INTERNATIONAL STANDARD

ISO 10724-2

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Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) —

Part 2:
Small plates

Plastiques — Moulage par injection d'éprouvettes en compositions de poudre à mouler (PMC) thermodurcissables —

Partie 2: Petites plaques

Reference number
ISO 10724-2:1998(E)

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.

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 10724-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 12, *Thermosetting materials*.

Together with part 1, this part of ISO 10724 cancels and replaces ISO 10724:1994, which has been revised to improve the definition of the injection-moulding parameters and has been restructured to specify two types of ISO mould for the production of the basic specimen types required for the acquisition of comparable test data.

Care has been taken to ensure that the ISO moulds described can all be fitted in existing injection-moulding equipment and have interchangeable cavity plates.

As far as possible, the wording of this part of ISO 10724 and its definitions corresponds to that in its counterpart for thermoplastic materials, ISO 294:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials*. Unlike the latter, however, there is no need for the separate moulding of rectangular bars (80 mm × 10 mm × 4 mm, which should be taken from the central portion of the multipurpose test specimen) and the moulding of small tensile bars ($\geqslant$ 60 mm × 10 mm × 3 mm). Therefore the type B and type C ISO moulds specified in ISO 294 were not included in this part of ISO 10724. Regardless of this, and to avoid confusion, the designation of the different mould types in this part of ISO 10724 and in ISO 294 correspond to each other.

ISO 10724 consists of the following parts, under the general title *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs)*:

— *Part 1: General principles and moulding of multipurpose test specimens*

— *Part 2: Small plates*

Annexes A to D of this part of ISO 10724 are for information only.

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Introduction

Many factors in the injection-moulding process which can influence the properties of moulded test specimens and hence the measured values obtained when the specimens are used in a test method. The thermal and mechanical properties of such specimens are in fact strongly dependent on the conditions of the moulding process used to prepare the specimens. Exact definition of each of the main parameters of the moulding process is a basic requirement for reproducible and comparable operating conditions.

It is important in defining moulding conditions to consider any influence the conditions may have on the properties to be determined. Thermosets may show differences in orientation of anisotropic fillers such as short fibres and in curing. Residual ("frozen-in") stresses in the moulded test specimens may also influence properties. Due to the crosslinking of thermosets, molecular orientation is of less influence on mechanical properties than it is for thermoplastics. Each of these phenomena must be controlled to avoid fluctuation of the numerical values of the measured properties.

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Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) —

Part 2:
Small plates

1 Scope

This part of ISO 10724 specifies two two-cavity moulds, designated the type D1 and type D2 ISO moulds, for the injection moulding of small plates measuring 60 mm × 60 mm with preferred thicknesses of 1 mm (type D1) or 2 mm (type D2) which can be used for a variety of tests (see annex A). The moulds may additionally be fitted with inserts for studying the effects of weld lines on the mechanical properties (see annex B).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10724. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10724 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 472:—[1], *Plastics — Vocabulary.*

ISO 2577:1984, *Plastics — Thermosetting moulding materials — Determination of shrinkage.*

ISO 6603-1:—[2], *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 1: Non-instrumented impact test.*

ISO 6603-2:—[3], *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 2: Instrumented impact test.*

ISO 10724-1:1998, *Plastics — Injection moulding of test specimens of thermosetting materials — Part 1: General principles and moulding of multipurpose test specimens.*

3 Definitions

For the purposes of this part of ISO 10724, the definitions given in ISO 472 as well as those in ISO 10724-1 apply.

