PVC recycling

by Stanley P. Graveline

Photos courtesy of Sika Sarnafil Inc., Canton, Mass.

The converging influences of economic pressure and increasing environmental awareness have been key drivers behind the dramatic growth of recycling initiatives in various North American manufacturing sectors. Skyrocketing raw material costs, rising disposal fees and ever more competitive market prices are squeezing the bottom line in many industries. Improving yields and finding ways to recapture whatever value they can from any scrap or off-spec material produced are critical to many companies' profitability. And, of course, there are several ecological benefits of doing so.

The situation

The U.S. Environmental Protection Agency has estimated 136 million tons of building construction- and demolition-related debris are generated annually. And the U.S. Green Building Council says these waste streams account for about 40 percent of all solid waste in the U.S. Roofing materials represent a significant portion of that total.

According to a study done in Wisconsin by consulting firm Camp, Dresser & McKee Inc., Cambridge, Mass., though roofing materials represent only 4 percent of construction waste (from new construction and renovation) in the state, they represent 26 percent of demolition waste. The potential effect of recycling roofing materials at the end of their service lives is tremendous.

The roofing predicament

Despite the enormous volume of materials resulting from roof system tear-offs and replacements, only a small amount is currently recycled because there are numerous obstacles to doing so. For example, aged materials are dirty, have been exposed to any number of environmental contaminants and, after decades of service, have deteriorated to some degree. The amount of success with recycling has varied with different roofing materials.

But because of new innovations in production equipment, roofing scraps, trimmings, etc., now can be recycled into new roof membranes. Typically used in a sheet's underside where potential color variations are not a factor, recovered materials can comprise up to 15 percent by weight of a finished roof membrane product.

Although regular "bare-backed" thermoplastic membranes can be recycled with little difficulty, until recently, felt-backed membranes could not. But state-of-the-art grinding equipment is now available that separates felt, allowing such sheets to be recycled in the same manner as standard products. The equipment also can extract encapsulated scrim reinforcement from the polymer matrix. Felt backing and scrim are subsequently used as fibrous filler in the fabrication of concrete blocks for use in landscaping and the construction of retaining walls, among other things.

Well-run, properly equipped modern thermoplastic membrane production plants are capable of achieving practically 100 percent raw material conversion through recycling. A single plant can recycle upward of 5 million pounds of material that, not many years ago, would have been destined for a local landfill.

In addition, a number of companies are capable of recycling asphalt shingles into paving material, according to the National Association of Home Builders. High-value metals such as copper often are recycled, as well.

The PVC story

And in the single-ply category, PVC roof membranes stand out as a noteworthy success story.

European PVC membrane manufacturers have been recycling roof membranes since 1994 (see "European efforts," page 31). In North America, the first post-consumer PVC recycling program began in 1999. A Massachusetts-based recycling company working with Sika Sarnafil Inc., Canton, Mass., developed a pavement

is now a reality

patching material using a mixture of old PVC roof membranes and a variety of other recycled plastics. Although the product was successful, the potential consumption of PVC membrane was modest.

Building on the experience of its European parent company Sika in Sarnen, Switzerland, Sika Sarnafil is recycling old PVC roof membranes into new material domestically. Two pilot projects illustrate Sika Sarnafil's initiative.

One project, the reroofing of the Boston Marriott® Long Wharf hotel in 2005, presented an ideal situation. All involved parties were motivated to recycle as much of the existing roof system as possible; the project was close to Sika Sarnafil's headquarters; and a local recycling company had an established program for recycling and reusing existing thermal insulation in addition to being experienced in grinding and processing the membrane material to be recycled.

The hotel has long been a Boston landmark. Unfortunately, it had been plagued by constant leakage at each of its six tiered roof surfaces for more than two decades because of the omission of through-wall flashings in the original construction. The only effective solution was to remove nine courses of brick and rebuild the lower portions of the walls with through-wall flashings. The

The salvage process

Although there were minor variations among Canton, Mass.-based Sika Sarnafil's pilot projects, there are some basic steps involved with roof membrane salvage.

