INTERNATIONAL STANDARD

ISO 15853

First edition
1999-12-01

Thermoplastics materials — Preparation of tubular test pieces for the determination of the hydrostatic strength of materials used for injection moulding

Matières thermoplastiques — Préparation d'éprouvettes tubulaires pour la détermination de la résistance à la pression hydrostatique des matières destinées au moulage par injection

Reference number
ISO 15853:1999(E)

Contents

Page

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet iso@iso.ch

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 15853 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

Introduction

This International Standard specifies a method of preparing, by injection-moulding (see the note to clause 1), tubular test pieces for the determination of the long-term behaviour of their constituent material.

Unlike the case of pipes, it is difficult to evaluate the resistance to internal pressure of injection-moulded piping components such as fittings or valve bodies. In fact, the material properties determined would be falsified for various reasons, such as

— the heterogeneity of any strain in the product;

— the fact that the product is shaped (e.g. tees, elbows);

— the presence of weld lines and, sometimes, an injection point.

It is therefore necessary to use test pieces injection-moulded in the form of a tube in order to be able to study the time-related behaviour under internal hydrostatic pressure of the compounds used for injection-moulding, as is done in the case of the pipes.

Test pieces produced in this way have a regular shape and uniform thickness without any weld lines, and the stresses induced in their walls are well defined.

This allows them to be subjected to the same test methods as pipes, including

ISO 1167 for the determination of the resistance to internal pressure;

ISO 9080, or a similar method of extrapolation of hydrostatic stress rupture data, to determine the long-term hydrostatic strength of thermoplastics pipe materials;

ISO 12162 for the determination of the MRS (minimum required strength) and the classification of the material.

However, the properties of the test pieces, and hence the measured values obtained, depend largely on the conditions of processing of the material. This means that the conditions of production must be harmonized in order to make the test pieces reproducible. For this, the main parameters of the moulding procedure have to be defined.

On the other hand, the determination of the basic characteristics of the material requires very long and expensive testing. It is therefore important to have test pieces exempt from failures which could affect the test results.

Checks should be carried out to verify, in particular, the degree of latent internal strain and the extent of any thermal degradation which may occur during processing.

Thermoplastics materials — Preparation of tubular test pieces for the determination of the hydrostatic strength of materials used for injection moulding

1 Scope

This International Standard specifies a general procedure for the production, by injection-moulding, of tubular test pieces for the determination of the resistance to internal pressure. It also specifies the design of the mould to be used.

By using the same material as for injection-moulded piping components, such as fittings, these test pieces make it possible to determine the time-related behaviour of the fitting material under hydrostatic pressure and under the very same conditions as specified for extruded pipes. It is possible to test the resistance to internal pressure of the injection-moulded tubular test pieces in accordance with ISO 1167, to extrapolate the results in accordance with a method such as that specified in ISO 9080 in order to determine the MRS, and to classify the material in accordance with ISO 12162.

The tubular test pieces also make it possible to verify individual points on previously established stress/time regression curves as a minimum material test requirement.

The basis established by this International Standard allows test pieces to be prepared reproducibly.

Nevertheless, the method given is a general one, and the injection-moulding parameters have to be specified for every material used.

NOTE If the compound used for the injection-moulding of piping components can also be extruded, then its time-related behaviour may be investigated using either injection-moulded or extruded tubular test pieces.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 294-1:1996, *Plastics — Injection-moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*.

ISO 580:—[1)], *Injection-moulded unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C), acrylonitrile-butadiene-styrene (ABS) and acrylonitrile-butadiene-acrylester (ABA) fittings — Behaviour to heat — Oven and liquid-bath methods*.

ISO 1167:1996, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method.*

1) To be published. (Revision of ISO 580:1990)

ISO 3126:—[2], *Plastics piping systems — Plastics piping components — Measurement and determination of dimensions*.

ISO 9080:—[3], *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*.

ISO 9853:1991, *Injection-moulded unplasticized poly(vinyl chloride) (PVC-U) fittings for pressure pipe systems — Crushing test*.

ISO 12162:1995, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient*.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in clause 3 of ISO 294-1:1996 apply.

4 Apparatus

4.1 Mould

For the fabrication of injection-moulded test pieces, a single-cavity mould shall be used. Figure 1 shows an example of a single-cavity mould and Figure 2 shows the corresponding test pieces.