4 Apparatus

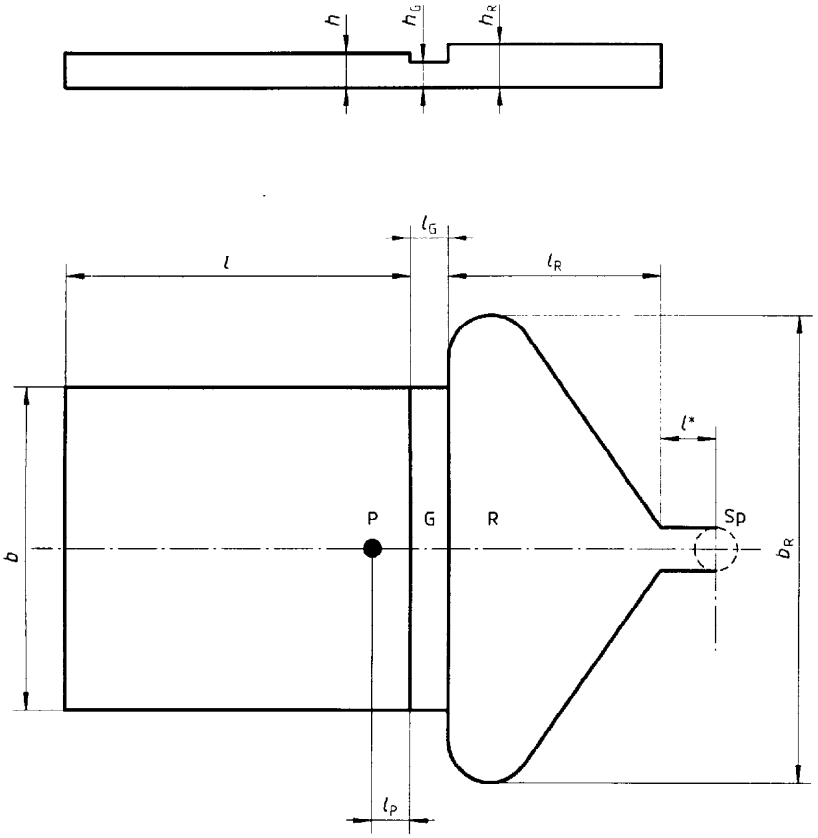
4.1 Type D1 and D2 ISO moulds

Type D1 and D2 moulds are two-cavity moulds (see Figure 2) intended for the preparation of plates measuring 60 mm × 60 mm. The plates produced using these moulds shall have the dimensions given in Figure 1.

1) To be published. (Revision of ISO 472:1988)

2) To be published. (Revision of ISO 6603-1:1985)

3) To be published. (Revision of ISO 6603-2:1989)



Key

Sp	Sprue	
G	Gate	
R	Runner	
P	Pressure sensor	
		Dimensions in mm
l	Length of plate	60 ± 2 [1]
b	Width of plate	60 ± 2 [1]
h	Thickness of plate:	
	type D1 mould	$1{,}0 \pm 0{,}1$
	type D2 mould	$2{,}0 \pm 0{,}1$ [1]
l_G	Length of gate	$4{,}0 \pm 0{,}1$ [2]
h_G	Height of gate	$(0{,}75 \pm 0{,}05) \times h$ [2] [3]
l_R	Length of runner	25 to 30 [4]
b_R	Width of runner at gate	$\geqslant (b + 6)$
h_R	Depth of runner at gate	$h + (1{,}5 \pm 0{,}5)$
l^*	Unspecified distance	—
l_P	Distance of pressure sensor from gate	5 ± 2 [5]

1) These dimensions are for the preferred test specimen used in ISO 6603.

2) See note 1 to subclause 4.1.

3) See note 2 to subclause 4.1.

4) See note 3 to subclause 4.1.

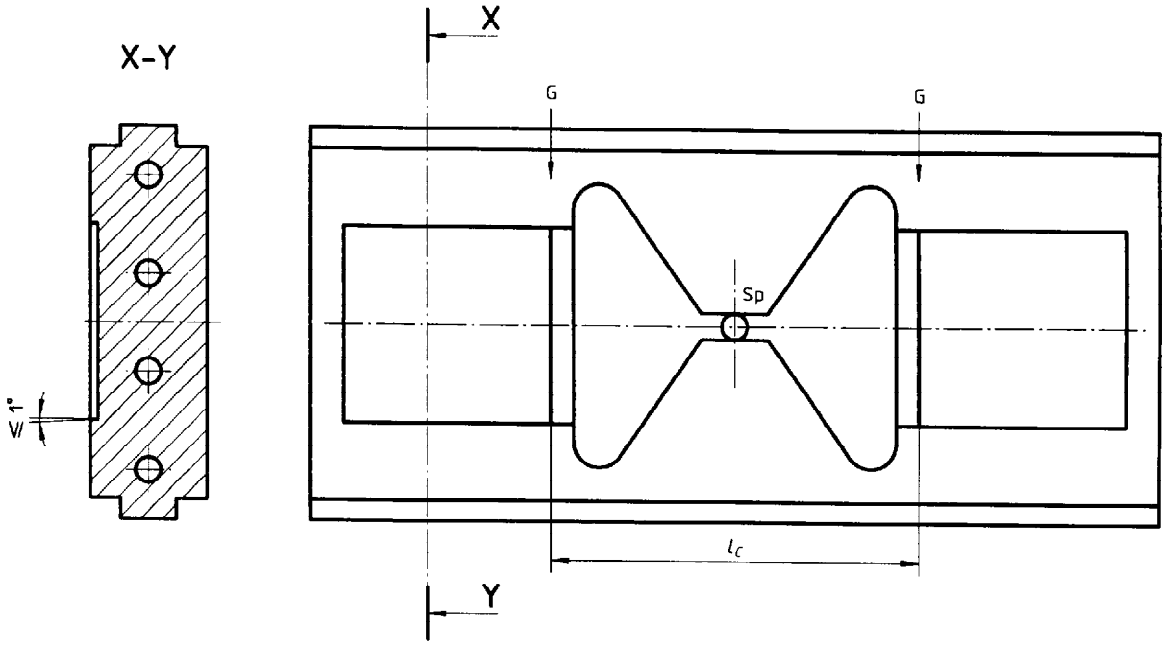
5) The position of the pressure sensor shall be further limited by the following conditions:

