Polyethylene Pipes and Manholes for Landfill-Applications

General:

The control of gas and fluids in landfill application requires safe and applicable pipe-systems. Due to environmental risks, the requirements for the raw-material and all finish and semi-finish products are much higher than for standard sewer applications. Also for welding and fabrication the quality-requirements are significantly higher. Special local approvals for raw-material, product, producer, welders and fabricators are often needed to simply enter the market.

For more than 30 years High Density Polyethylene (PEHD) has been successfully used in landfill-applications. Especially the modern bimodal types of PEHD are the perfect material for the challenges we face in landfills and in contact with hazardous fluids and gases.

The excellent chemical resistance of polyethylene against a multitude of acids, lyes and organic hydrocarbons is a strong argument for using Polyethylene in Landfills.

Also very important are the mechanical characteristics and the durability. Today we have been using Polyethylene successfully in the pipe-industry for more than 55 years and tests have shown clearly, that we can consider a life service time of more than 100 years. The long-term-hydrostatic pressure curves (pic. 1) provide the basis for the stress-related design. The reliable strength depends on the temperature and the stress-loaded time. In terms of strain and stiffness the creep-modulus, the flexibility and the behavior against Slow-Crack-Growth (SCG) has to be considered.

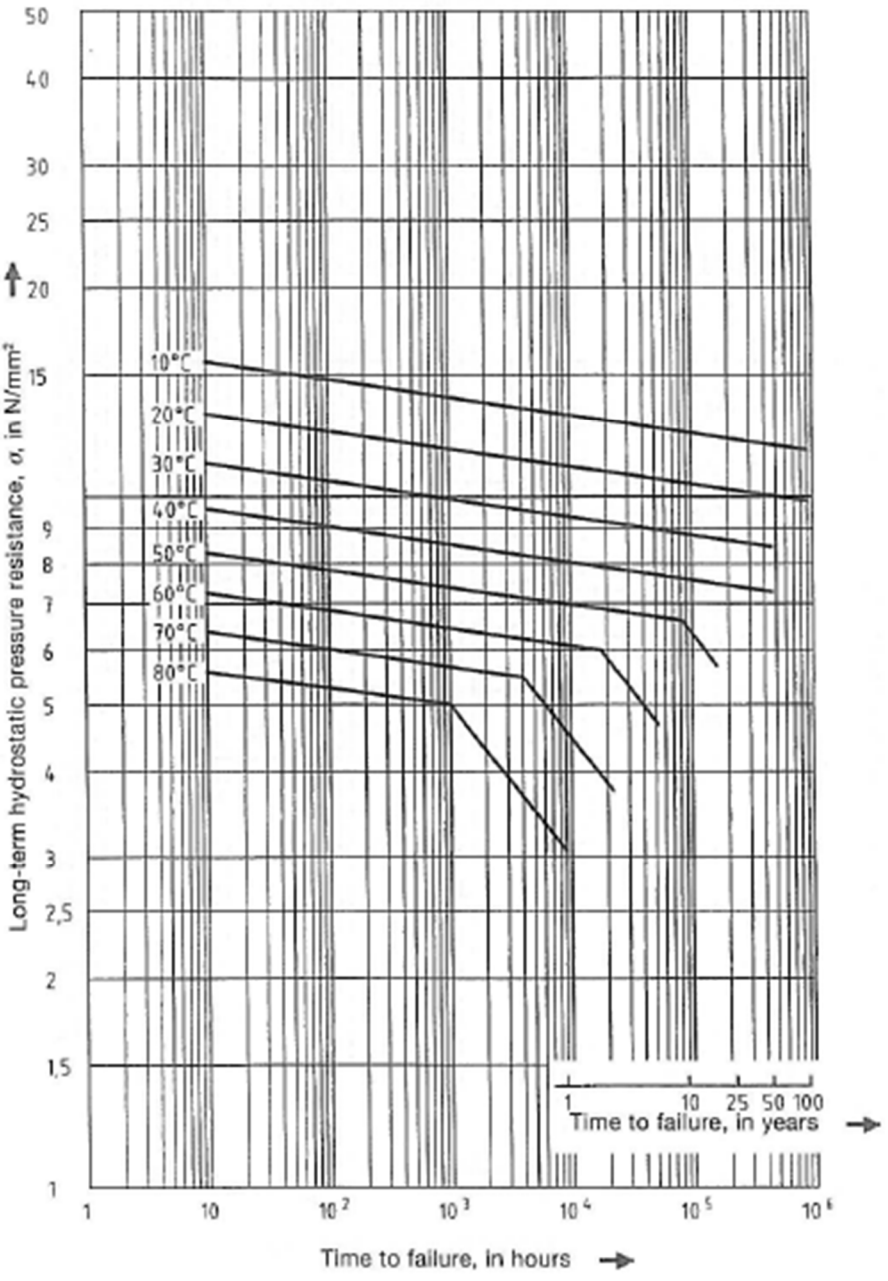
Landfills are planned for generations of human life. To guaranty a maximum of safety for our environment and thus our all health, Polyethylene serves as the most convenient solution and should be used.

Typical technical characteristics of a modern High Density Polyethylene, used for pipes, fittings, semi-finished products and of course for fabrication of manholes, tanks and apparatus etc. in landfill-application:

Properties	**Value**	**Standard**
Density	≥ 940 kg/m³	DIN EN ISO 1183
Color	Black	-
Carbon-Content of PE100 (not valid PE-el)	2-2,5 %	DIN EN ISO 11358
Thermal stability / OIT	≥ 20 min (210 °C)	ISO 11357-6
Strain at yield	≥ 8 %	ISO 6259-3
Strength at yield	> 23 MPa	ISO 6259-3
Strain at break	> 350 %	ISO 6259-3
Flexural-Modulus 1 min	1100 MPa	ISO 178
Long term strength (20°C, 50 years, H_2O) (Minimum required Strength / MRS)	10 MPa (MRS 10)	ISO 9080 ISO 12162
Hydrostatic Strength (80°C, 1000 h, H_2O)	≥ 5 MPa	DIN EN ISO 1167-1,2
slow crack propagation (not valid for PE-el) Full-Notch-Creep-Test (FNCT)	≥ 1600 h (80°C,4 MPa, 2% Arkopal)	EN 12814-3

Typical application for Polyethylene Pipes in landfills are:

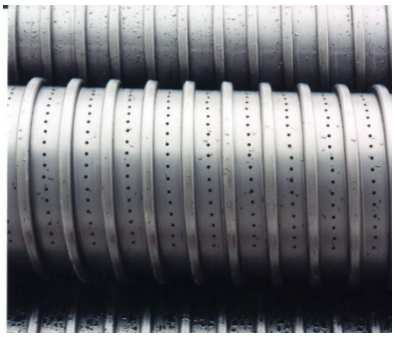
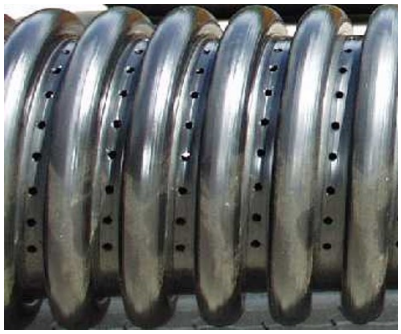
- Drainage pipes for leachate
- Leachate manholes
- Penetration-Constructions
- Leachate collector Pipes
- Gas Collectors
- Leachate reservoirs and pumping stations
- Condensate separators



Pic.1: Long Term hydrostatic pressure resistance of pipes made from PE 100, acc DIN 8075 (99)

Helical extruded polyethylene pipes and manholes

For all large diameters ≥ DN/ID 300 helical extruded pipes (Krah-pipes) are well-proven.
The possibility of tailor-made wall structure provides many advantages in design of the components. Profiled-wall is usually used when stability/stiffness is needed and solid-wall when strength is wanted. For leachate-drainage-pipes often a combination of solid-wall and profiled-wall is used. The holes or slots are made between the profiles, so that the entrance-resistance for the liquid can be reduced and the stiffness of the complete pipe is guaranteed:

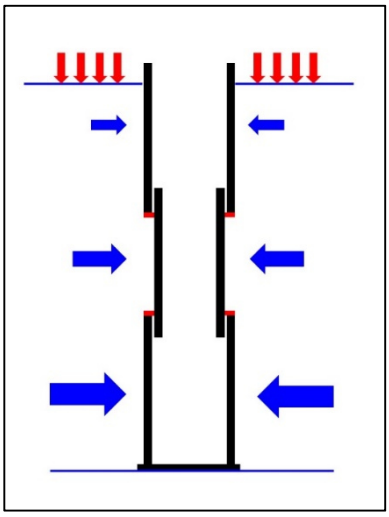

Pic.2,3,4: Leachate drainage pipes (Henze GmbH, Krah GmbH, Germany)

For other applications like manholes, shaft-systems, leachate-reservoirs, pumping stations and other large diameter constructions, the structured profiled wall is indispensable.
The static design is following ATV M127 standard and has to consider the special load situation in landfills. The waste-filling of the landfills cannot be considered as a fix and stable system, because of undefined rotting, higher temperatures and accruing gas. The waste-filling is settling down which affects the induced down-drag-forces to the shaft. Also the load-distribution is completely different to applications where defined soil-conditions are existing.

Pic.3: Manholes in Landfill application (Henze GmbH, RBV Pöthe, Germany)

Telescopic manholes

For manholes with high depth a telescopic system is well-proven and can be a good alternative. The settlement in landfills can be up to 40%. During settlement, the telescopic shaft is reducing the height automatically and is avoiding any static overload. Due to the telescopic-system the induced forces can be minimized. Each segment of the system is flexible and is adjusting to the height of waste around. Mostly the segments are jointed with predetermined breaking points either by welding or by using special pins. In the case of settlement the breaking-point will clear the way for reduction of manhole-length.



Pic. 4: scheme telescopic shaft

Manholes for landfill-gas

Another specialty of landfill-application is the landfill-gas. Wherever components come into contact with landfill-gas, they have to be protected against electrostatic charging. Because plastic materials are by nature not electrically conductive, a special recipe for the Polyethylene has to be used. Raw-material suppliers provide Polyethylene-material with a higher content of black carbon to achieve the necessary electrical conductivity. The required value for the electrical conductivity depends on national regulations (e.g. GUV R127), but typically the requirements are as follows: Surface-Resistance ≤ 10^6 Ω. In each case the surface has to be grounded!

The helical extrusion technology provides the possibility to produce only the inner layer of the pipe with PE-el and the remaining wall structure with typical PEHD (PE100). This save costs and additionally it has technical advantages. PE-el is optimized for electrical properties, but not for the mechanical loads we face in this application. It is recommended to use for the stress-loaded parts and components of modern PE 100 only.

Pic. 5: Landfill shaft (Henze GmbH, Germany)
(Henze GmbH, Germany)

Pic.6 - Gas-well-manhole
(Henze GmbH, RBV Pöthe, Germany)

Leachate reservoirs / Double wall constructions

Having regard of environmental protection means to transfer highly loaded leachates into the sewer without any leakage loss. This task begins at the dam's side of the landfill. The total route in the dam's side from the penetration-building up to the leachate reservoir should be designed with a double walled profile. All following pipelines and shaft structures must be manufactured in a way that leakage tests can be carried out.

Because of thermic induced expansions, the inner and outer pipe walls are firmly connected. The monitoring area can be tested for leakproofness via vacuum or excess pressure. A permanent monitoring display or humidity sensor can be additionally installed at the drainage point. Thus, a central monitoring in the control station is possible.

What needs to be considered:

"Landfill leachates are harming the environment as they contain hazardous liquids. Their exact composition is mostly unknown and can change over the years."

Constructions for the storage of leachates are thought to transfer heavily loaded leachates in reduced amounts into the treatment plant and/or to create stowage space as temporary storage until the leachates are collected by a suction vehicle.

The manufacturing of these storage tanks from spiral wound profiles enables the leakage controle of the whole system. The storage pipes have an inner and an outer homogenous pipe wall. As spacers between both pipe walls, either a square or round profile is integrated. Additonal drilling inside the profile create a cavity, which is used as a monitoring space for excess pressure and vacuum.

Pic. 7: Double wall Leachate-reservoir
(Henze GmbH, RBV Pöthe, Germany)

Pic. 8: Penetration construction
(Henze GmbH, Germany)

Author:

Stephan Füllgrabe,
Plaspitec GmbH, Germany