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R 293

PLASTICS
COMPRESSION MOULDING TEST SPECIMENS OF THERMOPLASTIC MATERIALS

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BRIEF HISTORY

The ISO Recommendation R 293, *Plastics—Compression Moulding Test Specimens of Thermoplastic Materials*, was drawn up by Technical Committee ISO/TC 61, *Plastics*, the Secretariat of which is held by the American Standards Association, Inc. (ASA).

Work on this question by the Technical Committee began in 1954 and led, in 1958, to the adoption of a Draft ISO Recommendation.

In october 1959, this Draft ISO Recommendation (No. 318) was circulated to all the ISO Member Bodies for enquiry. It was approved by the following Member Bodies:

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.

One Member Body opposed the approval of the Draft:

France.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in February 1963, to accept it as an ISO RECOMMENDATION.

ISO Recommendation R 293 February 1963

PLASTICS

COMPRESSION MOULDING TEST SPECIMENS OF THERMOPLASTIC MATERIALS

1. SCOPE

This ISO Recommendation covers only 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 plastics material. These conditions are properly a part of the specification for the material, or should be agreed upon by the seller and the purchaser.

NOTE. — It may be necessary to treat the moulding granules in some manner, prior to preparation of test specimens. Preheating, drying, etc. are often required, particularly with those plastics which absorb moisture.

2. GENERAL

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

(1) Raising of the temperature of the material to a level where application of pressure can cause sufficient flow without thermal decomposition taking place,

(2) Application of pressure to the material, causing flow and assuming the shape of the mould in which it is contained,

(3) Cooling of 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 thermoplastic materials are described below and shown schematically in Figures 1 to 4 (page 5).

3.1 A simple type of mould which is suitable for many thermoplastic materials is the three-plate, frame type, examples of which are shown in Figures 1 and 1 A. In the interests of combining simplicity with reproducibility of results between testing organizations, this is the preferred type. However, other types, such as those described in clauses 3.2, 3.3 and 3.4 below, are not excluded.

3.2 A variation of the three-plate mould is the two-plate type, in which the center and lower plates are combined. An example of this type of mould is shown in Figure 2.

3.3 A further variation of the two-plate mould is shown in Figure 3. In this case, the upper plate has a plunger or force which fits into the cavity in the lower plate. This enables materials of high bulk factor to be moulded.
All three moulds, described in clauses 3.1, 3.2 and 3.3, are heated indirectly by means of heated platens.

3.4 Another type of mould, which is usually larger and more complicated than the three previous types, 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 4.
While the simpler types of mould described in clause 3.1 are preferred, all four types of mould can give satisfactory test specimens. 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.

4. PROCEDURE

4.1 Means of heating

A satisfactory and convenient method of heating is by means of high-pressure steam (see Note below). This method combines the advantage of rapid heating with avoidance of "hot spots". Plates and fixed moulds should be cored or channeled to provide heating by means of passing steam through them. The channels should be as large and as numerous as possible in order to insure rapid and uniform heating and still maintain the required strength and rigidity of the mould.

NOTE: Steam heating is inadequate for high heat resistant materials, such as fluoro-carbons.

Another convenient method of heating involves the use of electrical resistance heaters. This method is slower than steam, but has the advantages of cleanliness and simplicity. Care should be taken in the design and construction to provide maximum heat without the occurrence of "hot spots" and to maintain rigidity of the plates.
Cooling is most conveniently accomplished by passing cold water through channels provided for the purpose.

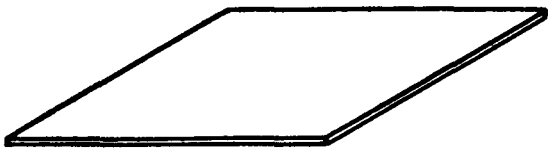
4.2 Temperature measurement

Temperature should be measured in both parts of the mould by means of 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 plates near the surface of the plates. It is not sufficient to estimate the mould temperature from the pressure of the steam used.

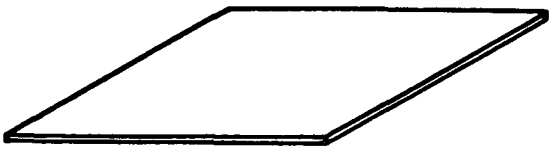
4.3 Temperature control

When test specimens are prepared, the moulding temperature, as indicated by the thermocouples or thermometers in both parts of the mould or both plates, should not vary by more than $\pm$ 2.5 °C from the specified or agreed moulding temperature (see Note below). The mean value of both is considered the moulding temperature.

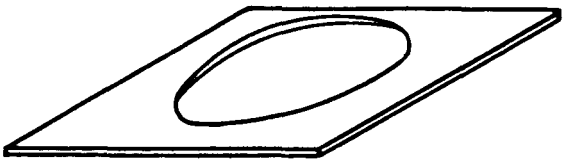
NOTE. — In some circumstances it may prove necessary to exercise a closer control on the temperature than $\pm$ 2.5 °C, but in general this tolerance will be found adequate.



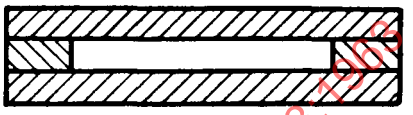
Upper plate



Lower plate



Center plate (frame)



Section

FIG. 1. — **Simple three-plate mould**

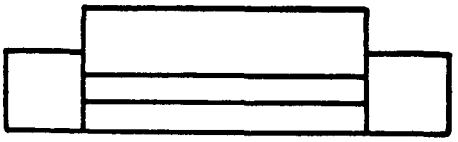


FIG. 1 A. — **Simple three-plate mould**

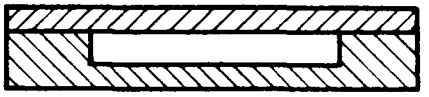


FIG. 2. — **Section of simple two-plate mould**

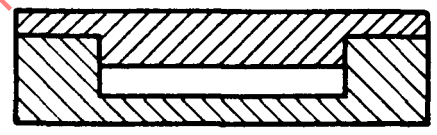


FIG. 3. — **Section of two-plate mould for increased volume of load**

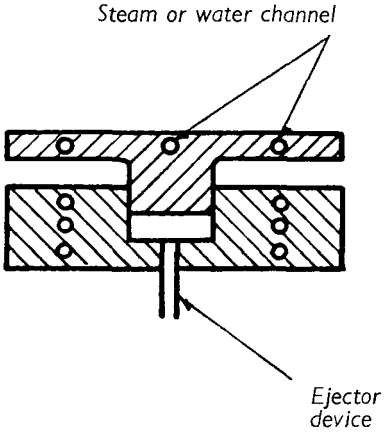


FIG. 4. — **Section of mould cored for steam heating and water cooling**

4.4 Moulding cycle

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

4.4.1 Place an appropriate weight of material in the mould, the mould being at the temperature required for moulding.

4.4.2 Close the press so that the plastics material is under light pressure (4 kgf/cm² or less), while the moulds or plates are 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 minutes 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 35 kgf/cm².

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

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, e.g., temperature (annealing), etc., they should be as agreed upon between seller and purchaser, and should be suitably stated in the report (see Section 6).

NOTE. — For the purpose of this moulding practice, the moulding pressure is calculated by dividing the total force exerted by the press on the moulding (or mouldings) in kilogrammes-force by the projected area of the moulding (or mouldings) in square centimetres.

This area includes any flash on which pressure is exerted.

5. COMMENTS APPLICABLE TO SPECIAL CLASSES OF MATERIAL

5.1 Polyvinyl chloride and copolymers of vinyl chloride

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 material used be in the form of sheet and not in the form of granules or small particles. If the material is not in the form of sheet, it should be sheeted by milling at a suitable temperature before the moulding operation is carried out. The milling time is the minimum 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.

In order to prevent anisotropy, the strips to be moulded are arranged in the form of a cross.

Compression-moulding temperatures vary with plasticizer content and polymer type but should normally be within the range 125 to 190 °C.