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**1 Scope of application**

This technical code applies to the heated tool butt welding of panels, pipes and piping parts made of PVC-C.

The PVC-C panels are used for the fabrication of storage and process tanks and miscellaneous construction elements by means of heated tool butt welding. These components are predominantly utilised in the field of the storage of liquids and solids as well as in the field of process chemistry.

The PVC-C panels and piping parts must comply with the DVS 2205-1 technical code, Supplement 9 and Supplement 11, as well as with the properties specified for compounds in ASTM D 1784-03, Cell 23448. The Vicat softening temperature must exceed 105°C.

The fittings made of PVC-C must exhibit the same properties as the piping. If these are not available, it is recommended to fabricate these from pipes. Piping and fittings predominantly serve to transport liquids, gases and solids.

**2 General requirements**

The quality of the welded joints is dependent on the qualification of the welders, on the suitability of the utilised machines and jigs as well as on the compliance with the technical codes for welding. The weld can be tested using non-destructive and/or destructive procedures.

The welding work must be monitored. The contracting parties must reach agreement on the type and scope of the monitoring. It is recommended to document the process data on welding record sheets (for specimens, see the appendix) or on data carriers.

Within the framework of the quality assurance, it is recommended to manufacture and test trial welds in the given working conditions before commencing and during the welding work.

Every welder must be trained and must possess a valid qualification certificate according to the DVS 2212-1 guideline for PVC-U in the WZ and WF processes as well as, at present, an HS process with another material (requirements for PVC-C are under preparation). The planned area of application may determine the type of the qualification.

**3 Measures before the welding****3.1 Prerequisites for the welding**

The welding area must be protected from unfavourable weathering influences (e.g. the action of moisture, great air currents and temperatures below + 5°C). If suitable measures (e.g. preheating or heated assembly tents) ensure that a semi-finished product temperature sufficient for the welding can be complied with, the work may be carried out at any outdoor temperature – provided that the handling of the welder is not hindered. In any case, it is recommendable to provide additional evidence by manufacturing trial welds in the conditions of the construction measure (see Section 5).

If the semi-finished product is heated non-uniformly due to solar radiation, the temperatures must be equalised by covering the area of the welding point in good time. It is necessary to avoid any draught-induced cooling or non-uniform heat distribution during the welding operation. When pipes are welded, it is recommended to close the pipe ends in advance.

The joining faces of the parts to be welded must not be damaged and must be free from contaminants (oil, dirt, grease, deposits, chips etc.).

**3.2 Cleaning**

For the manufacture of flawless welded joints, it is decisively important that not only the joining faces but also the tools and the heated tools are clean and free from grease.

**3.2.1 Cleaning agents**

The cleaning fluid or the cloths which have been moistened with cleaning fluid in the factory and are kept in a lockable plastic box must consist of a solvent with 100 % or complete vapourisation. For example, the cleaning fluid consists of 99 parts ethanol with a degree of purity of 99.8 % and one part MEK (methyl ethyl ketone for industrial use). Agents tested according to DVGW VP 603 comply with this stipulation. If commercially available spirit which

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has a lower purity and may contain other additives is used, this may lead to a quality reduction due to the water contained in it and to other contaminations.

The paper for the cleaning must be clean, unused, absorbent, non-fraying and undyed.

### 3.2.2 Cleaning of the heated tools

The heated tools must be cleaned with cleaning cloths or paper before every welding operation. No residues of the cleaning agent or of the paper may remain on the heated tool. Ensure subsequent extraction.

### 3.2.3 Cleaning of the joining faces

Before the chip-producing machining of the joining faces, it must be ensured that the utilised tools and the workpieces are clean and free from grease beyond the welding area. If necessary, the cleaning must be carried out with a cleaning agent. Ensure subsequent extraction.

The joining faces must be machined immediately before the beginning of the welding.

Immediately before the welding, the faces to be joined must be subjected to chip-producing machining with a clean and grease-free tool so that they have parallel faces in the clamped condition. In the case of fresh saw cuts, it is not necessary to mechanically clean the welding faces of panels. It is urgently advised not to perform any cleaning with chemical agents or solvents.

Any chips which may be present must be removed without touching the joining faces.

## 4 Heated tool butt welding

### 4.1 Process description

In the case of heated tool butt welding, the joining faces of the parts to be welded are aligned at the heated tool under pressure (alignment), are subsequently heated at a reduced pressure (heating-up) and, when the heated tool has been removed (changeover), are joined under pressure (joining). Fig. 1 shows the principle of the process.

All the welds must be executed with machines and devices which satisfy the requirements according to the DVS 2208-1 technical code.

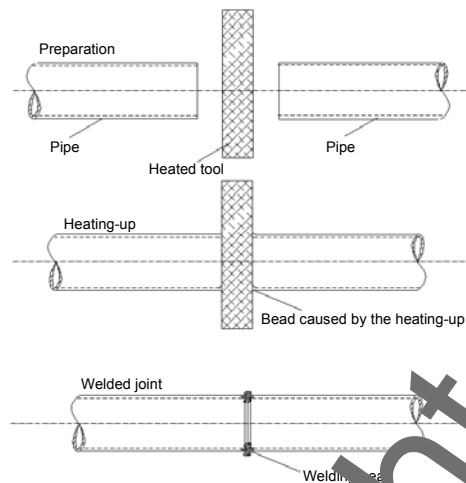


Figure 1. Principle of heated tool butt welding using the example of a pipe weld.

### 4.2 Preparation for the welding

The heated tool temperature necessary for the welding must be checked before the beginning of the welding work. This is carried out, for example, with a quick-display temperature gauge for surface measurements. The control measurement must be taken in the working area of the heated tool for the corresponding semi-finished product. So that a thermal equilibrium can occur, the heated tool may be utilised, at the earliest, ten minutes after the nominal temperature has been reached. It is recommended to record the temperature measurement at several positions in the heated tool area used for the welding operation concerned in order to check the uniformity of the temperature distribution.

In order to achieve optimum welds, it is necessary to clean the heated tool with absorbent, non-fraying and non-dyed paper before every welding operation. The anti-adhesive coating or covering of the heated tool must be undamaged in the working area.

The respective joining forces or joining pressures must be stipulated for the machines to be utilised. These may refer, for example, to information from the manufacturer or to calculated or measured values. In the case of pipe welding, it is also necessary to read the movement force or movement pressure arising during slow movement of the workpiece off the display instrument of the welding machine and to add this to the previously determined joining force or to the joining pressure.

In the joining area, the nominal wall thicknesses of the parts to be welded must be within the tolerances in DIN EN ISO 1501 for plates and in DIN 8079 or DIN EN ISO 15493 for pipes.

Pipes and fittings must be aligned axially before they are clamped in the welding machine. The easy longitudinal mobility of the parts to be welded on must be ensured, for example, using adjustable dollies or a swinging suspension.

The permissible gap widths of the parts to be joined before the alignment are shown in Table 1.

Table 1. Maximum gap widths between the machines welding faces.

Panel width [mm]	Pipe diameter D [mm]	Gap width [mm]
–	–	0.25
≤ 1,500	> 63 to ≤ 110	0.50
> 1,500 to ≤ 2,000	> 110	0.70
> 2,000 to ≤ 2,300	65 to ≤ 400	0.80
> 2,300 to ≤ 3,000	–	1.00

The misalignment must be checked at the same time as the gap width. The misalignment of the joining faces in relation to each other must not exceed the permissible dimension of  $0.1 \times$  wall thickness  $s$  on the outside of the pipe or on the panel. If the misalignment is  $> 0.1 \times s$ , this results in a distinct quality reduction which significantly affects the load-bearing capacity of the welded joint due to the notch sensitivity of the PVC-C. In this case, an evaluation should be carried out according to the DVS 2202-1 technical code taking account of the requirements on the welded joint and the structure.

The machined welding faces must not be either soiled or touched by the worker's hands since another cleaning operation according to Section 3.2.3 would otherwise be necessary.

If piping parts are welded, it must be ensured that any chips which have fallen into the pipe are removed after the planing operation without soiling the welding faces.

### 4.3 Execution of the welding

In the case of heated tool butt welding, the faces to be joined are heated up to the welding temperature using the heated tool and, when the heated tool has been removed, are joined together under pressure (Fig. 2).