INTERNATIONAL STANDARD 293

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Plastics — Compression moulding test specimens of thermoplastic materials

Matières plastiques — Moulage par compression des éprouvettes en matières thermoplastiques

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 293 was drawn up by Technical Committee ISO/TC 61, *Plastics*. It was submitted directly to the ISO Council, in accordance with clause 6.12.1 of the Directives for the technical work of ISO.

This International Standard cancels and replaces ISO Recommendation R 293-1963, which had been approved by the Member Bodies of the following countries :

Argentina	Hungary	Poland
Australia	India	Romania
Austria	Israel	Spain
Belgium	Italy	Sweden
Burma	Japan	Switzerland
Chile	Mexico	United Kingdom
Czechoslovakia	Netherlands	U.S.A.
Germany	Portugal	U.S.S.R.

The Member Body of the following country had disapproved the Recommendation :

France

Printed in Switzerland

Plastics — Compression moulding test specimens of thermoplastic materials

1 SCOPE AND FIELD OF APPLICATION

This International Standard lays down the general principles to be followed when compression moulding test specimens of thermoplastic materials. The exact conditions required to prepare adequate specimens vary for each material. These conditions are properly a part of the specification for the material, or should be agreed upon by the seller and the purchaser.

2 GENERAL

The principal stages in the compression moulding process for thermoplastics are the following :

a) raising the temperature of the material to a level where application of pressure can cause sufficient flow without thermal decomposition taking place;

b) application of pressure to the material, causing it to flow and assume the shape of the mould in which it is contained;

c) cooling the material to a temperature at which the moulding can be removed from the mould without distortion taking place.

3 SUITABLE TYPES OF MOULDS

Types of moulds which have been found suitable for use when compression moulding thermoplastics are described below and shown schematically in figures 1 to 5.

3.1 A simple type of mould which is suitable for many thermoplastics is the three-plate frame type, examples of which are shown in figures 1 and 2.

3.2 A variation of the three-plate mould is the two-plate type, in which the centre and lower plates are combined. An example of this type of mould is shown in figure 3.

3.3 A further variation of the two-plate mould is shown in figure 4. In this case, the upper plate has a plunger or force which fits into the cavity in the lower plate. This enables materials of higher bulk factor to be moulded.

All three moulds, described in 3.1, 3.2 and 3.3, are heated indirectly by means of heated platens.

3.4 Another type of mould is one which is fixed permanently in a press and which is cored to allow direct heating and cooling of the mould. An example is shown in figure 5.

The choice of mould type, and actual design and manufacture of the moulding device, depend on the material to be tested, the dimensions of the test specimen to be moulded and other considerations of practical convenience. The surfaces of the mould in immediate contact with the moulding material should be anticorrosive and polished.

4 PROCEDURE

4.1 Means of heating

A satisfactory and convenient method of heating is by means of high-pressure steam. This method combines the advantage of rapid heating with avoidance of "hot spots". Platens and fixed moulds should be cored or channeled to allow heating by passing steam through them. The channels should be as large and as numerous as possible in order to ensure rapid and uniform heating while still maintaining the required strength and rigidity of the mould.

Another convenient method of heating involves the use of electrical resistance heaters. This method permits higher temperatures than can be attained with steam. Care should be taken in design and construction to provide maximum heat without the occurrence of "hot spots" and to maintain rigidity of the plates.

The choice of the method of heating depends largely on the services available and the temperature required to mould a particular material.

Cooling is most conveniently accomplished by passing cold water through channels provided for the purpose.

4.2 Temperature measurement

Temperature should be measured in the parts of the mould by thermocouples or thermometers or other suitable means, at positions in the mould as near as possible to the mould surface and/or at positions in the platens near their surfaces.

4.3 Temperature control

When test specimens are prepared, the moulding temperature, as indicated by the thermocouples or thermometers in the parts of the mould or both platens, should not vary by more than ± 3 °C from the specified or agreed moulding temperature (see note below). The mean value of both is considered the moulding temperature.

NOTE – In some circumstances it may prove necessary to exercise closer control on temperature than ± 3 °C, but in general this tolerance will be found adequate.

4.4 Moulding cycle

The main steps in the compression-moulding cycle are as follows :

4.4.1 With the mould heated to the required temperature, load an appropriate amount of material into it. The mass of the mould charge should be sufficiently greater than the mass of the finished moulding to compensate for any flash loss.

4.4.2 Close the press so that the material is under light pressure (approximately 0,4 MPa), while the mould is returning to the required temperature.

4.4.3 Maintain the temperature and light pressure for a period of time sufficient to ensure that the material has reached a relatively free-flowing state. A period of 5 to 15 min will normally be sufficient.

4.4.4 After the preheating period, increase the pressure and commence cooling. The exact rate of increase in pressure and the exact time that cooling commences (i.e. whether immediately prior to or at some time after increase of pressure) will depend on the shape of the moulding and the material to be moulded. The pressure is increased to a value of not less than 3,5 MPa. The pressure shall be held constant during cooling and the rate of cooling should be controlled and reproducible.

For the avoidance of bubbles, voids, etc., the pressure may be removed momentarily between the preheating period and the application of the increased pressure.

NOTE – For the purpose of this International Standard, the moulding pressure is calculated by dividing the total force exerted by the press on the moulding (or mouldings) by the projected area of the moulding (or mouldings).

4.4.5 Remove the moulding from the mould as soon as it has cooled sufficiently to allow removal without distortion taking place.

The compression-moulding process should give test specimens almost free from stress and orientation and free from voids and bubbles. In many cases, flow lines and granular boundaries will be visible. Unless very pronounced, such phenomena are not considered objectionable. It is noted, nevertheless, that all such manifestations, bubbles, flow lines, etc., are potential sources of erroneous results. Whenever post-moulding treatments are deemed necessary, for example heating (annealing), etc., they should be as agreed upon between seller and purchaser, and should be suitably stated in the report (see clause 6).

NOTE – The use of release agents is not usually recommended. When necessary, thin aluminium sheets (0,1 mm thick), cellophane or polyester films may be used as separators between the moulding and the surfaces of the cavity.

5 COMMENTS APPLICABLE TO SEVERAL CLASSES OF MATERIAL

5.1 Polyvinyl chloride plastics

In order to obtain optimum mechanical properties from specimens compression-moulded from materials based on polyvinyl chloride and copolymers of vinyl chloride, it is recommended that the mould charge be in the form of sheet rather than granules. If the material is in granular form, it shall be sheeted by milling at a suitable temperature before the moulding operation is carried out. The milling time shall be the minimum necessary to form the material into a continuous homogeneous sheet. This precaution is necessary because of the difficulty of adequately fusing together granulates of polyvinyl chloride materials by the compression-moulding process.

NOTE – The milling operation will be described in another International Standard.

The sheet is cut into strips of such size that they can be placed in the mould cavity and alternate strips are laid crosswise to prevent anistropy in the moulding.

Compression-moulding temperatures vary with plasticizer content and polymer type but should normally range from 150 °C (plasticized) to 190 °C (unplasticized). Moulding pressures should range from 5 to 10 MPa.

5.2 Polyethylene plastics

Polyethylene compounds are characterized by a high shrinkage on cooling and this requires special care to be taken in the cooling and application of pressure, if voids are to be prevented. The rate of cooling is an important variable affecting crystallite formation and such properties as density and resistance to stress cracking. In designing moulds, allowance for shrinkage must be taken into consideration.

Compression-moulding temperature varies with the grade of polyethylene, but should normally be within the range 135 to 175 °C.

5.3 Polystyrene plastics

Compression-moulding temperatures vary with type and grade of polystyrene plastics, but should normally be within the range 160 to 210 °C.

5.4 Cellulosic plastics

Cellulosic plastics are characterized by a tendency to absorb moisture on storage, and it may, therefore, be necessary to dry the material before moulding. Drying in trays for a period of 3 h, in layers of approximately 10 mm thickness, at a temperature of 70 °C, should usually be sufficient.

Compression-moulding temperatures can vary widely with grade of materials. The moulding temperature should normally be within the range 140 to 240 °C.

6 REPORT OF MOULDING CONDITIONS

The report of the moulding conditions shall include the following particulars :

a) date of moulding;

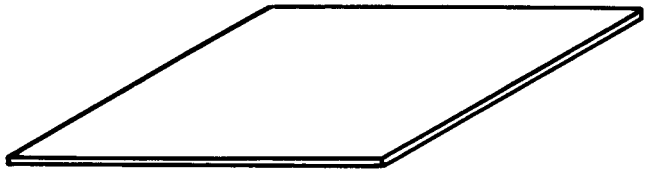
b) complete identification of material moulded;

c) type of mould used;

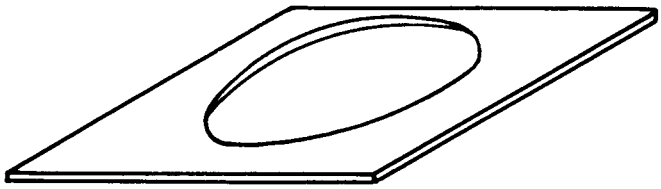
d) details of

- moulding temperature,
- preheating time,
- moulding pressure,
- physical form of moulding material,
- preheating or other pre-treatment of moulding materials,
- post-moulding treatment, if used by agreement,
- release agent, if used;

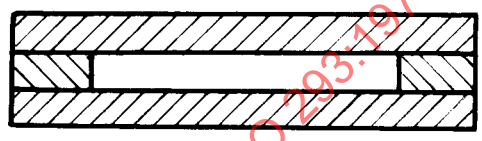
e) any other relevant details.



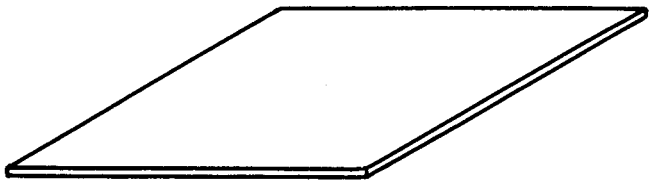
Upper plate



Centre plate (frame)



Section



Lower plate

FIGURE 1 — **Simple three-plate mould**

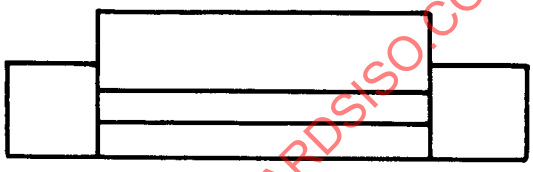


FIGURE 2 — **Simple three-plate mould**

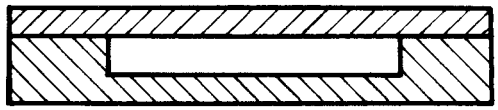


FIGURE 3 — **Section of simple two-plate mould**

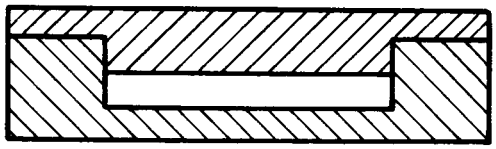


FIGURE 4 — **Section of two-plate mould for increased volume of load**

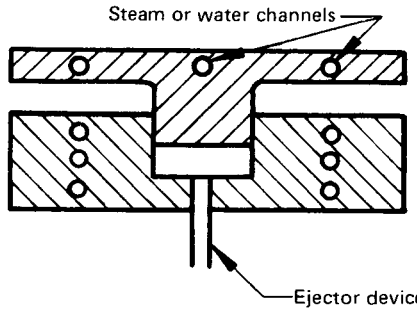


FIGURE 5 — **Section of mould cored for steam heating and water cooling**