$l_P + r_P \leqslant 10$

$l_P - r_P \geqslant 0$

where r_P is the radius of the sensor.

Figure 1 — Details of type D1 and D2 ISO moulds



Key

Sp	Sprue	Moulding volume $V_M \approx 30\,000$ mm³ (at 2 mm thickness)
G	Gate	Projected area $A_P \approx 11\,000$ mm²
l_C	is the distance between the lines along which the test specimens are cut from the runners (see notes 4 and 5 to subclause 4.1)	

Figure 2 — Cavity plate for type D1 and D2 ISO moulds

The main constructional details of type D1 and D2 ISO moulds shall be as shown in Figures 1 and 2 and shall meet the following requirements:

a) See ISO 10724-1:1998, subclause 4.1.4, item a).

b) Not applicable.

c) See ISO 10724-1:1998, subclause 4.1.4, item c).

d) and e) Not applicable.

f) See ISO 10724-1:1998, subclause 4.1.4, item f), but without the last part of the second sentence.

g) See ISO 10724-1:1998, subclause 4.1.4, item g), but with reference to ISO 6603.

The main dimensions, in millimetres, of the cavities shall be as follows (see also Figure 1):

- Length: 60 to 62;
- Width: 60 to 62;
- Depth: type D1 mould 1,0 to 1,1
  type D2 mould 2,0 to 2,1.

h) to j) See ISO 10724-1:1998, subclause 4.1.4, items h) to j).

k) Figure 1 shows the position of a pressure sensor P within the cavity, which is mandatory for the measurement of moulding shrinkage only (see ISO 2577). It may be useful, however, in controlling the injection period with any ISO mould [see ISO 10724-1:1998, subclause 4.1.4, item k)]. The pressure sensor shall be flush with the cavity surface in order to avoid interference of the melt flow.

l) See ISO 10724-1:1998, subclause 4.1.4, item l).

m) See ISO 10724-1:1998, subclause 4.1.4, item m), and annex C of this part of ISO 10724.

n) See ISO 10724-1:1998, subclause 4.1.4, item n), and annex D of this part of ISO 10724.

NOTES

1 The height and length of the gate strongly influence the process of curing of the melt as it flows into the cavity, and hence the moulding shrinkage (see ISO 2577). The dimensions of the gate are therefore defined with tight tolerances.

2 Gates which are severely limited in height have a great influence on the orientation of the material within the cavity, even at large distances from the gate. The change in height at the gate has therefore been fixed at a value which facilitates subsequent measurement of the moulding shrinkage (see ISO 2577).

3 Separating the test specimens from the runner has to be done immediately after removal from the mould cavity. Otherwise, the plates will be irreversibly distorted due to the fact that the shrinkage of the runner and gate is different from that of the plate.

4 The value specified for the gate length l_G allows the two test specimens to be stamped or sawn from the runners with a fixed distance l_C between the cuts (see Figure 1), even when the moulding shrinkage varies from one material to another. (It has been shown that it is inadvisable to break off the test specimens from the runners immediately after removal of the mouldings from the mould because of the deformation this causes in the plates.)

5 The distance l_C between the lines along which the test specimens are cut from the runners (see Figure 1) is given by $l_C = 2(l_G + l_R + l^*)$ (see Figure 1). Taking this distance as 80 mm gives the advantage that the same cutting device can be used to cut 80 mm × 10 mm × 4 mm bars from the central sections of multipurpose test specimens [see ISO 10724-1:1998, subclause 4.1.3 and subclause 4.1.4, item l)].

4.2 Injection-moulding machine

See ISO 10724-1:1998, subclause 4.2, with the following exception:

In subclause 4.2.4, the recommended minimum locking force F_M for type D1 and type D2 ISO moulds is given by $F_M \geqslant 11000\, p_{max} \times 10^{-3}$; i.e. 880 kN for a maximum melt pressure of 80 MPa.

5 Procedure

5.1 Conditioning of material

See ISO 10724-1:1998, subclause 5.1.

5.2 Injection moulding

See ISO 10724-1:1998, subclause 5.2, but with the following new text in subclause 5.2.2:

For type D1 and D2 ISO moulds, it is recommended that the injection velocity v_I be chosen such that the injection time t_I is comparable to that used for the type A ISO mould.

6 Report on test-specimen preparation

The report shall include the following information:

a) a reference to this part of ISO 10724;

b) to h) see ISO 10724-1:1998, clause 6, items b) to h).

Annex A
(informative)

Recommended applications for small-plate test specimens or parts thereof

The type D2 ISO mould is recommended for the preparation of test specimens for use in determining multiaxial impact properties as described in ISO 6603 (see note 1 to this annex), in determining moulding shrinkage as described in ISO 2577, in preparing specimens of coloured plastics (see note 2), in studying the anisotropy of mechanical and thermal properties (see note 3) and, with the mould fitted with gate inserts, in studying the effects of weld lines (see annex B).

The type D1 ISO mould is especially suitable for producing test specimens for use in determining electrical properties (see note 4), water absorption (see note 5) and dynamic mechanical properties (see note 6).

NOTES

1 It is proposed that multiaxial impact strength be included with the mechanical properties in ISO 10350-1[7] and ISO 11403-1[8].The recommended specimen thickness is 2 mm.

2 Plate specimens produced from coloured or natural materials are suitable for use in determining optical and mechanical properties in order to study the influence of weathering in accordance with e.g. ISO 4892-2[4].

3 Type 4 tensile specimens as specified in ISO 8256[6], taken at different positions and orientated in different directions from the plate mouldings by machining in accordance with ISO 2818[3], are suitable for use in studying the anisotropy of mechanical properties by tensile and tensile-impact testing as described in ISO 527-1[2] and ISO 8256[6], respectively. Moreover, the anisotropy of thermal properties, especially the coefficient of linear thermal expansion, may be studied in analogous fashion by using parallel-sided test specimens (e.g. 10 mm wide) taken at different positions and in different directions as described above (see also reference [9]).

4 ISO 10350-1[7] recommends the measurement of the following electrical properties: relative permittivity and dissipation factor, volume resistivity and surface resistivity using plate specimens 2 mm thick and electric strength using 1-mm-thick and 2-mm-thick plates.

5 ISO 10350-1[7] recommends the measurement of water absorption as described in ISO 62[1] using a test specimen $\geq$ 1 mm thick in order to be able to determine the saturation values within a reasonable test time.

6 ISO 6721-2[5] describes the determination of the complex shear modulus using a torsion pendulum and specimens preferably with a thickness of 1 mm. These can be taken from plates produced by a type D1 ISO mould.

Annex B
(informative)

Weld lines

The effects of weld lines on mechanical properties can be studied by fitting suitable inserts in the mould cavities (see Figures B.1 and B.2).

Figure B.1 shows a single insert (hatched) near the gate, the weld line (shown by a continuous line) from which is formed between the two parallel melt flows produced (shown by dotted lines). Type 4 tensile-bar specimens as specified in ISO 8256[6] can be machined from the moulding, allowing the effect of the weld line to be studied, using tensile or tensile-impact testing in accordance with ISO 527-1[3] and ISO 8256[7], as a function of the distance from the insert (dotted lines).

Figure B.2 shows the use of a multiple insert (hatched) which generates weld lines (shown by continuous lines) from opposed melt flows, each weld line representing a flow path of a different length.

The parallel melt flows shown in Figure B.1 and the opposed ones in Figure B.2 represent the two basic types of weld-line formation. In each case, only symmetrical arrangements of the two-cavity mould should be used.

