# Hot Plate Welding of Mouldings Made of Polyolefins (PE, PP) in Volume Production

11



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# Contents:

- Scope
- 2 Description of process
- З Short description of the materials PE, PP to be welded
- 31 Polvethylene (PE)
- Ethylene- Homopolymers 3.1.1
- 3.1.2 Ethylene-Copolymers
- Polymer blends 3.1.3
- PE with additives 3.1.4
- Polypropylene (PP) 3.2
- 3.2.1 Polypropylene-homopolymers
- Polypropylene-copolymers 3.2.2
- 3.2.3 Elastomer-modified PP
- PP with fillers and reinforcements 324
- PP with additives 3.2.5
- Material-caused influences on the welding behaviour 4
- 4.1 Flow behaviour
- 42 Additives
- 4.3 Fillers and reinforcements
- 4.4 Recycled components, regranulates, regenerated material
- 4.5 Influence of moisture Requirements on the manufacture quality for joining 5 components 6
- Structural design of joining components 7
  - Welding equipment
- 71 Types

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- Machine configuration 7.2
- 7.3 Requirement for the hot plate
- 7.4
- 7.5 Temperature control at the working surface
- 7.6
- 7.7 Holders and fastening aids
- Features of high-temperature welding 7.8
- 7.9 Features of welding with radiant heat
- Welding conditions 8
- 8.1 Heating procedures
- 8.2 Adjustment pressure
- 8.3 Adjustment time/adjustment displacement
- 8.4 Heating pressure
- 8.5 Heating time
- 8.6 Changeover time
- 8.7 Joining pressure
- 88 Cooling time
- 8.9
- Criteria of high-temperature welding 9 Influences on the weld quality
- 9.1
- Structural directions Melt behaviour
- 9.2
- Soilings 93
- 9.4 Influence of surface treatment and coating
- 9.5 Multi-layer coatings
- 10 Testing of the welded joining components
- 10 1 Non-destructive tests
- 10.1.1 Visual tests
- 10.1.2 Ultrasonic and x-ray tests
- 10.1.3 Leakage test
- 10.1.4 Thermal imaging
- 102 Destructive tests
- 10.2.1 Mechanical tests
- 10.2.2 Microscopical investigations

11.1 Structural and process FMEA Investigations for machine-capability and process-capa-112 bility

Measures for quality assurance in the manufacturing

- Entrance test of joining components 113
- 11.4 Quality regulating card in continually manufacture
- 11.5 Statistical process control
- 12 Safety regulations

nrocess

- 13 Standards and specifications
- 14 Annex: Selected samples of application

#### 1 Scope

These guidelines are valid for welding mouldings together using hot plate welding, and also for combinations of mouldings and semi-finished products made of Polyolefins, homopolymers and copolymers as well as blends of these (reinforced, fille elas tomer-modified, fire protected and special settings of plastics).

The hot plate welding of pipes to fittings is not subject-m this specification. For this the specifications DVS 2207, and . are valid.

This specification is to discuss in connection with spe ation DVS 2215-1, which the general bases for "Hot g wel thermoplastic mouldings in volume production' bed.

#### 2 Description of process

See specification DVS 2215-1.

3 Short description of the

Polyolefins are semi-cry calline p stics which are characterized e wereing. Because of their cs have versatile applications in wide melting range these the field of hot plate welding, e cially in the processing of semiolume production of moulfinished products as well as in dings. In nearly all special fields the polyolefines are processed by the hot plate welding procedure. The choice of the material or the type has to ne place not only according to the profile of he la plication field but also according the requirements of type-specific we ehav ur.

rials

be welded

Crosslinked polyolefines are not resp. not much suitable for weldina

Materia alu Il as type-specific properties can be taken as sheets as well as the data bases of the raw m pro on dat and institutes. ma. rial ph

#### Polye lene (PE)

cording ISO 1872-1 (DIN 16 776-1) PE moulding comthermoplastic moulding compounds on the basis of ds a Ethylene-nomopolymers and/or Ethylene-copolymers.If no supplementary specifications are made, they have the complete composition prior to processing. If necssary fillers and/or reinforcements can be included.

This publication has been compiled on a honorary basis by a g important source of knowledge. The user must at all time him or her is still current. Any liability on the part of the Germ rienced experts as a team, and it is recommended that it should be respected as an hich the contents apply to his or her special case and whether the version available to d of those participating in the preparation of this document is excluded. exte ding Socie.

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Temperature range Holding tools

#### 3.1.1 Ethylene-Homopolymers

Polyethylenes are produced with different degree of branching depending on the conditions of polymerization. With decreasing branching of the molecules the crystalline parts and the density will increase.

The melting temperature and melting viscosity are higher with increasing density and mole mass. With increasing melting viscosity polyethylene can be welded easier because of the tendency to stick at the hot plate declines. Density and molecular weight influence the mechanical and thermal properties of the polyethylene too.

PE-LD (density 0.915 to 0.934 g/cm<sup>3</sup>) is polymerized in the highpressure process and has a long-chain branched structure. However the linear built-up PE-HD (density 0.935 to 0.97 g/cm<sup>3</sup>) has higher stiffness, hardness, and deflection temperature. It is produced in the low-pressure process and has few short-chain branches.