The mould shall be end-gated and the sprue diameter at the nozzle side shall be at least 5 mm.

The heat-transfer system of the mould shall be designed so that temperature differences between any points along the edge of the mould or on the surface of the cavity are less than 5 °C.

Machining tolerances for the cavity itself will depend upon the material to be moulded. The diameter of the test pieces shall remain within 0,2 mm.

4.2 Injection-moulding machine

4.2.1 Use an automatic reciprocating-screw injection-moulding machine equipped with all the necessary devices for control of the moulding conditions (see 4.2.5).

4.2.2 The mould-closing force shall be high enough to prevent the formation of excessive flash under any operating conditions.

4.2.3 The screw shall be of a type (e.g. diameter, length, thread height, compression ratio) suitable for use with the injection-moulding material concerned. It is recommended that a screw with a diameter in the range between 18 mm and 40 mm be used (see ISO 294-1).

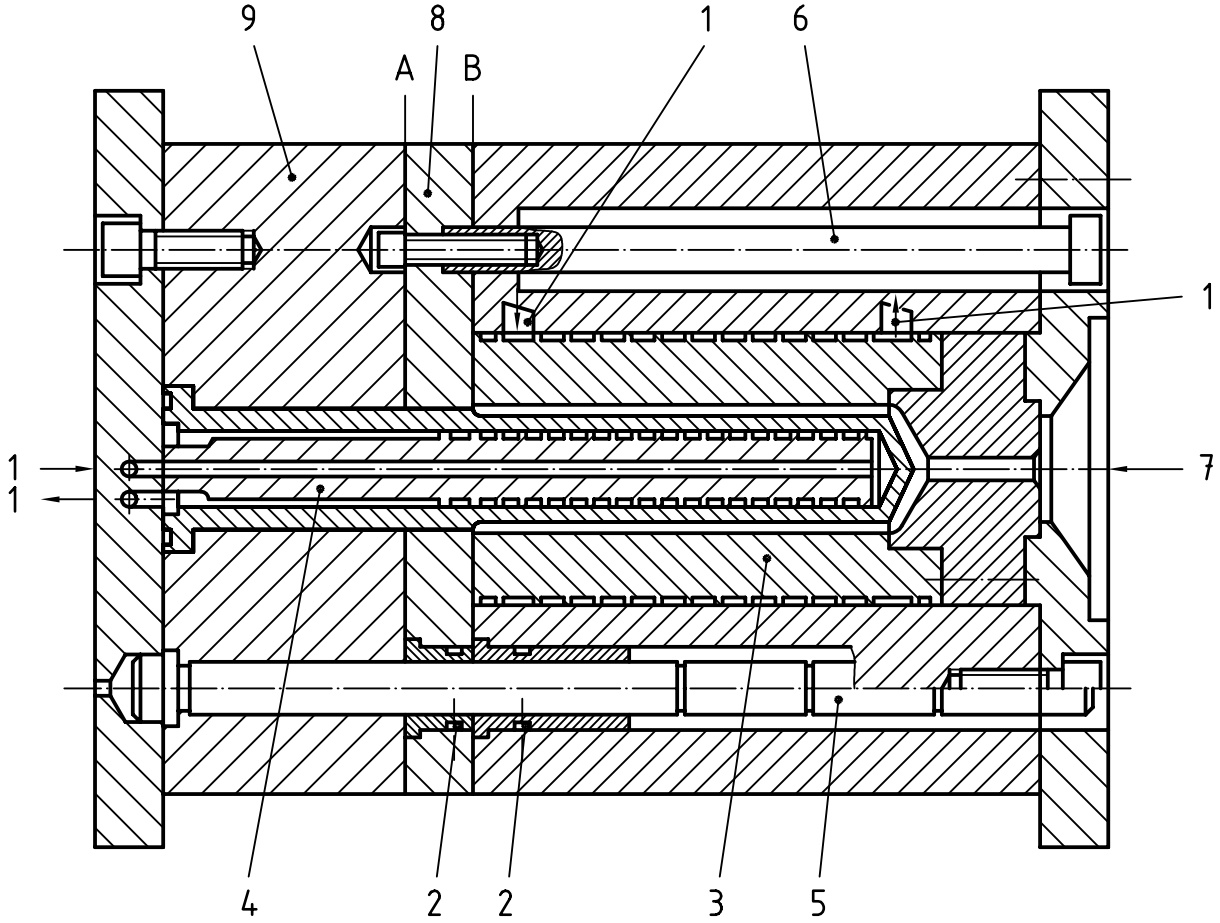
4.2.4 The ratio of the screw stroke volume to the shot volume shall, in general, not be less than 1:10 or more than 1:2 (i.e. between 10 % and 50 % volume efficiency).

