

TPO: Getting Better With Age

By Michael Mendoza, TPO product manager, Firestone Building Products

Thermoplastic polyolefin has matured. By any criteria, TPO is no longer the new kid on the block when it comes to commercial and industrial roofing. In fact, it continues to be the fastest growing commercial roofing membrane on the market today, accounting for more than 40 percent of the United States’ installed square feet of roofing during the past seven years.

Industry reports show that nearly 1.2 billion square feet of TPO was installed in 2013 alone. Its momentum and market acceptance continues to outpace the overall commercial roofing market. In addition, TPO seems to be a leading option for white, reflective, energy-efficient and heat-welded single ply roofing systems.

While TPO can now be considered a mature product, it didn’t become one without growing pains. TPO roofing membranes were first used in Europe in the 1980s. The material was then introduced in the U.S in 1992. Some manufacturers with little or no experience were attracted to the new, largely unfamiliar market and in its infancy, the TPO industry did not have the strict regulations it does today. The ASTM standard for TPO is now the most stringent of any single ply roofing material (see chart below).

	TPO (old ASTM)	TPO (new ASTM)	EPDM	PVC	KEE
ASTM Standard	D6878	D6878	D4637	D4434	D6754
Xenon Arc					
Temperature	80°C	80°C	80°C	63°C	63°C
Hours @ 0.35 W/m²	8,000	8,000	4,000	5,000	5,000
Oven Aging					
Temperature	116°C	116°C	116°C	80°C	80°C
Days	28	224	28	56	56

Initially, some manufacturers faced performance challenges that led to material failures. Formulation trial and error was not uncommon. This left some to question the durability of TPO. Today, those issues have largely been eliminated. Many of the early manufacturers either left the business or refined their original formulas and processes to solve initial performance problems. The evolution of TPO was very similar to that of other commercial roofing materials—ethylene propylene diene monomer (EPDM) and polyvinyl chloride (PVC), for instance—where trial and error eventually led to the creation of quality materials. It only took eight years after its initial introduction for TPO to make serious inroads in the U.S. Some of the material’s growth stemmed from well established companies with significant experience in polymer engineering entering the TPO market.

The companies that remained have helped drive today's exacting performance specifications. Professional standards have brought a much-needed level of credibility to the TPO manufacturing community; not to mention peace of mind for architects, contractors and building owners.

TPO is part of the thermoplastic single-ply membrane family. Polypropylene based plastic and ethylene/propylene rubber allows TPO membranes to be durable and remain flexible even in low temperatures.

Among common TPO misconceptions is that one membrane is the same as the next. In reality, each TPO manufacturer guides a unique chemical formula and product design. It's important to understand that all manufacturers make their own version of TPO.

High quality TPO is ultimately rooted in good chemistry. A solid formula is essential to engineering an ideal polymer. This is a critical consideration because the polymer is the backbone of the product—the base that allows all the other elements of the formulation to work together to achieve desired results.

Technically speaking, the polymer is crucial if the ultraviolet (UV) stabilizers, fire retardants, titanium dioxide, antioxidants and heat stabilizers are to do their jobs. TPO, like all polymers, is subject to UV and heat degradation. This potential problem is mitigated using stabilizers which work to slow polymer breakdown. These stabilizers, too, must comply with all other formulation components, as incongruity may lead to premature degradation.

Striking the right balance between the polymer and raw materials is what makes manufacturing quality TPO difficult. Perhaps this challenge serves as one explanation of why only a handful of companies today have the resources to manufacture TPO.

The material's eventual acceptance by the commercial roofing marketplace is really no mystery. Once the performance issues were resolved, building owners, architects and contractors could objectively analyze its many benefits.

For example, because TPO is a thermoplastic, it can be heat welded. This creates a monolithic roof while simultaneously providing strength and durability.

UV light stabilizers are critical in that they provide weathering resistance and long-term strength. Fire retardants, such as magnesium hydroxide (non-halogenated), contribute to the fire resistance of TPO without negatively affecting its UV stabilization, nor harming the environment.

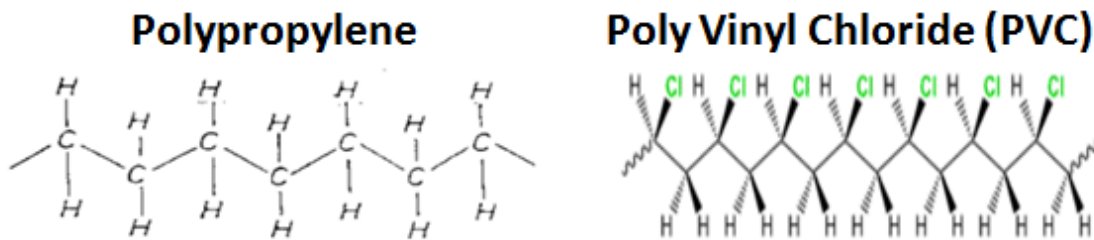
Titanium dioxide pigments determine the color of the membrane and help provide increased brightness and reflectivity. Heat stabilizers guard against heat degradation during the manufacturing process and after installation. The list goes on.