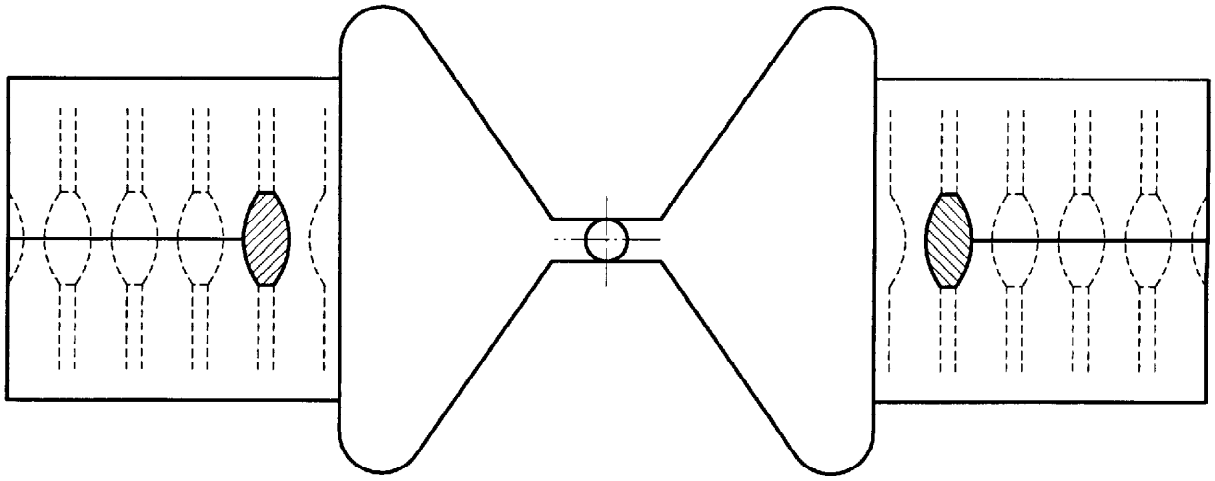


Figure B.1 — Moulding produced using single inserts (hatched), showing the locations from where tensile specimens can be taken (dashed lines)

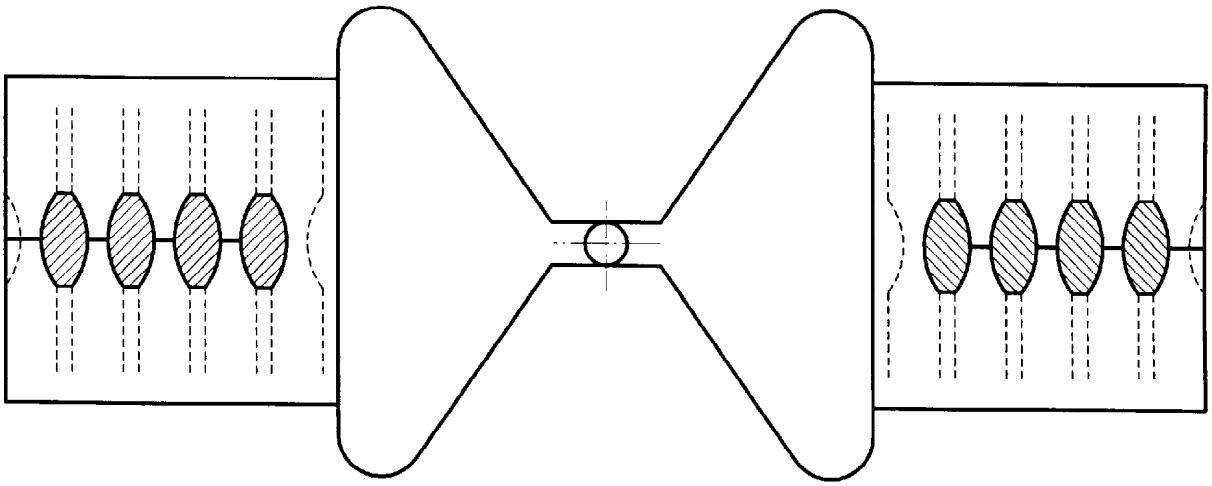


Figure B.2 — Moulding produced using multiple inserts (hatched), showing the locations from where tensile specimens can be taken (dashed lines)

Annex C
(informative)

Marking of test specimens

The purpose of marking is to enable the following to be determined (even if the runners have been cut off from the mouldings):

— the original positions of the two mouldings in the cavities;

— which side is the top and which is the bottom of the two test specimens (because it may be important for the results of e.g. multi-axial impact properties if the top or underside is located in the tensile-stress area during loading);

— the orientation, as well as which side is the top and which is the bottom, of e.g. 60 mm × 10 mm × 1 mm or 60 mm × 10 mm × 2 mm bars which have been taken from the mouldings either parallel (p) or normal (n) to the melt flow direction (e.g. to study the influence of filler or reinforcement orientation on certain mechanical properties).

