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Plastics — Joining of thermoplastic moulded components — Specification of variables for thermal joining processes

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document has been developed to help organizations better understand and implement controls with thermal joining processes through the use of thermal joining process specifications.

Plastics — Joining of thermoplastic moulded components — Specification of variables for thermal joining processes

1 Scope

This document specifies the minimum essential variables in order to produce a component of the required consistency and quality for the following thermal joining processes:

— ultrasonic welding/staking/spot welding;

— infrared welding;

— hot gas convection welding;

— linear vibration welding;

— orbital vibration welding;

— spin welding;

— laser welding;

— hot plate welding;

— heat staking: hot air;

— heat staking: electrical; and

— heat staking: infrared (IR).

This document defines the thermal joining process specification (TJPS) for each of the thermal joining processes listed above, to ensure that all the essential variables are properly considered, including the qualified range of each variable, in order to establish and maintain component quality at an acceptable level.

NOTE Standards on joining of plastic pipes, fittings, valves and/or auxiliary equipment, and the assessment of the properties of the resulting joints are developed and maintained by ISO/TC 138.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 472, *Plastics — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
dimensional report
full measurement report on product before welding including flatness at weld joint

3.2
essential variable
joining condition that influences the quality of the joint and requires qualification

3.3
joining organization
organization responsible for the serial production joining and maintenance of quality

3.4
joining procedure
specified course of action to be followed in making a joint, including the *joining process(es)* (3.5), reference to materials, preparation, pre-heating (if necessary), control of process parameters and necessary equipment to be used

3.5
joining process
method of softening or melting to obtain a permanent *joint* (3.7)

3.6
joining process qualification record
JPQR
record comprising all data of mechanical test results for the specified range of each *essential variable* (3.2) needed for qualification of a TJPS, used by the *joining organization* (3.3) as part of the sign-off documentation

3.7
joint
junction of two sub-components

3.8
moisture content
amount of moisture content in parent material at the time of *welding* (3.12)

3.9
process report
document confirming that the sub-component has been manufactured using the correct moulding process parameters, conditions, material grade, masterbatch reference, masterbatch percentage, and regrind percentage

3.10
thermal joining process specification
TJPS
document that has been qualified and provides the required variables of the *joining procedure* (3.4) to ensure repeatability during production

3.11
visual examination acceptance criteria document
document specifying imperfections on sub-components that affect the functionality of the joint, such as weld lines, burn marks, surface contamination

3.12
welding
process of uniting softened surfaces of materials, generally with the aid of heat

3.13
work instruction
simplified TJPS, suitable for *joining process* (3.5) owner

4 Technical content of thermal joining process specification (TJPS)

4.1 General

A TJPS shall provide the minimum information specified in 4.2 to 4.5 required to make a joint of acceptable quality, as part of the component manufacturing quality agreement between the joining organization and the customer.

TJPSs cover a certain range for each essential variable. The range of each essential variable shall be qualified using a JPQR, and the procedure for measuring each variable shall conform to agreed specifications.

When completing the TJPS the technical support/manual/documentation of the joining process equipment manufacturer or service supplier may be consulted.

NOTE 1 Example templates of TJPSs are given in Annex A to Annex K. Worked example TJPSs for hot plate welding and heat staking: electrical are given in Annex L and Annex M, respectively.

NOTE 2 A work instruction can be prepared for each specific, applicable TJPS as part of detailed production planning.

4.2 Related to the joining organization

a) identification of the joining organization;

b) TJPS reference number/revision;

c) signature of the person responsible for approval, appointed by the joining organization.

NOTE The responsibilities, knowledge, skills and competence for the person responsible for approval are set out in PD CEN/TR 16862[1].

4.3 Related to the sub-component(s)

a) sub-component material:

   1) material supplier name;

   2) designation of the material(s) and reference standard(s), if any, or an alternative identification if a reference standard does not exist;

   3) moisture content;

   4) regrind percentage;

   5) masterbatch reference and masterbatch percentage;

b) dimensional report;

c) process report;

d) customer component/part number;

e) supplier component/part number;

f) visual examination acceptance criteria document number

4.4 Common to all joining processes

a) joint preparation;

b) ambient temperature;

c) sub-component temperature;

d) joining process qualification record (JPQR)

4.5 Specific to a joining process

4.5.1 Ultrasonic welding/staking/spot welding

a) joining process(es): welding, staking or spot welding;

b) machine type (fixed or handheld);

c) frequency;

d) power rating;

e) maximum tool temperature;

f) tool face amplitude/amplitude profile;

g) down speed;

h) trigger force (if applicable)/(not handheld);

i) pre-trigger/touch (yes/no) (not handheld);

j) pre-trigger amplitude (if applicable)/(not handheld);

k) joining force/force profile (if applicable)/(not handheld);

l) meltdown/collapse/weld displacement (if applicable)/(not handheld);

m) joining or welding time;

n) hold/cooling time;

o) weld energy.

NOTE A template for the TJPS for ultrasonic welding/staking/spot welding is given in Annex A.

4.5.2 Infrared welding

a) emitter condition;

b) distance of sub-components from IR source;

c) pre-heat/soak temperature (or power);

d) pre-heat/soak time;

e) full heat temperature/power;

f) full heat time;

g) removal of heating to sub-component contact time/changeover time;

h) welding force;

i) meltdown/collapse/weld displacement;

j) cooling time.

NOTE A template for the TJPS for infrared welding is given in Annex B.

4.5.3 Hot gas convection welding

a) gas flow rate;

b) gas temperature;

c) gas feed type;

d) distance between sub-components and tool;

e) heating time;

f) removal of heating to sub-component contact time/changeover time;

g) welding force;

h) meltdown/collapse/weld displacement;

i) cooling time.

NOTE A template for the TJPS for hot gas convection welding is given in Annex C.

4.5.4 Linear vibration welding

a) frequency;

b) amplitude/amplitude profile;

c) IR pre-heat time (if applicable);

d) IR pre-heat power (if applicable);

e) IR pre-heat changeover time (if applicable);

f) welding force/force profile;

g) meltdown/collapse/weld displacement;

h) welding time;

i) hold/cooling time.

NOTE A template for the TJPS for linear vibration welding is given in Annex D.

4.5.5 Orbital vibration welding

a) frequency;

b) amplitude/amplitude profile;

c) welding force/force profile;

d) meltdown/collapse/weld displacement;

e) welding time;

f) hold/cooling time

NOTE A template for the TJPS for orbital vibration welding is given in Annex E.

4.5.6 Spin welding

a) machine type (servo-drive/inertia);

b) head mass (inertia machines only);

c) run-up time (inertia machines only);

d) rotational speed;

e) down speed;

f) welding force/force profile;

g) welding time;

h) number of rotations (if applicable);

i) meltdown/collapse/weld displacement;

j) hold/cooling time;

k) final angular position (if applicable).

NOTE A template for the TJPS for spin welding is given in Annex F.

4.5.7 Laser welding

a) wavelength;

b) laser power;

c) peak power (pulse lasers only);

d) pulse energy (pulse lasers only);

e) pulse duration and repetition rate (pulse lasers only);

f) beam delivery (contour);

g) focal length of focusing lens;

h) beam energy profile/dimensions;

i) power density;

j) laser transmission of lower sub-component;

k) laser transmission of upper sub-component;

l) laser absorber type (if applicable);

m) welding/clamping force;

n) scan speed (if applicable);

o) number of passes (if applicable);

p) weld time (if applicable);

q) meltdown/collapse/weld displacement;

r) temperature close/loop (if applicable);

s) power mapping/zoning (if applicable);

t) hold/cooling time.

NOTE A template for the TJPS for laser welding is given in Annex G.

4.5.8 Hot plate welding

a) plate temperature;

b) hot plate surface coating (if applicable);

c) melting force;

d) heating time;

e) meltdown/collapse/displacement;

f) removal of heating to part contact time/changeover time;

g) welding force;

h) weld collapse/displacement;

i) hold/cooling time.

NOTE A template for the TJPS for hot plate welding is given in Annex H.

4.5.9 Heat staking – hot air

a) hot air temperature;

b) airflow;

c) distance of stake pin from end of nozzle;

d) heating time;

e) changeover time;

f) cold stake tool/platen force;

g) cold stake tool contact time;

h) final cold tool position/dead stop (if applicable).

NOTE A template for the TJPS for heat staking - hot air is given in Annex I.

4.5.10 Heat staking – electrical

a) heated tool temperature/temperature profile;

b) heating time (if no temperature profile);

c) tool/platen force;

d) cooling time (if no temperature profile);

e) release temperature (if no temperature profile);

f) final tool position/dead stop (if applicable).

NOTE A template for the TJPS for heat staking - electrical is given in Annex J.

4.5.11 Heat staking – infrared

a) IR power;

b) distance of stake pin from heat source;