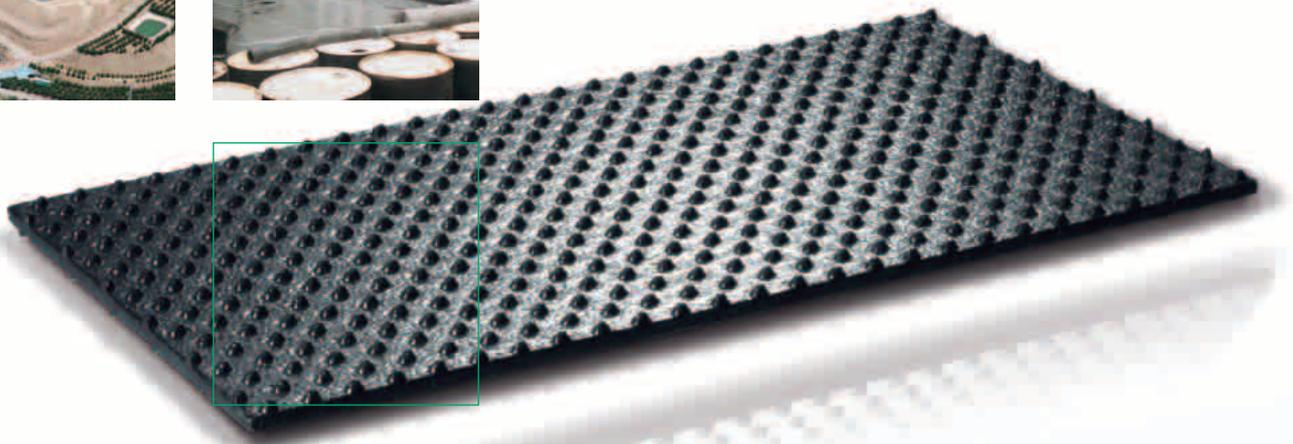




Advantages of **Carbofol®** geomembranes

- ✓ versatile sealing applications possible
- ✓ excellent chemical resistance due to selected raw materials
- ✓ extreme high elongation during uni-axial and multi-axial deformation
- ✓ high stress cracking resistance
- ✓ very high UV-resistance
- ✓ direction independent shear stress transfer with structured surfaces
- ✓ high interface friction angles with embossed structured surfaces
- ✓ slope dependent structured surfaces available for project specific designs
- ✓ complete quality control from the resin to the final product
- ✓ installation advantages with up to 9.40 m wide liner
- ✓ high Melt Flow Index allows an excellent welding performance
- ✓ smooth edges with removable plastic tape for clean welding surface and overlap lines
- ✓ more than 40 years of project experience
- ✓ also available with BAM- and DIBt approval
- ✓ ISO 9001 certified
- ✓ CE marked



Carbofol®

Carbofol® geomembranes are manufactured using high density polyethylene (HDPE). Carbofol® is produced in various thicknesses and with smooth or embossed structured surfaces.



Fig. 1: Carbofol® MegaFriction and Carbofol® with different surface structures

Carbofol® geomembranes provide a complete seal against even the most toxic substances. Carbofol® is typically used in sealing applications for landfill base seals as well as caps, in environmental sealing applications for the protection of

groundwater from contamination and in water conveyance structures, canals or ponds.

Advantage:

High-level stress crack resistance

The service life of geosynthetic components, such as geomembranes, is determined by inadmissible stress and/or ageing. Polyethylene was therefore subjected to thorough testing regarding its ageing properties as no other material before. To ensure the long-term durability of geomembranes it is important that they are highly resistant against stress cracking. Based on numerous investigations, NAUE GmbH & Co. KG has stabilised Carbofol® geomembranes so that they now feature a high long-term and stress crack resistance. This was tested with the Notched Constant Tensile Load Test (ASTM D 5397) as well as achieved according to the concept of creep curves in internal pressure tests (ISO/DIS 9080:1998102, Draft).



Fig. 2: Test device for Notched Constant Tensile Load Test (ASTM D 5397)

The life expectancy of Carbofol® geomembranes is therefore estimated to be in the range of around 1,000 years at 20 °C ground temperature.

Advantage: Embossed structure

allows shear force transfer independent of direction. Safety is the top priority for all sealing applications, especially on slopes. Based on many years of experience with various geomembrane structures it was clear that

an improved friction surface can only be an embossed profile of the same resin as the base geomembrane sheet.

This process not only ensures the continuity of the raw material for the sheet and the friction anchors but also a long-term service life due to the homogeneity of MegaFriction. There are 31,500 friction anchors/m² which contribute to excellent high friction properties. These anchors are 900 µ high and are machine reproducible at all times during the manufacturing process. Delamination of the **Many Effective Geomembrane Anchors** does not occur. The improved surface is especially developed for steeper inclinations and secures the stability on slopes. For example, a friction angle of about 33° can be achieved with a combination of Carbofol® MegaFriction and a Secutex® nonwoven geotextile.

Advantage:

Weld protection strips and lateral marking

The Carbofol® geomembranes are provided with a white edge mark on both sides. These edge marks indicate the recommended areas of overlapping and are also a visual aid during the installation. Furthermore, a thin protective sheet (~150 mm wide) is attached to both edges and is peeled off immediately prior to the welding process to provide an absolutely clean welding area.



Fig. 3: Installed Carbofol® geomembrane with overlap protection strip on a landfill cap (Ämmässuo, Finland)

Advantage: High melt flow index

Carbofol® geomembranes feature a melt flow index (MFI) between 1 and 3 g/10 min tested at 190 °C/5 kg and thus have the advantage of a large welding window. This is a factor which makes Carbofol® geomembranes flexible and easy to handle during on-site installation. The speed at which welding processes can be carried out on Carbofol® geomembranes is distinctly higher than that of other liners with an MFI less than 1. This gives Carbofol® yet another major benefit during on-site installation and welding.

APPLICATION

PIPELINE ENCAPSULATION WITH CARBOFOL®

LINING OF SUKHAYBARAT GOLD MINE

The Saudi Company for Precious Metals (SCPM) is a limited liability company of Saudi Arabia and is wholly owned by Saudi Arabian Mining. SCPM have made provision for a new tailing facility at Sukhaybarat Gold Mine in Qaseem province for the containment of the tailing of the gold ore process in accordance with a technical specification drawn up by the Engineering Consultant TS Markteknik AB.

To cope with the harsh chemical conditions of the containment and to ensure an environmental safe solution the designer decided to specify a double-lined system comprising of a primary HDPE geomembrane and a needle-punched geosynthetic clay liner (GCL). The new tailing facility is approximately 580 m x 380 m surrounded by an embankment 7 m high. The total area including the slopes of the embankments (232.000 m²) was lined with a double lining of Carbofol® HDPE 406 above Bentofix® NSP 4900.

It was decided to use a 2 mm thick HDPE Carbofol® liner due to the excellent chemical and UV resistance which ensures a longterm service life. Carbofol® was protected on the base area with Secutex® R 504 non-woven geotextile before placement of a 30 cm thick protective layer of heap leach gravel with stones less than 15 mm diameter.

Fig. 4:
Installation of
Carbofol® over
Bentofix®



A protective embankment and layer of rockfill was created at one end of the tailing facility to slow down the flow of tailing sand pouring into the tailing pond. A separation layer of Secutex® R304 was specified for this area prior to the positioning of the rockfill and also below the drain material and the drainage pipes. The lining work was carried out by Trading and Development Partnership who are NAUE's approved installer in Saudi Arabia. The work was completed in 13 weeks.

An existing pipeline between the harbor in Porto and one of the largest refineries in Portugal began having leaks after decades of usage; thus requiring its replacement with a new pipeline system according to current strict environmental protection laws. In the immediate vicinity of the beach, the existing pipeline route runs parallel to the Atlantic coastline such that a spill would unavoidably damage the environment. Plans for the new project therefore incorporated a sealed pipeline ditch (1,800 m long) in which 20 individual pipelines were to be run.

After a review of technical and economic aspects, the contractor (Mota y Companhia) and the planner (IDOM) decided that the entire pipeline ditch should be continuously sealed with smooth Carbofol® 507 2 mm. The engineering arguments for the HDPE geomembrane were its great chemical resistance and its long predicted service life.

Concrete retaining walls were built on both sides of the ditch and Carbofol® was placed against these walls to a height of 2.5 to 3 m and fastened with a Carblock connection strip. The 13 m wide base of the ditch is sealed with a double lined system and also has a control layer along its midpoint to provide continuous leak detection. Additional detection pipes are laid in



Fig. 5:
The structure's
cross section with
geosynthetics

the gravel layer between the two Carbofol® geomembranes which are welded together along the edges to provide a secure, closed system.

Robust, needle-punched Secutex® nonwovens were installed on both sides of the Carbofol® as protection against mechanical damage, particularly during the construction phase. The mass per unit area for Secutex®, and therefore its protective effectiveness, depended on the site fill and subsoil material. Therefore three different Secutex® types were used: 201 GRK3, 351 GRK5 and 501 GRK5.

Our Portuguese partner, BBF, installed all geosynthetics for this project. They completed their professional work (over 90,000 m² of Carbofol® and 160,000 m² of Secutex®) within the scheduled timeframe; thus producing a high-quality, environmentally correct solution.

H A N D L I N G A N D I N S T A L L A T I O N



Carbofol® handling



Site storage



Subsoil preparation



Carbofol® installation



Carbofol® welding



Carbofol® connections



Cover soil placement



Spreading of soil



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