With increasing mole mass -characterized by lower MVR/MFRvalues – impact strength and resistance against stress cracking of PE increase; the latter increases additionally with increasing density, that means with increasing degree of branching.

Moreover the mole mass distribution (MMV) influences considerably the properties and manufacturing process. Small MMV supports impact strength and poorness of deformation, wide MMV supports resistance against stress cracking and as well as flowability.

# 3.1.2 Ethylene-Copolymers

Copolymerization of Ethylene leads to branched chain structures. By it the crystalline components are reduced and the melting temperature, density, and stiffness are decreased and the resistance against stress cracking lowered. With the low-pressure process only apolar co-monomers like I-Butadiene, I-Hexene, I-Octene are usable for this purpose. In this connection low density Polyethylenes are produced like PE-ULD, PE-VLD, and PE-LLD (density 0.88 to 0.93 g/cm<sup>3</sup>) and PE-MD medium density (density 0.93 to 0.94 g/cm<sup>3</sup>), which have a linear structure with short chain branching. The degree of branching and the flexibility increase with concentration of co-monomers.

With the high pressure process there are polar co-monomers like vinyl acetate (VA), acrylic acid (A), acrylates (EA), which have in addition to the flexibilizing effect other properties, for example higher adhesion to foreign materials.

The copolymers (EVA, EAA, EEA) are characterized apart from density and  $MVR/MFR^{\circ}$  supplementary by kind and amount of the co-monomers.

#### 3.1.3 Polymer blends

Polymers blends are produced by mechanical recessing of other polymers (e.g. PA). Tests for establishing the weldability have to be performed, because of the quality, kind and concentration of the second component in the blend can influence the quality of the welded joints.

# 3.1.4 PE with additives

Polyethylenes contain the most different additives like stabilizers, 4 colouring agents, antistatic agents, processing aids, fire protecting agents and partly fillers and/or reinforcements. The weldability has to be cleared up by tests, because the additives influence the welding properties.

### 3.2 Polypropylene (PP)

According to ISO 1873-1 (DIN 16 774-1) PP moulting compounds are thermoplastic moulding compounds on the rsis of Propylene-homopolymers and/or Propylene-copolymers. The are homopolymers with high or low crystalline components, block copolymers, random copolymers, elastomer modifi s as all as filled and/or reinforced types. Polypropylen and is good

\*) look 4.1

ditions for the hot plate welding. As with the joining of semifinished products also good weld qualities are achieved.

#### 3.2.1 Polypropylene-homopolymers

Mouldings made from homopolymers are characterized by high stiffness, hardness and deflection temperature. The range of melting temperature begins at  $160^{\circ}$ C. The decreasing of toughness at temperatures less than  $5^{\circ}$ C has to be taken into account. The different types are always characterized by its MVR/MFR-values.

#### 3.2.2 Polypropylene-copolymers

At the copolymers there are block copolymers (PP-B) and random copolymers (PP-R). Copolymers have a better toughness than homopolymers with comparable MVR/MFR-values. At the block copolymers this is valid especially for temperatures less than about 5°C. Random copolymers have a better transparency and a reduced wider melting range.

The different types are always characterized by its MVR/MFR-values resp. by its toughness.

#### 3.2.3 Elastomer-modified PP

The elastomer-modified PP-compounds contain mostly the elasticizer Ethylene-propylene-rubber (EPM, EPDM). They are characterized especially by good impact strength in the cold sufficient stiffness in the warmth, they are good to b and with fillers and/or reinforcements and they show good procuring possibilities.

#### 3.2.4 PP with fillers and reinforcements

Glass fibre-, chalk- or talc-filled polymers show a hig er st ness hardness and deflection temperature, but generally "ver im pact strength than the non filled materials.

Glass fibre reinforced types with chemical cupling two especially high strength, stiffness and deflection emperature orientations of the glass fibre in the final parts influence there op, ties and deformation. For this reason these types have to be ked concerning their weldability.

### 3.2.5 PP with additives

Additives like foreign poly coloun stabilizers, antistatic agents, procest a and me protecting agents of PP. specially if they are added in a influence the properti great amount or if # v chan alline structure. Therefore it is necessary to ck/ e weldability.

# 4 Material-caused influences in the welding behaviour

# 4.1 Flow behavi

The flow beh viour melt of polyolefins is characterized by the melt flow /FR) melt volume rate (MVR) according to DIN 53 735 / ISO 1133 the standard is defined the combination of m tem, ature, at which the melt flow rate has to be deteri hed. s only possible to compare such values with each other vhic wei measured at the same test conditions (load temp veigh ature).

b) plastin, g behaviour of the joining zone is decisively influenced, the molecular weight and so by the flow behaviour of the melt, the material to be welded.

# Seneral ules are:

Eurowing PE- and PP-types with high MFR plastify more quickly than tough-flowing types with low MFR which therefore tend towards adhesion of the melt on the hot plate more easier. This is valid especially for ethylene-copolymers. Reducing the hot plate temperature decreases the adhesion.

The following welding parameters have to be adjusted to meet certain criteria: