Is PVC Reallly the - Bad Boy - of Sustainable Design?

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The U.S. Green Building Council's discussion on whether or not to offer a LEED™ (Leadership in Energy and Environmental Design) credit for projects that refrain from using PVC (polyvinyl chloride) has re-energized the debate over PVC and the environment. The arguments for this 20-plus-year dispute provide us with an excellent opportunity to consider what really constitutes a sustainable material. We continually read about the latest and greatest "green materials" that have high recycled content or are made from 100% renewable resources, such as soybean roof coatings or shredded denim insulation. Behind the novelty of these "green" material fads is the often overlooked reality that these materials are expected to perform. Throughout the life of a building, "green" materials that do not perform as well or as long as traditional materials may actually end up being less sustainable when considering the energy and materials required to repair prematurely failed systems or improve poorly performing systems. Along these lines, durability and performance should be two of the most important factors in selecting materials for critical building systems.

The case against PVC has been well documented. Reports of health problems due to phthalates and dioxins caused by PVC production and disposal resulted in the banning of PVC in some European cities in the late 1980s and early 1990s (most notably Berlin, Germany). All of these bans have since been repealed, and PVC currently makes up a large component of the roofing market in Europe. Despite the fact that PVC production requires half the fossil fuels required by other roofing membranes, the chlorine required for PVC production results in a number of hazardous byproducts. Even if properly contained and disposed of, the main argument against PVC is that these hazardous materials are still being created and at some point end up in our environment.

Because of these concerns, PVC may not be appropriate for short-term or low importance applications such as packaging or furniture. A building's roof, however, is integral to the ability of a building to function and subject to a wide spectrum of loading, including wind, rain, and solar radiation. PVC is well suited to address the major factors affecting the roof lifespan, including the durability of the roofing material, easy installation, and resistance to environmental loads.

Some of the more established PVC roof membrane manufacturers have engineered their products into high-performance systems. Their products and installation procedures are continually evolving, learning from past mistakes, and working toward providing the best quality with the most efficient use of time and materials. Manufacturers' standard details and factory-fabricated membranes and accessories eliminate the contractor guesswork and variations in

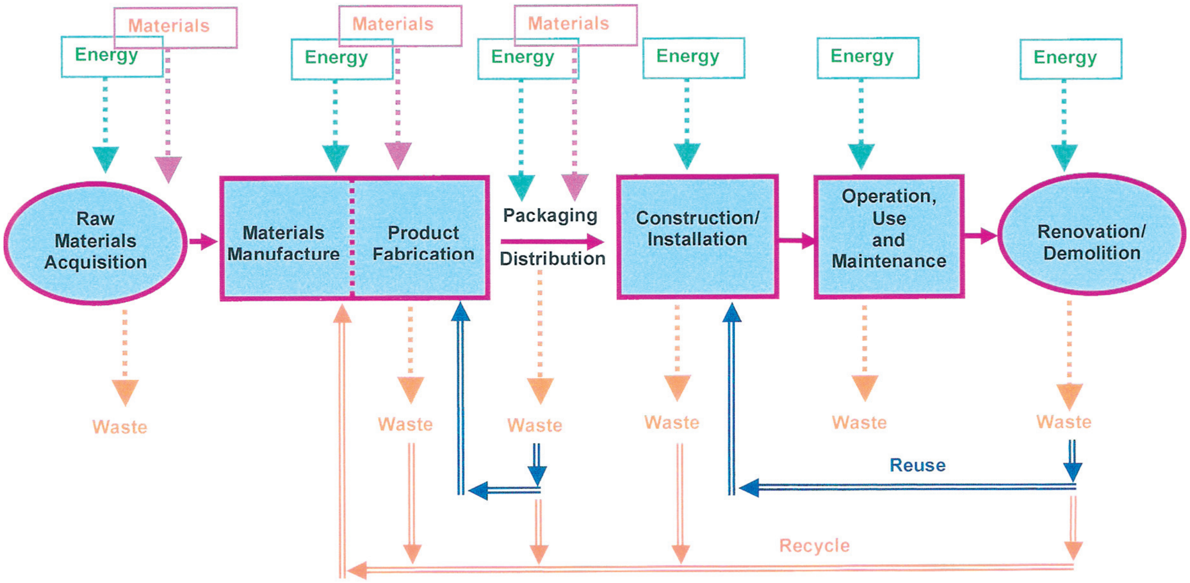

Figure 1: Schematic of Product Life-Cycle Stages

quality associated with field-fabricated membranes. PVC membranes can be fully adhered or loosely-laid, installed over almost any substrate, and can be used in a variety of roof assemblies. The installation process, which consists of heat-welding large sheets of membrane together, is clean, easy, and familiar to contractors. There is no need to deal with the fumes and kettles associated with bitumen-based systems. In comparison with other single-ply roofing systems, the heat-welded seams in PVC do not rely on any adhesives or tapes as with EPDM systems and are much less susceptible to the cold welds or burn-throughs associated with TPOs.

PVC roof systems also provide some of the best options for cool roofs and garden roofing assemblies. The high reflectance and emittance provided by cool roofing membranes can decrease surface temperatures on a hot summer day from +180°F to around 110°F, which consequently reduces cooling costs, slows breakdown of the materials, and minimizes contributions to the urban heat island effect.

Studies have shown that the expected lifespan of PVC roofing membranes increases more significantly than other roofing membranes when protected from extremely high service temperatures. In parts of the U.S., the estimated lifespan of a PVC roof can be almost doubled just by switching from a black to white membrane[1].

Bituminous roof systems require coatings to achieve the same reflectance and emittance values, and white EPDM should not be used since it requires less reliable UV stabilizers than its black counterpart. Decreasing the roof temperature also reduces cooling loads. Case studies by Lawrence Berkeley Laboratory illustrate that a 10,000 square foot roof in the Southeast U.S. can save anywhere from $300 per year for a R-30 roof assembly to $10,000 per year for a R-1 roof assembly simply by switching from a dark- to a light-colored exposed roof membrane.[2]

In terms of garden roofing systems, one manufacturer has tested samples of its membranes installed on planted roofs over 35 years ago in Europe and found them to still be in very good condition. In California, where cool roofs will be mandatory for low-slope commercial building beginning in October 2005, some designers would like to install a cool roof membrane that can be turned into a garden roof at some later date. Today, there is only one product that can serve both functions, and it is a PVC membrane.

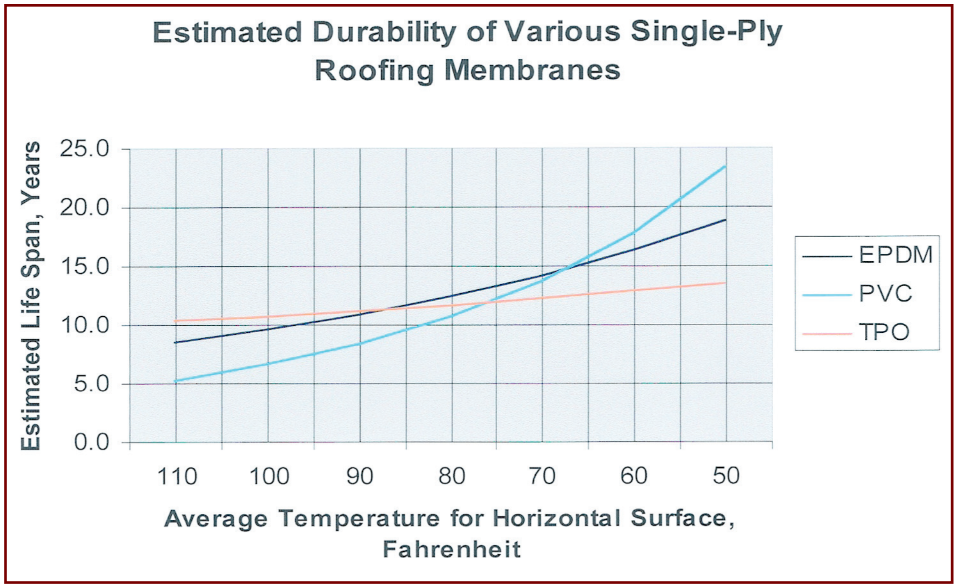

Chart 1: Derived from "Estimating the Durability of Roofing Systems," by C. G. Cash.

Once a PVC roofing system has been installed, it requires very little maintenance (in the neighborhood of $0.025 per square foot per year, according to some manufacturers) and is easily repaired. When the roof eventually reaches the end of its useful life, it must be disposed of. PVC can be recycled, but different formulations and additives make this fairly difficult. Currently, the only program for recycling PVC roofing is in Germany, where the Association for Recycling of PVC Roof Membranes takes old PVC roofing, pulverizes it, removes reinforcing, and returns it to the original manufacturer for reuse on the back of membranes, walk pads, and other accessories.

So, what's the verdict? As with every good design, the answer completely depends on the specifics of the project. For short-term or low importance uses, the hazards of PVC production don't justify its use, especially since in most cases there are better suited materials. For long-term, high importance uses (such as roofing), and until newer systems are time tested, improved, and create their own performance history, PVC may prove to be one of the more sustainable options for now.

Regardless of the debate on PVC, as we are learning more about life-cycle assessment and the full extent of sustainable design, the areas of durability, performance, and adaptability will become increasingly important. The products and systems that address these considerations will be the ones that lead us into the future of sustainable, high-performance design.

1. Cash, C.G., "Estimating the Durability of Roofing Systems," Durability 2000: *Accelerated and Outdoor Weathering Testing*, ASTM STP 1385, J.D. Evans and W.D. Ketola, Eds., American Society for Testing and Materials, West Conshohocken, PA, 2000.
2. Backenstow, D. E., "Comparison of White Versus Black Surfaces for Energy Conservation," *Proceedings from the 8th Conference on Roofing Technology,* April 16-17, 1987.

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