prefabricated with 80-85% of the seaming handled by the manufacturer in a controlled environment.

2. CSPE—Chlorosulfonated Polyethylene
CSPE polymer was first manufactured by E.I. du Pont under the Hypalon trade name in 1951 and has been used as a polymer in roofing membrane since 1966. CSPE is a synthetic rubber. Although categorized as a non-vulcanized elastomer, it does cure after exposure to the elements.

Hypalon-based membranes have been used extensively in the U.S. and overseas over the past 20 years, and one manufacturer reports more than one billion square feet installed. Hypalon-based systems remain a viable roofing selection for specific applications, particularly those with stringent chemical resistance requirements and those which require a high fire rating.

Despite a long history of performance, there are some application issues related to Hypalon-based membranes, most notably, the difficulty of repairing or re-welding cured membrane. It can be done, but it's a hassle for most applicators. There have also been reports of dirt pickup, chalking and biological attack on Hypalon-based membranes, with some isolated failures in coastal areas.

The performance of Hypalon-based sheets can also vary from manufacturer to manufacturer, as can the percentage of Hypalon found in each supplier's product. But overall, most Hypalon-based membranes have held up fairly well in a variety of demanding environments.

3. EIP—Ethylene Interpolymer Alloy
The EIP compound uses DuPont Elvaloy KEE (ketone ethylene ester) as its principal polymer blended with PVC.
The Elvaloy KEE modifier is a polymeric plasticizer that is generally more chemical resistant and less susceptible to plasticizer migration than monomeric plasticizers used in some PVC membranes. However, monomeric plasticizers generally offer greater low temperature flexibility and lower water absorption characteristics than EIP (see PVC below).

Reinforced with a variety of denier weft reinforced Dacron polyester fabrics, one EIP product features a prodigious tensile strength of 9500 PSI (ASTM D882). The weft reinforced polyester is primed and coated with EIP before the membrane is produced to make the sheet as monolithic as possible and reduce the potential for wicking and delamination. A patented process impregnates fibers, helping to form a molecular bond.

The fabric reinforcement isn't cheap but it does fight shrinkage and dissipate stress in the membrane thanks to a proprietary weave design. Thanks to its reinforcement, the membrane is highly puncture resistant. It also offers resistance to UV, fire, fungus and algae or micro-biological attack.

Fleece-backed products can be fully adhered over asphalt-based roofing systems with conventional asphalt adhesives.

4. NBP — Nitrile Thermoplastic Membrane
One of the older members of the single-ply roofing family, NBP, or nitrile alloy with butadiene acrylonitrile co-polymers, is a PVC blend in the same general category of CPA and EIP membranes (see above). It offers greater chemical resistance than PVC and uses nitrile rubber in place of plasticizers, giving the membrane greater flexibility than PVC.

Although the prevalent compound in the membrane is the nitrile alloy, as many as 18 separate polymers are used to contribute to the membrane's performance.

5. PVC — Polyvinyl Chloride
The grandfather of single-ply roofing, PVC laid the groundwork for manufacturing and application details for all other one-ply membranes. The earliest preparation of a vinyl chloride monomer

Reinforced TPO technology has been available in the roofing industry for nearly 10 years.

dates back to 1835, and the first PVC-based roofing membranes were installed in Europe in the early 1960s. The track record of PVCs is long, with at least two suppliers touting roofs that are still performing after 35 years of exposure to the elements.

There are four key components that determine the performance of a PVC membrane: formulation, thickness, reinforcement and production techniques (spread coating, calendering and extrusion). There are also four basic ingredients in today's PVC membranes: PVC resin, plasticizers, stabilizers and pigments. All four must be properly balanced to achieve good weatherability from the membrane.

Plasticizers are used to keep PVC sheets flexible, but some have been observed to migrate out of the membrane over time, resulting in membrane shrinkage or shattering in unreinforced membranes. Better plasticizers and polyester or fiberglass reinforcements have greatly improved the performance of PVC.