With thermally sensitive thermoplastics, a lower ratio may be required. The ratio shall not be so high, however, that crosslinking starts.

---

[2] To be published. (Revision of ISO 3126:1974)

[3] To be published. (Revision of ISO/TR 9080:1992)



Key

1 Heat-transfer fluid inlets and outlets
2 Lubrication holes
3 Mould
4 Core
5 Guide pins
6 Ejection pins
7 Direction of injection

NOTE The moulding is ejected in two steps, as follows:

a) parts 8 and 9 move away from plane B, together with the moulding, until the ejection pins are stopped (the moulding breaks off at the sprue);

b) part 9 moves away from plane A until the moulding drops out.

Figure 1 — Example of a single-cavity mould

Dimensions in millimetres

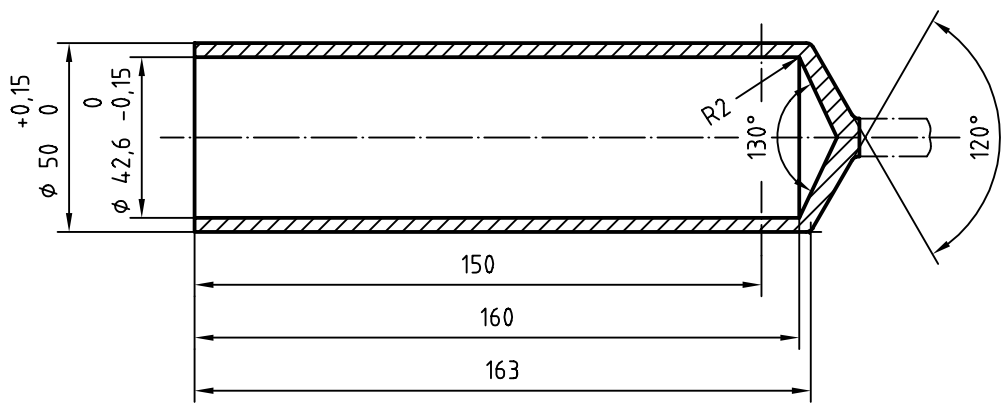


Figure 2 — Injection-moulded test piece (d_n = 50, pipe series S6,3)

4.2.5 The control system shall be capable of maintaining the operating conditions within the following ranges:

— injection pressure ±3 %;

— injection time ±0,05 s;

— hold pressure ±5 %;

— hold time ±5 %;

— melt temperature ±3 °C;

— mould temperature ±3 °C up to 80 °C;
±5 °C above 80 °C;

— shot mass ±1 %.

4.2.6 A calibrated needle-probe pyrometer accurate to ±1 °C shall be used to measure the temperature of the melt. A calibrated surface pyrometer accurate to ±1 °C shall be used to measure the temperature of the surface of the mould cavity.

5 Test pieces

5.1 General

The tubular injection-moulded or extruded test pieces are for use in the hydrostatic pressure test specified in ISO 1167.

5.2 Injection-moulded test pieces

Injection-moulded test pieces shall have one end closed, as shown in Figure 3.

NOTE Injection-moulded test pieces with a longitudinal weld line and both ends open should preferably be used for comparative and investigative purposes only.

The nominal outside diameter d_n of the test pieces shall be between 25 mm and 110 mm inclusive. The wall thickness will depend on the material concerned.

The free length l_0 of the test pieces, excluding the ends, shall be $3d_n$, except for test pieces with d_n = 50, for which the minimum length shall be 140 mm.

