End of Service Life Recycling of Thermoplastic PVC Roofing Membranes

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Recycling of Thermoplastic PVC

Pre consumer and post industrial recycling of products made from poly-vinyl chloride (PVC) is already well established in a variety of industrial segments. According to one study, approximately one billion pounds of PVC are recycled annually in North America. With regards to thermoplastic PVC roofing membranes, efforts to reclaim and recycle plant trimmings go back well over a decade. The earliest initiatives involved collecting the material for processing by third party companies who would pulverize the scraps and remove the bulk of the reinforcing fabric. The resulting powder was used to manufacture injected molded roof walk way pads. The treaded membrane material could be hot air welded into position and had the same life expectancy as the base membrane it protected. The program was very effective and it is estimated that over 1,000 tons of material were diverted from the landfill over a period of about 10 years from a single plant.

With time, membrane manufacturing technology has evolved, and state of the art production lines are now capable of incorporating scrap material back into their feedstock. The material is first processed into granulate, to enable effective blending. The recycled material is typically substituted for new resin at a rate of 5% to 15% by weight. It is used exclusively in the membrane back-side, never on the exposed surface, where any color variation could impact surface reflectivity and/ or esthetics.

The grinding process is very effective at separating scrim, as well as the polyester felt backing used in some applications, from the polymer matrix. The residual fluff can be used as a reinforcing fiber in the production of cement blocks for landscaping and retention wall construction or as feedstock in waste to energy conversion processes.

Although a significant amount, the roughly four million pounds of trimmings material produced, processed and recycled annually by one manufacturer, pales in comparison to the potential volumes available for post consumer recycling. When one considers the billions of square feet of vinyl membranes installed in North America over the past decades, one begins to get an appreciation for the magnitude of material that could potentially be recycled.

End of Service Life of Roofing Materials

The EPA estimates that 136 million tons of construction and demolition waste are generated annually in the USA, which represents somewhere between 25 and 40% of all solid waste. In a study conducted in Wisconsin, they found that roofing materials make up four percent of debris in new construction. In renovation and demolition however, they found that roofing waste accounts for 26% of the total.

Recognizing the enormity of the issue, the Canadian Federal Government organized a multi stakeholder two day workshop in Toronto in February, 2007. The attendees represented a broad cross section of material manufacturers, government agencies, environmental organizations, researchers, waste management companies, and others. Although attendees were able to identify general actions that need to be taken, consensus was not achieved on how best to move forward, and unfortunately only very limited progress has been achieved since then.

The challenge is indeed daunting. Qualification of material types and condition suitable for recycling, removal of the installed products, separation from other system components, collection, distribution and processing as well as re-integrating recycled materials into new products create a complex set of issues to be resolved.

Post Consumer Recycling of Thermoplastic PVC Membranes

In Europe in the early 1990s, the leading manufacturers of PVC roofing membranes began recycling PVC roofing membranes at the end of their service life for re-use. The first installations of membrane produced with post consumer recycled composition were completed in 1994. To date there has been no difference in the field performance of these materials when compared to those produced exclusively with virgin raw materials.

The first trial project done in North America was the Boston Marriott® Long Wharf hotel in 2005. The tiered design of this landmark waterfront structure, although an interesting architectural feature, contributed to the extensive leakage experienced at each of the six lower roof levels. The problems started shortly after the hotel was opened, and a complete re-roof in 1984 did little to reduce the ongoing water infiltration. Ultimately, the problem was found to be due to 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 portion of the walls with a through wall flashing. Taking into account the small horizontal surface area of each roof section, the need to remove all membrane flashings and the high likelihood of mechanical damage to the existing membrane, it was decided to proceed simultaneously with a complete re-roof, despite the fact the existing membrane was in excellent condition, having retained more than 70% of its original plasticizer content.

The Protected Membrane (PMR) system was easily “dis-assembled”. The ballast was sold to a landscaping company for re-use. The extruded polystyrene was likewise sold for re-use in other applications such as insulating agricultural buildings. The PVC membrane was cut into strips, rolled up and sent to the processing company where it was ground and forwarded to the membrane manufacturer for recycling.

In 2008, a Michigan contractor carried-out what is believed to be the biggest roofing recycling project ever in North America. A 250,000 square foot automotive facility was re-roofed in Lansing, MI. The existing roof which actually consisted of two complete roof assemblies (the roof was recovered once) was removed to the steel deck. A new mechanically attached 60 mil PVC membrane assembly was installed in its place. Both layers of PVC membrane were recycled, diverting close to one half of a million square feet of material from the landfill.

The program is now being introduced in Canada. Commitments have already been made to recycle more than 75,000 ft2 of material to be removed from two projects in the coming months. In both cases; Lester B. Pearson International Airport's Terminal 3 and the Oakridge Arena in London, Ontario, the buildings will be re-roofed with new PVC membrane assemblies.

In a sign that PVC recycling is gaining acceptance, a prominent national retail chain has embraced the program. The company has an ambitious goal of becoming a "zero waste" company. They have already cut waste internally by more than 70 percent through a variety of recycling and re-use programs. They specify PVC membranes on practically all of their roofs and have done so for decades. In the Spring of 2007, the membrane on a store in Maryland had reached the end of its service life, and was due for replacement. During the tear-off, the membrane was segregated from the balance of the construction waste for recycling. The company, which keeps very detailed documentation on all its roofing activities, estimated that cutting, rolling and storing the material for recycling, as opposed to simply disposing of all materials in a single, mixed dumpster did take some extra time. However they found that they were able to reduce that time to a minimum once they got over the initial learning curve. To date the membrane from more than 20 stores has been recycled.

Converting Post Consumer Waste into New Products

Although the program is geared towards recycling of the manufacturer's own membranes at the end of their service life, competitive PVC products have represented a significant portion of the recycled materials. All non-adhered (mechanically attached, loose laid) membrane produced by the manufacturer is eligible for recycling, regardless of age or condition. Competitive materials are tested and qualified prior to a decision being made on whether or not to accept them for recycling.

Recovered materials are processed into three specific applications. One is the production of the company's standard walkway membrane. Loadings as high as 25% have successfully been integrated into this 96 mil thick material, without any impact on the product's physical properties. A 55 mil thick protection layer for use in green/ vegetated roof assemblies has similar loadings. Both products can incorporate a blend of both in-house produced and competitive materials.

Lesser amounts of the post consumer material are recycled into the back side of roofing/ waterproofing membranes. Competitive materials are not used in the production of these membranes.

Research is being carried out to develop a mechanism for recycling membranes which are adhered to insulation, cover boards or other substrates. Preliminary results are positive and trials are ongoing.

Economic Viability

The ultimate success of the program depends heavily on its economic viability. The two largest cost drivers in the program are the freight to move the material from the project to the processor and ultimately to the membrane manufacturer, and the fee to process it. Plant trimmings, which are clean and free of debris, are processed in-house. Despite the best efforts in the field, tear-off material

inevitably contains a variety of debris such as fasteners, lumber, ballast, etc. Third party processing plants are typically well equipped with magnetic systems for drawing out metal pieces, appropriate conveyors which allow for manual removal of debris and other associated equipment and are therefore always used for post consumer recycling.

One manufacture covers all costs (freight from the job site to the processor, processing/grinding and freight to the manufacturer) for projects in the Eastern half of the USA and Canada. Additionally, the elimination of tipping fees that would normally have been paid to dispose of the membrane appears to more than offset any minimal additional labor involved in sorting and preparing the materials for transport. For projects in the Western half of the continent, net costs (excluding tipping fee savings and any increase in labor) are in the range of a few hundred dollars to a few thousand dollars, depending on project size and location. As new processing partners are identified and brought on line in the West, it is anticipated that the program will be offered at no charge across Canada and the USA in the near future.

Conclusion

Thermoplastic has demonstrated that it can be recycled back into new roofing membrane products at the end of its service life. After a two year technical and market trial, the program was launched commercially in the USA in 2007. Approximately 5 million square feet of membrane that in the past would have gone to landfill at the end of its service life has been recycled back into new membrane products that will once again provide decades of performance across. The program is having an important impact, and was recently recognized by the Massachusetts Department of Energy and Environmental Affairs.

While this article highlights the experiences of a single company, it should be noted that the members of the Vinyl Roofing Division of the Chemical Fabrics and Films Association are working together to develop a comprehensive, industry wide roof recycling program. Combining the roofing volumes of all member companies will further improve the feasibility of the program by attracting additional material processors and adding to the collective recycling experience of the industry.

References

Principia Partners, Post Industrial and Post Consumer Vinyl Reclaim, July, 1999

Graveline, S.P., Recycling of Thermoplastic PVC Roof Membranes, Interface, April/ May, 2007

U.S. Environmental Protection Agency, Characterization of Building Related Construction and Demolition Debris in the United States (EPA530-R-98-010), 1998

Camp, Dresser & McKee, Quantity and Composition Study of Construction and Demolition Debris in Wisconsin, February, 1998

Goodfellow Agricola Consultants Inc., Enhancing Recovery of End-of-Life Roofing Materials: An Implementation Plan, Canadian Construction Innovation Council, Toronto, March 2007

Kyle, B.R., Pending Changes to Roofing Waste Diversion Practices, Roofing Canada, Spring/ Summer 2008

Graveline, S.P., PVC recycling, Professional Roofing, December, 2007

Graveline, S.P., End of Service Life Recycling of Low Slope Roofing Materials, RCI Foundation Symposium on Building Sustainability, Washington, DC, April 30 – May 1, 2009