The markings used, and their positions in the mould cavities, should preferably be as follows [see Figure C.1 and ISO 10724-1:1998, subclause 4.1.4, item m)]:

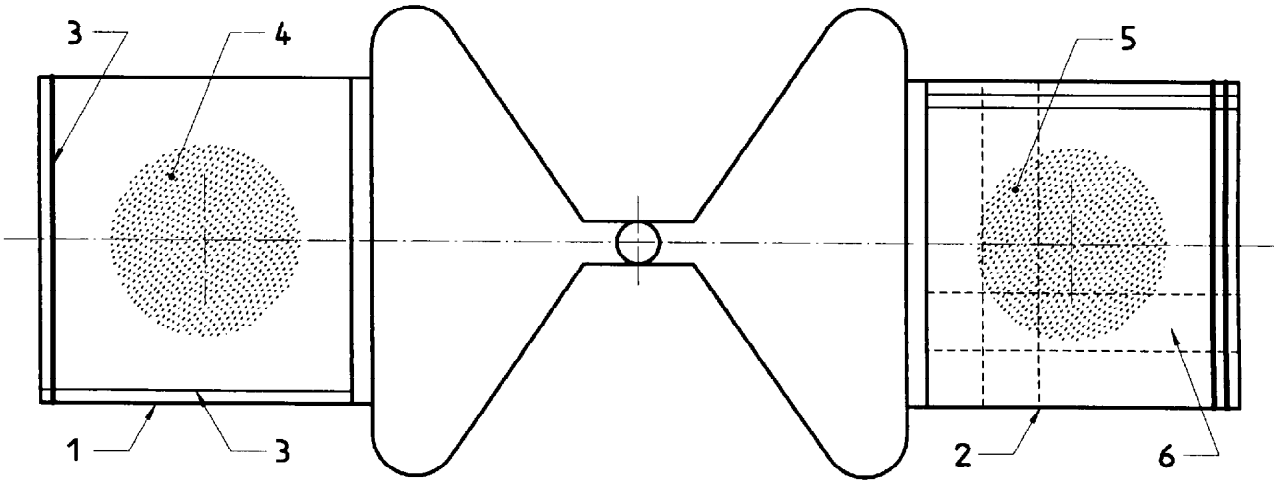
— lines parallel and close to the edges of the cavities should be used instead of numbers: two single lines (along two different edges perpendicular to each other) should be used to indicate cavity "1" and two pairs of parallel lines (also along two different edges perpendicular to each other) to indicate cavity "2";

— the lines should be outside the test area of the specimen [see ISO 10724-1:1998, subclause 4.1.4, item h)];

— the lines running in the melt flow direction should by disposed assymetrically with respect to the centre of the mould plate so that these lines run along the same edge (e.g. the left-hand edge) of their cavity when viewed in the flow direction;

— the width of the lines running parallel to the flow direction should be significantly smaller than the width of those running normal to the flow direction (which means that thin lines on a bar taken from a moulding will always indicate that it has been taken normal to the flow direction and broad lines will indicate that it has been taken parallel to the flow direction, thus precluding any confusion);

— the lines should be just visible (i.e. not very deeply "engraved") to avoid any damage to the mould cavity surface and to avoid the moulding sticking when removed.



Key
1 Cavity 1
2 Cavity 2
3 Marking line
4 Test area (∅ 50 mm)
5 "n"-specimen
6 "p"-specimen

Figure C.1 — Positions of the markings for cavities "1" and "2"

Annex D
(informative)

Bibliography

[1] ISO 62:—[4], *Plastics — Determination of water absorption.*

[2] ISO 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles.*

[3] ISO 2818:1994, *Plastics — Preparation of test specimens by machining.*

[4] ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources.*

[5] ISO 6721-2:1994, *Plastics — Determination of dynamic mechanical properties — Part 2: Torsion-pendulum method.*

[6] ISO 8256:1990, *Plastics — Determination of tensile-impact strength.*

[7] ISO 10350-1:1998, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials.*

[8] ISO 11403-1:1994, *Plastics — Acquisition and presentation of comparable multipoint data — Part 1: Mechanical properties.*

[9] ISO 11403-2:1995, *Plastics — Acquisition and presentation of comparable multipoint data — Part 2: Thermal and processing properties.*

4) To be published. (Revision of ISO 62:1980)

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