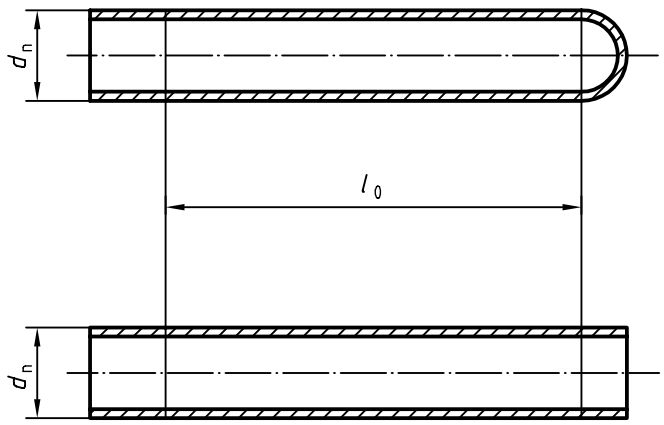


Figure 3 — Test pieces produced by injection-moulding (upper test piece) and extrusion (lower test piece)

5.3 Extruded test pieces

Extruded test pieces shall have both ends open, as shown in Figure 3, and shall be capped afterwards for the subsequent pressure test.

Test pieces may be obtained from an extruded pipe.

The nominal outside diameter d_n of the test pieces shall be between 25 mm and 110 mm inclusive. The wall thickness will depend on the pipe series for the material concerned.

The free length l_0 of the test pieces, excluding the extremities, shall be $3d_n$, with a minimum of 250 mm.

6 Injection-moulding process

If necessary, the material shall be conditioned prior to processing.

Adjust the moulding conditions until the mouldings are free of sink marks, voids and other faults and have minimum flash.

Keep the injection velocity low to allow for the high length:diameter ratio and thin wall of the moulding.

NOTE 1 For many thermoplastics, an injection velocity of 80 mm/s $\pm$ 40 mm/s will be suitable.

Discard the mouldings until the machine has reached steady-state operation. Then record the operating conditions and start collecting test pieces.

NOTE 2 It is advisable to check that no decomposition of the material has occurred during the moulding process by carrying out suitable tests such as comparison of the melt flow rate and K-value with the values for the raw material. The results should be within the values specified in the relevant product standard or by the raw-material supplier.

During the moulding process, maintain the steady-state conditions by suitable means, e.g. by control of the injection volume or the shot mass.

Maintain the hold pressure until the material in the gate region has solidified, i.e. until the mass of the moulding has reached a maximum value under these conditions.

The following injection-moulding data shall be recorded:

a) the mould surface temperature, in degrees Celsius;

b) the melt temperature, in degrees Celsius;

c) the injection time, in seconds;

d) the injection pressure, in megapascals;

e) the hold time, in seconds;

f) the hold pressure, in megapascals;

g) the cycle time, in seconds;

h) the calculated average injection velocity, in millimetres per second;

i) the ambient temperature, in degrees Celsius;

j) the shot mass, in grams.

Carry out post-moulding heat treatment of the test pieces only for materials for which the intended product is also heat-treated and under the same conditions.

7 Characteristics of the injection-moulded test pieces

7.1 General

Carry out the following investigations in order to check whether the test pieces are suitable to endure the tests envisaged.

7.2 Appearance

When viewed without magnification, the internal and external surfaces of the test pieces shall be smooth, clean and free from scoring, cavities and other surface defects which could affect the results of subsequent tests.

7.3 Dimensions

Following complete cooling, measure the dimensions of the test pieces to the precision required by ISO 3126.

Determine the moulding shrinkage.

7.4 Oven test

When the test pieces are tested in accordance with ISO 580, they shall conform to the basic specifications given in ISO 580.

7.5 Crushing test

When the test pieces are tested in accordance with ISO 9853, they shall conform to the basic specifications given in ISO 9853.

7.6 Test piece production report

The report shall include the following information:

a) a reference to this International Standard;

b) a full description of the plastic material (type, designation, manufacturer);

c) details of any conditioning of the material before moulding;

d) the type of test piece produced;

e) details of the injection-moulding machine used (maximum shot volume, mould-closing force, control system);

f) the moulding conditions:

- the melt temperature, in degrees Celsius;
- the temperature of the mould, in degrees Celsius;
- the injection velocity, in millimetres per second;
- the injection time, in seconds;
- the hold pressure, in megapascals;
- the hold time, in seconds;
- the cooling time, in seconds;
- the cycle time, in seconds;
- the mass of the moulding, in grams;

g) the appearance of the mouldings;

h) the dimensions of the mouldings, in millimetres;

i) the result of the oven test;

j) the result of the crushing test;

k) any factors which may have affected the production procedure, such as any incidents or any operations not specified in this International Standard;

l) the date of production of the test pieces.

ICS 23.040.01; 83.080.20

Price based on 7 pages