First, after consulting the membrane manufacturer, a contractor estimates the number of gaylords (4- by 4- by 4-foot heavy-duty cardboard boxes) that will be required based on a roof's surface area, membrane thickness and existing assembly construction. The contractor then orders the gaylords and equivalent number of empty pallets from the membrane manufacturer when ordering the new material for the roof system replacement, and everything is shipped to the site simultaneously.

Once the material arrives on-site, the contractor removes all debris from the roof surface and slits the existing membrane to a maximum 39-inch width and 30- to 50-foot length. The material is rolled as tightly as possible with the strip's end tack-welded along its edge with a hand-held hot-air welding tool to prevent it from unrolling. The rolls are laid in the gaylord lengthwise until the box is full.

For mechanically fastened roof systems, a contractor typically cuts the membrane along each side of the overlap and in-seam fasteners and then slits the sheet down the middle. The seams and fasteners are removed in a separate step. For a protected roof membrane project with no fasteners in the seam, only a single cut is required at the overlap in addition to the slit down the middle of the sheet. No additional surface preparation is required. On all Sika Sarnafil pilot projects, the membranes were about 6½ feet wide. The actual number of cuts will depend on sheet width; the goal is to slice the material in 39-inch-wide strips.

For a ballasted roof system, the surface should be swept clean before cutting and rolling. Once reroofing begins, scrap membrane and trimmings also can be placed in the gaylords to be recycled.

Once tear-off is complete, the gaylords, which are placed on individual pallets, are removed from the roof system to be shipped for processing.

The roof systems of the Boston Marriott® Long Wharf hotel (above) and University of Iowa's Carver Hawkeye Arena (below) were recycled.

21-year-old PVC membrane was still performing well, having retained more than 70 percent of its original plasticizer content. However, in light of the extent of the masonry work to be done and the likely damage that would have occurred on the existing membrane and flashings, it was decided it would be prudent and cost-effective to replace the roof system in conjunction with the masonry and flashing work.

The protected membrane roof system was easily disassembled; the 1¼-inch crushed stone ballast was sold to a landscaping company for reuse; and the extruded polystyrene insulation was sold for reuse in other applications, such as insulating agricultural buildings. The PVC membrane was cut into strips, rolled and sent to a recycling company, where it was ground. The filter fabric was the only component that could not be recycled or reused and was discarded.

The contractor, NRCA member Commonwealth Building Systems LLC, Rockland, Mass., had used the same recycling company to recycle insulation from a number of previous projects and was familiar with the handling and storage procedures involved. The old membrane was shipped to the recycler's facility along with the insulation, resulting in minimal incremental freight charges as a percentage of the overall salvage costs.

The other project was the University of Iowa's Carver Hawkeye Arena in Iowa City. The 25-year-old, 158,000-square-foot mechanically attached PVC roof system had been damaged by a severe storm accompanied by tornados. In light of the roof system's age, the university decided to replace it rather than repair it. Because the campus prides itself on its sustainability-related initiatives, university officials welcomed the opportunity to recycle the old membrane even though recycling was not included in the original scope of work.

NRCA member CEI Roofing Texas LLC, Dallas, a Tecta America company, ensured the roof membrane was separated from the other waste materials during tear-off. In light of the great distance to the vendor's plant, it was decided to grind the membrane locally, thereby minimizing the volume of material to be shipped and reducing freight charges. This was considered particularly important because there was no local insulation recycle and reuse program in the area, as was the case in Boston, to help defray the membrane shipping costs.

The contractor on the Marriott project estimates it saved about 25 percent versus the traditional cost of disposal and related fees for the membrane and insulation. Although some additional handling was required, it was minimal.

Throughout the pilot project process, the projects generally were found to be at least cost-neutral. The savings in disposal fees and value of the salvaged material typically exceeded the cost of any additional labor, shipping and grinding fees.

Based on these experiences, it would appear all parties (roofing contractor, building owner and membrane manufacturer) should at least be able to break even when recycling thermoplastic PVC

roof membranes in the manner described. A roof system's size and complexity, project location and contractor's experience will have a significant bearing on the various cost elements in the value chain.