PVC is another member of the thermoplastic single-ply membrane family. At first glance, it is easy to see the similarities between the two products. TPO and PVC are both thermoplastic materials that share the ability to be heat welded, which provides a monolithic seam to prevent water intrusion. Both materials are also considered "cool" because they are light in color,

making them reflective and resistant to the sun's heat. Buildings with reflective roofs can stay cooler inside and save on air conditioning costs.

Additionally, the installation processes for TPO and PVC are nearly identical. They require the same type of attachment materials, tools, procedures and skills. They can be mechanically attached or fully adhered. The membranes are also both resistant to chemicals, grease and oil (to varying degrees). They are puncture resistant and can be easily repaired; flexible and designed to conform to the movement of a roof.

On the surface, it may be difficult to differentiate between these two thermoplastic family members. However, the differences are vast, beginning in the materials' chemistry. TPO, is a naturally flexible polymer-based material and does not require additives to achieve its flexibility.



Most highly reflective TPO membranes meet LEED®, ENERGYSTAR® and other environmental program criteria. Among its major environmental advantages is the fact that TPO can be easily recycled with other plastics, making it a primary consideration for companies committed to the stewardship of the planet.

Most people consider PVC to be the hard plastic piping sold at hardware stores. This solid, inflexible nature of PVC leads to the most significant difference between the two membranes.

PVC, unlike TPO, requires the addition of the aforementioned chemical plasticizers to achieve the pliability necessary to serve as a roofing membrane. Plasticizers artificially give PVC the flexibility that is innate in TPO.

This is a negative characteristic of PVC because plasticizers—those required to make the material flexible—can break down by attracting mold or microbes, causing it to revert to its original solid state. The microbes then tend to attach themselves to a roof. The unwelcome pests also turn the PVC a darker color and reduce the reflective quality that is crucial to energy efficiency.



The roof can shrink, too, making it more vulnerable to hail damage and difficult to heat weld during repairs.

Decisions on roofing membranes are frequently made based on the specifications and physical characteristics of the material. The question is: How will a single-ply roofing membrane stand up against long-term UV exposure?

As the industry has matured, numerous studies and tests have attempted to answer that question. One of the most comprehensive thermoplastic membrane [studies](#) was published in the May/June 2010 issue of *RCI Interface* magazine.

Testing was performed and reported by independent consulting firm, Jim D. Koontz & Associates in conjunction with Target Corporation, a national retailer that uses PVC roofing on its own facilities.

The consultant tested 11 single-ply membranes—five TPO and six PVC—from seven different manufacturers. Testing was of long-term exposure to UV rays during an 18-month time period. Results found that, on average, TPO membranes have a greater propensity for retaining physical properties when compared to PVC, ketone ethylene ester (KEE) and EV membranes.

The study provides evidence that when used in similar conditions, TPO will outlast PVC.

TPO was originally created to provide the advantages of PVC without its limitations at a better value and with a decreased environmental impact. Considering the significant savings of between 10 and 20 percent and studies proving its reduced carbon footprint, it's difficult to argue that this goal has not been achieved. The long-term return on investment is expected to be even more substantial.

While laboratory testing provides a scientific basis for comparison, the market is the ultimate proving ground. It has elevated TPO to the No. 1 choice in the U.S. commercial roofing industry.

The *RCI Interface* report confirms that not all TPOs are alike. The study indicates that there are substantial variations among the different manufacturers of TPO tested. So, how do you know which to choose?

Choosing the right manufacturer to meet your needs requires homework. A good place to start is with the following questions:

- How long has the manufacturer been making the membrane? The company should have a long-standing performance record.
- How often has the material been reformulated? Look for a manufacturer whose formula has not required ongoing experimentation to overcome pitfalls.
- Does the thickness over scrim meet ASTM requirements? ASTM requires 15 ml thickness over scrim.

Select a roof system from a manufacturer you have researched; one you are assured has the products, systems and know-how to back it up. Research the warranties so you know what is covered and what is not. Check the fine print for any temperature restrictions included and limitations on transferability. Look for limits on workmanship coverage.

Through its evolution, manufacturers have learned to perfect TPO. Performance and durability are the function of product design, material chemistry and manufacturing processes. However; without proper installation, the design, chemistry and manufacturing won't count for much. Be sure the manufacturer offers licensed, trained and experienced professional roofing contractors.

So, has TPO grown up? The facts are clear. Take a hard look at TPO and you'll find a roofing product that has truly come of age.