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1 Scope of application

This technical code applies to the heated tool butt welding and sleeve welding with an incorporated heating element of pipes and fittings which are made of Polyamide 12 (PA 12) according to ISO 22621-5 (under preparation) with a density of 1,000-1,040 kg/m³ and serve to transport gases, liquids and solids.

In normal storage conditions, the semi-finished product absorbs up to max. 0.8% moisture. The weldability up to this moisture content has been proven on the basis of tests.

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 and the guidelines for the 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 a specimen, 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.

This publication has been drawn up by a group of experienced specialists working in an honorary capacity and its consideration as an important source of information is recommended. The user should always check to what extent the contents are applicable to his particular case and whether the version on hand is still valid. No liability can be accepted by the Deutscher Verband für Schweißen und verwandte Verfahren e.V., and those participating in the drawing up of the document.

DVS, Technical Committee, Working Group "Fügen von Kunststoffen"

Every welder must be trained and must possess a valid qualification certificate. The planned area of application may determine the type of the qualification. DVS 2212-1 applies to heated tool butt welding and sleeve welding with an incorporated heating element in pipeline construction.

The machines and jigs used for the welding must comply with the requirements in DVS 2208-1.

3 Measures before the welding

3.1 Prerequisites for the welding

The immediate welding area must be protected from unfavourable weathering influences (e. g. wind or the action of moisture). If suitable measures (e. g. preheating, tenting or heating) ensure conditions permissible for the welding, the work may be carried out at any outdoor temperature – provided that the dexterity of the welder is not hindered (see the explanations). If necessary, additional evidence must be provided by manufacturing trial welds in the specified conditions (see Table 2).

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 prevent any cooling during the welding operation, e. g. by draughts. When pipes are welded, the pipe ends must be closed in addition.

PA 12 pipes from the ring coil are oval and curved immediately after the unrolling. The pipe end to be welded must be straightened before the welding, e. g. by means of careful heating-up and/or using a suitable clamping or rolling pressing jig.

The joining faces of the parts to be welded must not be damaged and must be free from contaminations (e. g. dirt, grease and chips).

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 other which have already been moistened with it in the factory and are kept in a lockable plastic box must consist of a solvent with 100% vaporisation, e. g. of 99 parts ethanol with a degree of purity of 99.8% and one part MEK (methyl ethyl ketone, denaturation). Agents tested according to DVS 2207-16 comply with this stipulation. The use of spirit leads to a quality reduction because of the water contained in it.

The paper for the cleaning must be clean, unused, absorbent, non-flaming and undyed. Ensure subsequent extraction.

3.2.2 Cleaning of the heated tools

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

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.

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

Any chips must be removed without touching the joining faces.

If the surface is soiled after the chip-producing machining (e. g. because of contact with the welder's hands), the welding areas must be treated with a cleaning agent if an additional chip-producing machining operation is not possible for process-related reasons.

4 Heated tool butt welding

4.1 Heated tool butt welding of pipes, piping parts and fittings

4.1.1 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 up to the welding temperature at a reduced pressure (heating-up) and, when the heated tool has been removed (changeover), are joined together under pressure (joining). Fig. 1 shows the principle of the process.

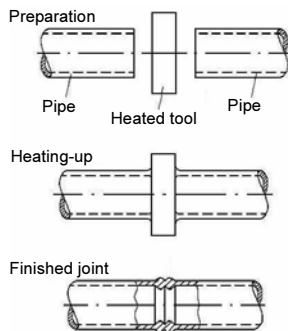


Figure 1. Principle of heated tool butt welding using the example of pipes.

4.1.2 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 with a contact area covering a diameter of approx. 10 mm. The control measurement must be taken within the heated tool area corresponding to the semi-finished product. So that a thermal equilibrium can occur, the heated tool may be used, at the earliest, ten minutes after the nominal temperature has been reached.

For optimum welds, it is necessary to clean the heated tool according to Section 3.2.2 before every welding operation. The anti-adhesive coating of the heated tool must be undamaged in the working area.

The respective joining forces or joining pressures must be calculated for the machines to be used. These may result, 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. Preference should be given to electronically controlled machines – if at all possible, with recording.

The nominal wall thicknesses of the parts to be welded must match in the joining area.

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

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. The permissible gap width under the alignment pressure is 0.5 mm.

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 on the outside of the pipe. A larger misalignment results in a reduction in quality which restricts the load-bearing capacity of the joint. In this case, an evaluation may be carried out according to the DVS 2202-1 technical code taking account of the requirements on the joint.

The machined welding areas must not be either soiled or touched by the welder's hands since another chip-producing machining operation would otherwise be necessary. **An additional cleaning operation is not required and does not give rise to any improvement in quality.** Any chips which have fallen into the pipe must be removed.

4.1.3 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 a heated tool and, when the heated tool has been removed, are joined together under pressure. The heated tool temperature is $230 \pm 10^\circ\text{C}$. The step-by-step sequence of the welding operation is illustrated in Fig. 2.

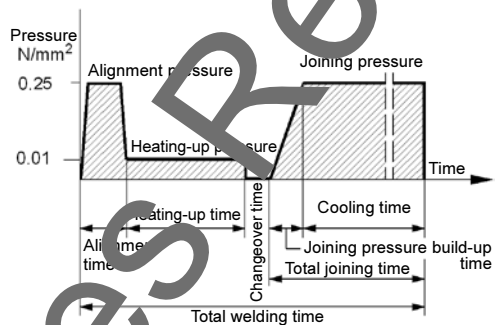


Figure 2. Process steps in the case of heated tool butt welding.

Alignment

In this respect, the joining faces to be welded are pressed on to the heated tool until the entire joining faces are in contact with the heated tool with parallel faces. This can be recognised by the formation of the beads. The alignment is finished when the bead heights around the entire pipe circumference have reached the values specified in Table 1, Column 2. The bead heights are regarded as an indicator that the whole area of the joining faces is in contact with the heated tool. The alignment pressure of 0.25 N/mm² is effective throughout the alignment operation.

Heating-up

For the heating-up, the faces must be in contact with the heated tool at a low pressure. To this end, the pressure is reduced to