Sustainable Geomembrane Recycling and Down-Cycling

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INTRODUCTION

Pennsylvania Department of Environmental Protection (DEP) and Department of Community and Economic Development (DCED) officials welcomed the recent creation of an entity that collects and reprocesses geomembranes used in various aspects of Marcellus Shale oil and gas drilling, development, and production. These various aspects include well pad liners, above ground impoundments, secondary containment, and floating covers. Well pad liners are placed over a large area (usually 60 m (200 ft) by 60 m (200 ft)) around the drill well to contain drilling fluids, provide an anti-slip surface for drill workers, and contain oil and gas products (see Figure 1). Above ground containment ponds are used for a variety of containment purposes, e.g., drill pad water, well flowback water, and shale derived liquids (see Figure 2). Secondary containment geomembranes are used around oil and gas storage tanks to contain any leaks from these tanks (see Figure 3). Floating covers are used to prevent contact with the environment and wildlife of various liquids associated with the shale play.

The DEP estimates over 90 kg (200 million pounds) of geomembrane have been installed at Pennsylvania shale drilling sites since 2010 for shale related activities. In 2012 alone, about 37 kg (81 million pounds) of geomembrane were installed at Pennsylvania gas drilling sites. Drillers use 4,536 to 9,072 kg (10,000 to 20,000 pounds) of geomembrane per drilling site and these geomembranes are damaged and replaced at each site from two to seven times during the drilling and production processes.

In 2012 about 4,100 new natural gas wells were permitted in Pennsylvania. This means a substantial amount of additional geomembrane material will be installed in the near future in Pennsylvania and eventually all of the geomembrane must be

collected and either landfilled or reprocessed. At present, the entity estimates that it has reprocessed over 1.1 million kg (2.4 million pounds) of geomembrane since July, 2012 which means at least 1.1 million kg (2.4 million pounds) of geomembrane has been diverted from landfill disposal. The potential for reprocessing a substantial amount of additional geomembrane is present at the Berwick, PA because this facility is presently utilizing only about 20% of its capacity. This article highlights the large potential for geomembrane reprocessing and the environmental, economical, and sustainability benefits that can be derived from reprocessing discarded geomembranes.

Figure 1. Well pad liner being installed around drill rig and other containment areas

Figure 2. Above ground drill pad water containment pond lined with a fabricated geomembrane

NEW ENTITY

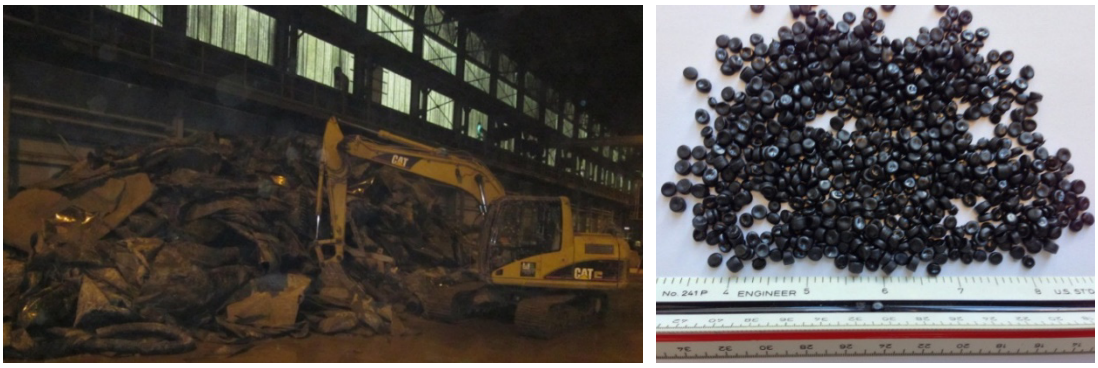
A new entity in Pennsylvania is pursuing the potentially lucrative market for collecting, cleaning, shredding, grinding, and pelletizing geomembranes discarded from Marcellus and Utica Shale drilling, development, and production activities. The new venture is a partnership between Wellspring Environmental Services, headquartered in Orwigsburg, PA, and Ultra-Poly Corporation, based in Portland, PA. WellSpring Environmental Services specializes in drill site decommissioning and waste hauling. Ultra Poly is a large recycler of polyethylene and polypropylene plastic in North America and has developed a proprietary procedure for reprocessing the discarded geomembranes.

Figure 3. Secondary containment for steel oil and gas storage tanks

The combined entity is the first of its kind venture, according to the Pennsylvania Recycling Markets Center, Inc. (RMC) executive director, Robert Bylone, Jr. The newly formed entity allows a substantial amount of plastic to be reprocessed, reduces the consumption of valuable landfill space, and lessens truck and roll-off container traffic around drilling sites. This venture has built a reprocessing plant in a building leased from the Berwick Industrial Development Authority in Berwick, PA to reprocess the discarded geomembranes from nearby shale drilling activities. Figure 4(a) shows a pile of discarded geomembranes in the plant from nearby shale drilling projects prior to shredding, melting, and extrusion into polyethylene strands and then pellets. HDPE geomembrane from a municipal waste landfill liner system that is being replaced nearby is also being recycled at this facility. Because the process is proprietary at present, the following summarizes the process to provide some details of the process.

Figure 5 presents a schematic of the process in which the discarded geomembranes are pushed into a primary shredder without washing so it is important for the geomembranes to not have a substantial amount of mud and dirt on them. If they do contain substantial mud and dirt, the geomembranes are washed before placement in the primary shredder. The primary shredder reduces the size of the geomembrane pieces that are then passed into a trammel, which is a rotary screen that helps remove

and remove soil and debris from the geomembrane. The soil is passed to a dust collector (see Figure 5) and the geomembrane is passed to a secondary grinder that reduces the geomembrane to even smaller sized pieces. In the secondary grinder, remaining soil and debris is separated from the geomembrane and collected by the dust collector. After the secondary grinder, the geomembrane is passed through a Star Screen that further separates soil and debris from the geomembrane due to the bouncing action and open areas of the screen. After the Star Screen, the clean and shredded geomembrane is ready for melting and then extrusion as plastic strands. The plastic strands which look like thick pieces of spaghetti, are cut into small resin pellets which are shown in Figure 4(b).



(a) (b)

Figure 4. (a) Pile of discarded geomembranes with excavator for materials handling and (b) polyethylene pellets extruded from discarded geomembranes after processing from nearby shale drilling projects

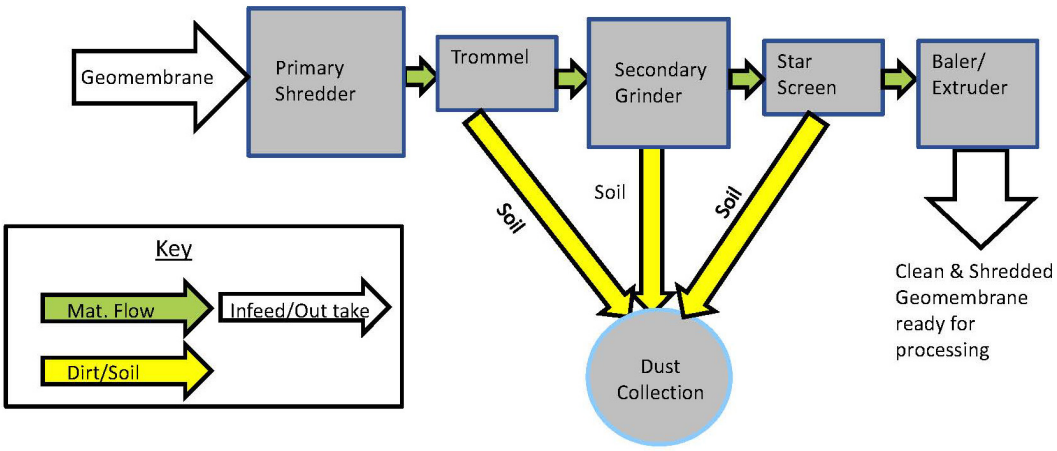


Figure 5. Schematic of geomembrane processing before melting and extrusion as strands of polymer

The resulting pellets (see Figure 4(b)) are being used to mold railroad ties (see Figure 6), structural beams, and other products at the Berwick plant. If the pellets are used for geomembrane production, the process is termed recycling. If the pellets are used for railroad ties, structural beams, or other non-containment products, the process is termed down-cycling. The term reprocessing is being used herein to encompass both recycling and down-cycling.

The entity also ships the resulting pellets in Figure 4(b) to domestic and international manufacturers. The entity initially created fifteen jobs to start the Berwick, PA plant and there are long-term plans to employ about 45 people. This new plant has revitalized an old manufacturing space and has contributed millions to Berwick's tax base. To date, the entity has invested approximately $4 million each in research and development for the recycling and down-cycling processes.

(a) (b)

Figure 6. (a) Pile of down-cycled railroad ties fabricated in Berwick, PA from discarded geomembranes and (b) close-up of down-cycled railroad ties

Wellspring teamed with Ultra-Poly to facilitate collection and navigation of the various regulatory hurdles that had to be overcome for handling and processing geomembranes that had been exposed to hazardous materials. To facilitate collection and transportation of the discarded geomembranes, Wellspring developed special equipment for on-site separation of well pad liners from landfill waste. In particular, geomembrane pieces from a well site are separated and transported to the Berwick reprocessing plant while the other waste is delivered to a landfill in the same trailer load. In the past, excavators were used to tear well pad liners into large sections for landfill disposal, which required eight to ten landfill trips with filled roll-off containers to remove the drill pad liner and transport it to a landfill. To reduce the time and truckloads involved in removing and disposing of the geomembrane material, WellSpring developed specialized equipment, e.g., modified sod cutters, that slice, clean, and tear-up the drill pad geomembrane to facilitate transport and initial processing at the Berwick facility. This recycling program is not only good for the environment but good for the financial bottom line because liner removal costs

are reduced while reducing truck traffic, protecting the environment, and generating commercially reusable material. Table 1 shows that there are several categories of geomembrane related material being used in shale oil and gas development each of which present a different set of challenges to reprocessing.

OTHER BENEFICIARIES

The DEP and gas companies are also benefitting from the reprocessing of discarded geomembranes by reducing material stockpiles, providing an environmental friendly process to the controversial hydraulic fracturing procedure, creating a beneficial use, and eliminating future environmental liability when the geomembrane is reprocessed instead of retaining liability after the geomembrane is placed in a landfill. Based on the success achieved in Pennsylvania, this entity is investigating expansion into Ohio, West Virginia, and Texas where shale oil and gas development is increasing rapidly. Of course, the ultimate goal of the entity is to reprocess 100% of the geomembrane material utilized in the shale oil and gas field but there is a ways to go before this goal is achieved.

Table 1: Recyclable materials and potential recycling value

Collected Material	Ability to Grind and Repelletize Geomembranes	Ease of Transportation to Reprocesser	Value of Material for Reprocessing
HDPE Sheet Material	Medium-High	Medium-High	High
HDPE Geomembrane with Polypropylene Scrim	Medium-High	Medium-High	Medium
HDPE Geonet (cross hatch)	Medium-High	Medium-High	Medium-High
Reinforced Liners (HDPE and LLDPE with Polyester Scrim)	Low	Low	Low
Non-woven Polypropylene (felt)	Low	Low	Low
Felt/Sheet Composites	Medium	Medium	Medium

SUMMARY

Because eventually all of the geomembranes associated with shale oil and gas development must be collected and either landfilled or reprocessed, it is prudent to develop recycling and/or down-cycling opportunities for this material. In 2012 alone, about 81 million pounds of geomembrane were installed at Pennsylvania gas drilling sites so this large amount of material should be reused in an environmentally friendly manner instead of landfilling. This process will provide environmental, economical, and sustainability benefits to this burgeoning field of geomembrane usage.