Key factors

To date, more than 800,000 square feet of PVC membrane from six projects have been recycled as part of Sika Sarnafil's initiative. The key observations and learning points from the accumulated experience have led to the drafting of the following guidelines, which, if followed, will help ensure a successful recycling project.

Ideally, the decision to recycle a roof membrane should be made well in advance of bidding a project, and the key steps and respective responsibilities of all involved parties should be clearly outlined in the specification and bid documents. Although pre-bid and job startup conferences always are a good idea, they are even more important on such projects.

Determining the number of gaylords (4- by 4- by 4-foot heavy-duty cardbood boxes) required; establishing where they should be located on the roof; where they will be stored once full; and how best to handle them before a project starts is critical to achieving a smooth, efficient workflow.

Frequent communication with the roofing crew also is important to ensure no foreign materials (rocks, fasteners, etc.) are placed in the gaylords and that the gaylords are filled correctly. The rolls of torn-off material must be properly stacked within the gaylords to ensure they are as full as possible before shipping. Each gaylord should contain at least 600 pounds of material (about 2,000 square feet of 48-mil-thick membrane), preferably more than 1,000 pounds.

Recycling the material

Sika Sarnafil has successfully incorporated high percentages (up to 25 percent) of recovered material into walkway protection membranes. The Carver Hawkeye Arena project's schedule allowed for some material from the old membrane to be processed into the walkway installed on the new roof system: the ultimate complete loop.

The program's next phase is to integrate recycled materials into regular roof membranes. Based on European experience and results of early trials, no significant problems are foreseen. (The limit of recycled content in new PVC membranes varies by company.)

Work already has begun on this next phase. At this time, only loose-laid membranes (mechanically attached, inverted, ballasted) have been processed in North America. The next objective is to be able to process membranes that are adhered to insulation or other substrates. Although Europeans have developed some solutions, the practices have not yet been attempted on this continent.

WEB EXCLUSIVE

For additional ways to recycle and reduce waste during construction and demolition, log on to www.professionalroofing.net.

A positive outlook

The pilot phase of Sika Sarnafil's recycling effort clearly has demonstrated post-consumer recycling of PVC roof membranes is not only feasible but can be cost-effective.

The process's technical viability was never in question. As noted previously, European PVC membrane manufacturers have been recycling membranes for quite some time. Even more important, after almost 15 years in service in Europe, no difference has been observed between membranes produced exclusively with virgin raw materials and those incorporating aged, recycled PVC in a sheet's underside. This demonstrates the product can be recycled without down-cycling it to lower value, shorter life products. The material, once recycled, will provide decades of service.

PVC membranes' high reflectivity (typically in excess of 80 percent), durability and ability to be recycled at the end of their service lives set a new benchmark for sustainability in the commercial roofing field.

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European efforts

During the early 1990s, Arbeitsgemeinschaft fur PVC—Dachbahnen Recycling (AfDR) was formed by a group of leading European PVC membrane manufacturers. The group funded the construction and operation of a facility in Germany for processing PVC roof membranes at the end of their service lives. Once processed, the materials were returned to their original manufacturers, who used them in a variety of applications, including as feedstock for producing new membranes.

A few years ago, the manufacturers trade association, the European Single Ply Waterproofing Association (ESWA), took over the coordination and management of the industry's recycling efforts, and AfDR was disbanded. Working with Interseroh, a pan-European waste-collection company, ESWA established ROOFCOLLECT© to facilitate the collection and processing of post-consumer PVC roof membranes. ESWA is investigating alternative outlets for the materials, which would allow for recycling to be carried out much closer to roofing projects.

The association sets yearly recycling targets in consultation with the European Commission. In 2006, 10,500 metric tons (about 23 million pounds) of post-consumer flexible PVC materials were recycled through this program of which 2,000 metric tons (about 4.4 million pounds) were roof membranes. The balance of the material consisted of other thermoplastic PVC membranes such as truck tarpaulins, flooring and synthetic leather.