There are a number of strategies that manufacturers pursue when it comes to PVC plasticizers. Either low or high molecular weight plasticizers are used, and both options offer different features and benefits. Low migration, high molecular weight formulations limit plasticizer loss. These linear, long-chain plasticizers are more difficult to "break up" than a non-linear or branch plasticizer. However, branch plasticizers are less expensive and aid in the manufacturing of some membranes.

Linear and branch plasticizers are both monomeric, compared to the Elvaloy KEE polymeric plasticizers used in EIP membranes (see above). Polymeric plasticizers are generally more chemical resistant and less susceptible to migration. However, membranes based on these plasticizers typically don't have the level of cold temperature flexibility and low water absorption characteristics of monomeric-plasticized membranes.

PVC displays less chemical resistance than TPO, CSPE and EIP, but is usually less sensitive to animal fats and vegetable oils than EPDM.

PVC should not be directly applied over asphalt or coal tar pitch, and like CPA, needs a separator sheet when installed over EPS insulation. (At elevated temperatures, plasticizers can be drawn out of the PVC and degrade expanded polystyrene boardstocks.)

PVC is also questionable in ballasted applications, where the dirt and clay associated with stone ballast can affect or accelerate plasticizer loss.

A strong reinforcement is not a replacement for polymer thickness. PVCs, once manufactured as thin as 32 mils, now weigh in at 48 mils or higher, and most other thermoplastic membranes have followed suit. Few, if any, products are available at less than 36 mils — the minimum allowed by ASTM D4434 for PVC membranes—and some PVCs can be specified as high as 120 mils in thickness. As the polymer typically represents 75% of the overall cost of the membrane, thicker sheets aren't cheap. But greater polymer thickness over scrim does offer greater weatherability, scuff and abrasion resistance. Reinforced membranes also offer better tensile strength and tear/puncture resistance.

Unfortunately, the chlorine component of PVC, which gives the product its inherent fire resistance, has been the victim of a lot of bad press. Chlorine is not environmentally friendly when it comes to incineration or disposal. While this hasn't had a major impact on the roofing market, which is still behind the curve when it comes to recycling, it may be an issue in the future. The price of the PVC resin has not changed much in the last 12 months, but the price erosion experienced by some manufacturers is dramatic. The lower cost of TPO membranes isn't helping PVC suppliers, either.

6. TPO—Thermoplastic Polyolefins
TPO is the newest kid on the block and growing up fast. Easily the fastest growing segment of the single-ply industry, double digit annual increases are the norm for many manufacturers.

Reinforced TPO technology has been available in the roofing industry for nearly 10 years. As a generic category, TPO fits neatly between EPDM and PVC, offering the weathering and cold temp flexibility of the former, and the heat-welding characteristics of the latter. This is possible via a synthesis of the two base TPO polymers, polypropylene (PP) and ethylene-propylene rubber (EPR). Thus, the "tough" properties of the PP are combined with the inherent flexibility of EPR.

Unlike PVCs and PVC blends, TPO contains no plasticizers that can migrate out of the membrane. One of the most obvious visible physical properties of TPOs are their relative stiffness compared to other membranes. However, flexibility varies from manufacturer to manufacturer, with the more flexible membranes generally easier to install.

Although TPOs are not inherently fire resistant like PVC, they can be made fire and UV resistant during manufacture. The TPO polymer is heated and mixed with UV stabilizers, pigments and fire retardants. Due to possible interactions between these stabilizers and other additives, care must be taken when formulating these membranes.

There are two basic fire retardant packages: halogenated FRs (bromine and chlorine) and non-halogenated products (hydrated minerals and phosphate ions). Both can be made to work in synergy with UV stabilizers if developed correctly. Obviously, the non-halogenated products are the most environmentally friendly.

While TPOs are not as chemical resistant as CSPE, CPE and some PVC sheets, they can endure animal fats, acids/bases and vegetable oils. They are also inherently resistant to microbial attack. They can also be directly applied over asphalt-based products and EPS insulation.▲

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