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Contents:

- 1 Scope of application
- 2 Semi-finished products – Panels made of PE-HD
- 3 Sealing systems
- 4 Remarks about installation
- 5 Design-related details
 - 5.1 Weld shapes
 - 5.2 Connections to components and fittings
- 6 Welding processes
 - 7 Welding devices
 - 7.1 General
 - 7.2 Requirements
 - 7.2.1 Preheating system
 - 7.2.2 Plastifying system
 - 7.2.3 Welding shoe
 - 7.2.4 Additional jigs (optional)
 - 8 Execution of the welding work
 - 9 Site tests and inspections
 - 9.1 Type and scope of the tests and inspections
 - 9.2 Inspection of the external condition
 - 9.3 Inspection of the dimensions
 - 9.4 Testing of the mechanical properties
 - 9.5 Testing for leak tightness
 - 9.5.1 Testing with a vacuum
 - 9.5.2 Testing with electrical high voltage
 - 9.6 Testing and inspection record sheets
 - 10 Remarks about repairs
 - 11 Remarks about system tests
 - 12 Standards, technical codes and guidelines

1 Scope of application

This technical code applies to the welding of panels made of high-density polyethylene (PE-HD) for the sealing of concrete structures in the field of ground water protection and for corrosion protection.

In detail, this technical code deals with sealing measures for the following areas of application:

- installations for the storage, filling, manufacture and treatment of water-endangering substances as well as installations for the use of water-endangering substances in the industrial sector and in the field of public facilities (Paragraph 1, Section 19g of the Water Resources Act)
- installations for the transfer of water-endangering substances (Paragraph 2, Section 19g of the Water Resources Act)
- installations for the transport, storage and treatment of waste water and of contaminated seepage water
- installations for the storage of strongly oxidizing media

This technical code is intended to give the responsible authorities, the customers, the executing companies and the responsible people in the quality assurance field instructions for the execution of the welding work and of the weld tests and inspections on the building site.

In particular, the technical code takes account of the stringent requirements which, in the case of these applications, must be set on the quality of the welded joint and thus on the proper exe-

cutation of the welding work in a way suitable for the material. In particular, it provides remarks for the structural designing of welded joints between the various semi-finished products made of PE-HD.

2 Semi-finished products – Panels made of PE-HD

The panels made of PE-HD must fulfil the requirements in DIN EN ISO 14632 as well as the requirements specified in miscellaneous sets of rules valid for the application concerned.

In order to improve certain properties, the panels may also have a multi-layer structure. The proof of the suitability of semi-finished products which do not comply with the standards must then be provided with reference to the above standards.

If the semi-finished products do not comply with the requirements in the standards or in DVS 2207-1, DVS 2207-3 and DVS 2207-4, their weldability must be proven separately, e.g. according to DVS 2203.

For sealing materials of collecting pans, collecting spaces, collecting devices and areas for the storage, filling and treatment of water-endangering substances (water conservation), the suitability of the semi-finished products and of their welding technology must be proven by a general construction supervisory authorisation from the German Institute for Building Technology (DIBt) Berlin, on the basis of the fundamental authorisation principles for plastic sheets. The semi-finished products must be marked permanently on one side according to their authorisation.

In the case of applications which are not governed by a construction supervisory authorisation, the semi-finished products must be marked, at least, with the following information:

- manufacturer
- product designation
- substance standard (DIN EN ISO 14632)
- moulding materials
- manufacturing date

The panels must have a nominal thickness of min. 5 mm.

3 Sealing systems

In the case of the sealing systems, a distinction is made between:

- One-layer and two-layer systems:
 - One-layer systems consist of a single sealing layer.
 - Two-layer systems consist of two sealing layers with a cavity located in between in order to prove the leak tightness (leak recognition). Two-layer sealing systems are usually divided into individual, defined testing sectors.
- Systems with and without anchoring in the concrete:
 - Mechanically anchored cladding is manufactured from panels made of PE-HD and, using the anchoring elements systematically arranged on its rear side, is firmly anchored in the concrete and is welded at the joints. The sealing can be anchored not only directly in the concrete structure but also subsequently, e.g. in face concrete, mortar or screed.

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DVS, Technical Committee, Working Group "Joining of Plastics"

In the case of loose sealing, the panels are placed on the areas to be sealed, are welded and are fastened to the walls, e. g. with metal rails, or are welded on to concreted-in sections or panel strips with anchoring elements.

Loose sealing must be limited to applications with low operating stresses.

4 Remarks about installation

The panels must be transported and stored exclusively according to the transport and storage guidelines from the manufacturers and installed according to their installation guidelines.

The work may only be carried out by specialist companies which are proven to have been instructed and trained in the proper further processing of the semi-finished products.

Before the beginning of the execution of the construction work, the executing company must elaborate a project-related installation plan with all the design-related details including the weld shapes and the weld dimensions.

With regard to the installation of mechanically anchored systems which are incorporated into the formwork before the concreting, it is necessary to choose formwork systems which require no or only a small number of clamping anchor holes. The joint areas which are welded subsequently must principally be chosen for the mechanical fastening of the panels to the concrete formwork. When the concrete is introduced, the whole area of the panels must be in contact with the formwork.

Exclusively specialists trained and certified according to DVS 2212-1, Subgroup II-1, or DVS 2212-3, Subgroup III-1, must be deployed for the welding.

With regard to the welding of panels which are anchored in the concrete, neither the residual moisture of the concrete nor any condensation water on the panel surface may affect the weld quality.

The number of filling and venting holes must be minimised in the case of the subsequent backfilling of the panels in bottom areas, e. g. with flow mortar.

5 Design-related details

5.1 Weld shapes

The panels must be installed with butt joints. However, for construction technology reasons, lap joints may also be required in individual cases. Internal and external corner joints are executed as well.

In part, strips and sections (e. g. H, tear-off, venetian blind, tear-off corner and enclosure sections) are utilised as structural aids for the formation of the joints (Figure 1).

In detail, a distinction is made between the following welded joints:

- butt joint with a surfacing weld (Figure 2)
- butt joint with supporting strips and a surfacing weld (Figure 3)
- butt joint with covering strips and surfacing welds (Figure 4)
- butt joint with an H-section and surfacing welds (Figure 5)
- butt joint with a venetian blind section and a surfacing weld (Figure 6)
- butt joint with a tear-off section and a surfacing weld (Figure 7)
- corner joint with an internal fillet weld (Figure 8)
- corner joint with an external fillet weld (Figure 9)
- corner joint with a strip and an internal fillet weld (Figure 10)
- corner joint with an angle (Figure 11)
- lap joint with a surfacing weld (Figure 12)

In the case of lap joints, only one-layer overlaps are permissible.

5.2 Connections to components and fittings

In principle, the panels should be connected to components and fittings made of PE-HD in the sealing plane. The following structural formations are applied (for example):

- pipe bushings (Figure 13)
- pump pit made of PE-HD (Figure 14)

- wall enclosures (Figure 15)
- fastening plates (Figure 16)
- closing of holes (Figure 17)

In order to have enough working space for the welding, the installed parts should be arranged at a minimum distance of 0.5 m away from corners and fillets.

Since panels and components made of different PE-HD moulding materials may be manufactured with different melting points and melt index values, the weldability must be proven by checking the strength and the deformation and failure behaviour. It is recommended to choose the moulding material with the higher melt index as the welding filler material. In order to create the same surface conditions for the welding operation for both the joining parts, it may be necessary to preheat the components differently using hot gas.

For quality reasons, the components and the fittings must be prefabricated in the factory in ambient conditions which are as defined as possible. In this respect, the corresponding DVS technical codes must be taken into consideration.

6 Welding processes

Exclusively hot gas extrusion welding is utilised for the areas of application of this technical code. Surfacing, single-V or fillet welds are applied depending on the panel thickness. High-speed hot gas welding may be used as an assembly aid for the joining of the panels and sections. Hot gas extrusion welding is characterised by the following features:

- A welding filler material (granules or wire) with the same composition as that of the base material is utilised for the welding.
- The welding filler material is plastified in a plasticising unit (extruder) and is applied to the welding groove on the joining face as a strand via a nozzle (welding shoe).
- The joining faces are heated by hot gas (air) and are transformed into the plastic state.
- The joining pressure is applied via the welding shoe when the welding filler material is inserted into the welding zone.

The plastified welding filler material is introduced into the welding zone via the welding shoe with which the necessary joining pressure is applied via the welding filler material. A material thrust which moves the device forward develops in this respect. The welding speed results from the extruder's output of the welding extruder and the welding filler material.

In order to prevent any lateral material flash, the advance of the device must not be hindered. Any weld flash which may arise must be removed without any notices after the cooling. The weld does not need to be post-treated.

In the case of surfacing welds, the front face of the upper semi-finished product must be bevelled at an angle of approx. 45°. In order to prevent the overlapping semi-finished products from running apart, they are locked with hot gas using a flat-sheet die before the joining.

The plastified welding filler material is applied immediately after the joining faces have reached the welding temperature.

In practice, the welding is carried out in the following parameter ranges when manual devices are used:

- hot gas temperature: 250 - 300°C
- extruder temperature: 200 - 230°C
- welding speed: 0.2 - 0.4 m/min

Only the continuous process according to DVS 2209-1 is utilised in the scope of application of this technical code.

7 Welding devices

7.1 General

The hot gas extrusion welding devices are manipulated by hand or with additional jigs. They consist of the following functional elements: