

VFPE geomembrane installation for landfill capping applications engineering

Holger Schreiber

GSE Lining Technology GmbH

Luc E.M.van de Walle

DSM Polyethylenes, Sittard, Netherlands

Introduction

Landfills will be nowadays more and more capped to control odors, to enable capture of methane gas generated during the natural decomposition and to minimize rainfall-generation leachate that may become contaminated due to the convectional transport through the waste body.

Therefore, the most advanced containment technology requires for landfills principally a composite base liner and a capping as part of an entire sealing, protecting and drainage concept.

The encapsulating of landfills requires a specific capping material to allow an optimum of a gaseous and liquid transfer barrier against the environmental interface.

Polyethylene resin types have been - with a view to a global application - successfully used for landfill liners because of their ideal short- and long-term stability and durability performance profile which is necessary to meet all the specific landfill conditions.

FML's, Flexible Membrane Liners, represent generally the product type range for landfill job applications. A VFPE is therefore a PE based very flexible membrane liner.

An example of the Netherlands landfill project is being presented here:

General Product Requirements

Because of the natural process of decomposition of waste, a volume reduction is initiated by time which results in subsidence and differential settlement. Therefore, a more flexible membrane is to be utilized for the landfills in comparison to the base liner application. Furthermore, appropriate physical strength and chemical durability is also requested for this application.

For the time being, a regulated composite barrier system - a composite membrane and an earthen barrier - is mandatory in Germany, but there are efforts to have an equivalent system. This is the reason to anticipate adequate specifications for that kind of geomembrane product.

From the very beginning, a resin type is required that is closely matched to the desired characteristic to provide the best physical properties combined with a superior chemical resistance for a polyethylene cap membrane.

This results in a resin type of lowest possible density range and a narrow molecular weight distribution both guaranteeing enhanced flexibility and elongation properties and an excellent chemical resistance and UV stabilized membrane type.

The Capping of Landfill Site „Ubach over Worms“

In the very south of The Netherlands next to the German border the formal landfill „Ubach over Worms“ is located. Since 1974 municipal waste has been dumped, in total over 10.000.000 m³. By the end of 1994 the site was used to its limits and therefore closed. However, at the time the site was put into use, regulations to protect the environment were still under development so no protective measures were undertaken. Hence, no landfill liner had been installed before dumping was started.

At present it is known that a landfill can cause environmental burden. For instance the groundwater can be polluted by leaking out of ingredients of the landfill site. Rain will even enlarge this problem. It was obvious that additional precautions had to be made. At this particular site at „Ubach over Worms“ the groundwater flows into Germany.

One of the measures taken was to prevent the rainwater entering the landfill site, and thus prevent the forming of additional leachate. In order to do so it was decided to use a double waterproofing capping system consisting of clay and a geomembrane. The total surface to be capped was closed to 400.000 m².

Large (differential) settlements were foreseen which implied special properties of the geomembrane to be used.

GSE Lining Technology GmbH in close co-operation with DSM Polyethyleones developed a very flexible geomembrane, which fulfilled the above mentioned requirements and combines many of the durability characteristics of HDPE membranes:

- No use of plasticisers,
- low temperature resistance,
- carbon black stabilization to UV light,
- good strength without the need for reinforce-ment,
- resistance to micro organisms, insects and rodents, etc.

After extensive tests conducted through the Dutch institute TNO-KRI, this VFPE geomembrane has shown excellent multiaxial elongation tests and puncture resistance.

Manufacturing Process

Manufacturing of a landfill membrane requires an overall concept which considers

- preserving resin properties
- forming the requested membrane thickness
- in economical process performance
- environmentally friendly processing

These considerations have influence on the process design and result in a flat-cast extrusion technology that allows to produce the best available thickness profile and minimum of inherent internal stress.

The layout design is based on an extrusion system consisting of adequate components to melt and homogenize the polymer in order to build up for the die unit a constant melt flow by temperature, pressure, and time. The line is fed by a resin supply system which provides the extrusion station. A calender roll unit that is installed behind the extra large die arrangement smooths and cools down the melt to form the polyethylene sheet with a subsequent further cooling off section.

All line equipment components have their own specifications and their own functions which are adapted to the process - beginning from the silo reservoir for the incoming resin supply until the winding up station where the finished sheet is collected to a 1.5 to heavy weight roll in an outer diam of 60 cm. As part of the whole manufacturing concept also all other peripheral machine components are designed to bring the process to its optimum.

Die and cooling & polishing unit are the main functional system components - the heart of the flat-cast extrusion line which require extensive know how from all parties who are involved in the design and in the operating matter. This is the preassumption that the end product is of highest possible quality level.

The installed thickness gauge is measuring the thickness profile - across and along to the machine direction in a fast frequency - which is recorded as part of the QC procedure and controls as main function the thickness adjustment at the die. This ensures the highest possible quality profile.

Furthermore a unique „spy hole detector“ enables us to monitor a potential hole in the membrane.

The manufacturing line is able to produce a 7,5 m finish trimmed polyethylene sheet of different grades in the range of 0,75 mm until 5,0 mm thickness. A 24 hr line operation guarantees under steady state conditions an economical process efficiency and the process continuity is the best base to achieve the highest possible quality level.

Texturing Process

To serve the market with a friction type liner a special equipment produces a surface texture in a patented unique process.

The roughness of the surface structure provides the membrane liner a high friction behaviour against the selected soil or protection component. The manufacturing process ensures that the textured liner remains with the same characteristics as the smooth sheet.

By choosing the friction side - both or only one side - the design engineer gets the flexibility to control the angle of friction of the interface of the selected material.

In particular the capping liner is with that resin profile able to allow an outstanding

multiaxial elongation which demonstrates the suitability for environmental protection applications as they are required for encapsulated landfills.

Along with the above properties a capping membrane is also equipped with a higher frictional behaviour due to the lower density. This enables the liner to stick more on the ground or in adjacent protection layers or allows higher slopes. Enhanced friction properties for steeper slopes will need a special manufacturing process which textures the surface to achieve highest possible friction behaviour.

Quality Assurance

The quality controls are part of the company's quality assurance program that prescribes all procedures in the manufacturing process starting from the resin supply, via the process and extends through the liner transportation until the liner is finally installed on the job site.

The production of a geomembrane requires for us to have key resin data controlled and documented which will be added to a fully Roll Test Data Report, RTDR. This report is a comprehensive summary of test data collected from the production of each roll according to a routine QC procedure.

Sampling from production in an agreed procedure - specimen routinely taken for tests from a certain position and in a certain frequency - allows a physical property profile which must meet the required specification of the relevant regulated standard.

These very flexible membranes have a lower melt flow index in the range of below 1,0 g/10 min (190°C/2,16 kp load).

This resin property profile requires changes in the process parameter in comparison to a standard MDPE type. It is the experience gathered from the manufacturing process to achieve a cap membrane of a flat thickness profile below 5 % deviation.

As result of the manufacturing process we achieve physical properties with the above membrane categories as follows

- Tensile strength at break 30 - 35 N/mm²
- Elongation at break > 800 %

- Tensile impact strength > 1050 mJ/mm²
- NCTL test > 400 hr
- Multiaxial tensile stress at break > 80 %

For the Ubach project 2,0 mm sheets were produced in a length of 100 m for the smooth as well as the textured version. In order to reduce the effort on the job size individual roll lengths were produced.

The textured liner version was produced as a double sided friction sheet type with excellent friction level against sand layer in the range of 32 ° friction angle.

The roll width was designed to diminish the number of welds on the job site and a 750 meter wide material was selected as the best compromise together with the installation requirements.

In order to increase the quality of the seams the welding edges of each roll were protected by a tape. This film of 15 cm width is to be removed before performing the seam in order to leave a smooth and clean surface on the edge of the geomembrane. The same practice is commonly spread in Germany on all projects ruled by BAM certification.

During installation all panels have been hot wedge welded and 100 % air pressure tested. A panel layout has been established after completion of the job site, in accordance with the common practice of the KIWA certified installer. The installation of the geomembrane capping was started late 1995 and will be completed in 1996. The total job will then be covered with soil and fully rehabilitated in 1997.