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DVS – DEUTSCHER VERBAND FÜR SCHWEISSEN UND VERWANDTE VERFAHREN E.V.	Heated tool welding of mouldings made of thermoplastics in series fabrication	DVS Technical Code DVS 2215-1

Replaces May 1999 edition

Contents:

1 Scope of application

This technical code applies not only to the heated tool welding of mouldings with each other but also to combinations of mouldings and semi-finished products, on this subject see also the DVS 2215-2 technical code (PE and PP) and the DVS 2215-3 technical code (heated tool welding of amorphous thermoplastics).

For the heated tool welding of pipes with fittings, it is also necessary to consider the DVS 2207 technical bulletins and technical codes elaborated for the welding of pipes.

Additional standards, guidelines, technical codes and technical bulletins are listed in Section 10.

2 Functional principle

The joining faces are plastified with a heated tool by means of contact or without any contact by means of heat radiation and are welded under pressure. In this respect, the welding process is divided into several welding steps (Fig. 1) where the main distinction is made between:

Matching = Compensation for unevenness

Heating = Plastification of the joining faces

Changeover = Removal of the heated tool

Joining = Welding of the plastified joining faces under joining pressure and cooling

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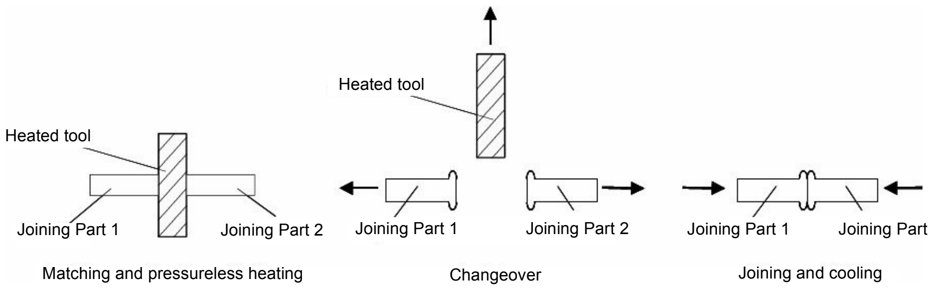

Figure 1. Partial processes in the case of heated tool welding.

2.1 Heated tool welding

For the plastic to be welded in each case, it is necessary to choose those heating conditions in which the joining zones are not damaged thermally. In order to transmit the heat, the joining faces are in contact with the heated tool.

Other heating conditions must be chosen for the welding of plastics whose melts adhere to the heated tool or require heating temperatures which are above the permissible utilisation temperature of the non-stick coatings (i.e. 270°C).

2.1.1 Non-contact heating of mouldings whose melts have a high inclination to adhesion

The joining faces can be plastified without any contact by means of heat radiation. The radiation source, the radiation exposure duration and the distance must be coordinated in such a way that the joining faces are plastified enough but are not damaged thermally.

2.1.2 High-temperature welding

The joining faces are plastified at high heated tool temperatures. Depending on the kind of plastic, it is necessary to set those temperatures (see Section 3.2.4) at which thermal degradation already occurs at the interfaces. Subject to this prerequisite, it is easier to detach the joining faces from the heated tool. Product residues vaporise on the heated tool during a certain time. In part, the degraded coats located on the joining faces are washed out by flow processes during the joining. In general, the welds manufactured by means of high-temperature welding have lower load-bearing capacities. For this heating method, consideration is predominantly given to those plastics whose residues vaporise on the heated tool. The vapours must be extracted. As a rule, high-temperature welding requires only short heating times.

In the case of the high-temperature welding of reinforced, filled or miscellaneous special types, non-vaporising residues may form on the heated tool. The influence of these residues on the welding behaviour must be checked and cleaning may be required.

2.1.3 Welding of plastics with different melt viscosities

The heating conditions must be adjusted correspondingly in order to match the melt viscosities. The melt viscosity is adjusted using different heated tool temperatures and/or heating times for both joining members.

3 Welding installations

3.1 Designs and execution shapes

In the case of heated tool welding machines, a distinction is made between standard machines and special-purpose machines.

– Standard machines are characterised by the fact that they can be used for the welding of mouldings with geometrically different designs due to the simple replaceability of the holder tools and the heated tools.

– Special-purpose machines are characterised by the fact that they are developed and utilised predominantly for one special welding task. The machines can be actuated hydraulically, pneumatically or electromechanically. The combination with other welding processes is possible as well.

Moreover, a distinction is made between horizontally and vertically working installations (movement of the mouldings in relation to each other) which are used depending on the moulding geometry and the handling possibility.

3.2 Requirements on heated tools

The dimensioning and the heating capacity must be adapted to the welding task.

Electrical radiators serve to transfer the heat to the surface of the heated tool through a material with a thermal conductivity which is as good as possible. The suspension must be thermally insulated in such a way that the heat dissipation is low. When designing the heated tool, it is necessary to take account of the thermal expansion in relation to the shaping and the fixing.

3.2.1 Designing

The shape and position of the heated tool attachments or of the directly heated tools must be adapted to the joining faces of the parts to be welded. Attachments and PTFE films must be easy to replace. Heat-shielding screens can be integrated in order to protect certain zones from radiant heat.

3.2.2 Materials

Heated tools must be made of materials which have good thermal conductivities, are as corrosion-resistant as possible and are suitable for the planned working temperatures. They are principally manufactured from Al alloys. Special materials are also utilised for high-temperature welding (e.g. aluminium-bronze and special steels).

3.2.3 Surface condition

The useful area of the heated tool must exhibit such a condition that there are no residues of the plastified material and the cleaning is possible without any damage. In order to make it easier to keep the surface clean and to decrease the adhesive forces during the detachment of the joining parts, coatings made of PTFE or coverings made of PTFE-coated glass fibre fabrics are recommended in the case of the contact heating. Customary coating thicknesses are 30 – 50 µm or PTFE glass fibre fabric films in thicknesses of 100 – 300 µm.

In continuous utilisation, PTFE coatings or coverings on the heated tools may be used up to max. 270°C only. The temperature on the bright heated tool surface applies to PTFE films. Higher temperatures must be avoided since decomposition products which are harmful to health may otherwise form.

Separating agents (PTFE or silicon spray and others) have negative effects on the weld strength.