INTERNATIONAL STANDARD 294

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Plastics — Injection moulding test specimens of thermoplastic materials

Matières plastiques — Moulage par injection 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 294 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 294-1963, which had been approved by the Member Bodies of the following countries :

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

The Member Bodies of the following countries had expressed disapproval of the document on technical grounds :

France
Switzerland*

* Subsequently, this Member Body approved the revision constituted by the present International Standard.

Printed in Switzerland

Plastics — Injection moulding test specimens of thermoplastic materials

1 SCOPE AND FIELD OF APPLICATION

This International Standard lays down the general principles to be followed when injection moulding test specimens of thermoplastic materials. Its purpose is to promote uniformity in describing the various components of the moulding operation, and also to establish uniform practices in reporting test conditions. The exact conditions required to prepare satisfactory test specimens vary for each plastic material. They should be a part of the specification for the material or be agreed between the interested parties.

NOTE — There are many factors present in injection-moulding machines that may influence the characteristics of mouldings and the numerical values of test results. Among those which may have an effect are the geometry and the temperature conditions of the heating cylinder, the pressures applied, the size and shape of runners and gates, the mould temperature, and the time cycle used. Also, it may be necessary to treat the moulding granules in some manner prior to preparation of test specimens. Preheating, drying, etc., are sometimes required, particularly with those plastics which absorb moisture.

2 APPARATUS

2.1 Moulds

The moulds shall be of the general design shown in the specifications for moulds for injection-moulded thermoplastic test specimens[1], unless it can be demonstrated that similar test results are obtained with specimens made in moulds of other design.

2.2 Injection-moulding machine

The mould shall be mounted in a suitable injection-moulding machine preferably operated hydraulically, although combinations of hydraulic and mechanical systems may be used provided that provision is made to measure and control the following :

a) feed of material to the injection cylinder;

b) injection pressure;

c) temperature of heating cylinder;

d) temperature of the plastic material;

e) mould temperature;

f) moulding cycle.

3 CONDITIONING

3.1 Material

If the plastic material must be conditioned before moulding, this shall be done as directed by the material specification, as recommended by the material supplier, or as agreed between the interested parties. Conditioning includes any prewarming and/or predrying which may be necessary.

3.2 Test specimens

Unless otherwise agreed, the moulded test specimens are to be conditioned as prescribed either by the appropriate material specification or by the designated test method. Conditioning also includes any required after-treatment such as drying, baking, and/or annealing.

4 PROCEDURE

4.1 Feed

The injection-moulding machine shall be set to feed the required amount of plastic material to the injection cylinder for each moulding cycle.

1) To be standardized later.

4.2 Injection pressure

The injection pressure shall be held constant for moulding given sets of test specimens. For hydraulically operated machines, the pressure in the injection cylinder shall be measured by means of suitable gauges.

NOTE – For an injection-moulding machine with a ram piston, the injection pressure may be calculated as follows :

$$\text{injection pressure} = \frac{\text{area of ram} \times \text{hydraulic pressure or mechanical force}}{\text{area of injection ram}}$$

The injection pressure is the total pressure applied to the plastic material.

NOTE – The actual pressure on the plastic in the mould cavity will be less than this pressure. Pressure will be lost in compacting the granules and in moving the material through the heating zone and through the sprues, runners and gates. However, if the applied pressure is kept constant, the actual maximum mould pressure should be constant provided that the moulding cycle and the feed of plastic granules remain unchanged. This will apply to only one set of operating conditions of temperature, moulding cycle time, etc., of a given moulding machine.

4.3 Injection cylinder temperature

Cylinder temperature shall be controlled by any suitable means. Usually, what is actually measured and controlled is the temperature of some particular point on the metal wall of the cylinder. This temperature will often vary by several degrees due to simple on-and-off types of controls. This may cause variation in the property being measured, even though all of the mouldings appear satisfactory.

4.4 Plastic (stock) temperature

The actual temperature of the plastic material can be determined by opening the moulding machine as for a "free shot" and inserting a needle thermocouple through the nozzle and into the plastic mass. Care shall be exercised to keep the point of the needle away from any metal surface. This temperature shall be measured after the machine has been operated under the selected conditions for several cycles. It is recommended that twice the cylinder capacity be moulded under test conditions, in order to ensure uniformity.

An alternative method of determining the temperature of the plastic material consists in injecting the "free shot" into a suitable container and immediately inserting the thermocouple into the hot plastic mass.

NOTE – Under a fixed set of operating conditions, there will generally be a constant difference between the observed plastic temperature and the cylinder wall temperature. This difference will vary as conditions are changed.

4.5 Mould temperatures

Mould temperatures, including both cavities and runners, are controlled by circulating suitable liquids through the parts of the mould. They may be measured with a carefully calibrated surface pyrometer accurate to $\pm 1{,}5\ ^{\circ}C$. The thermocouple of the pyrometer shall make good contact at any given point on the surface of the mould until the needle of the dial scale reaches equilibrium. Readings shall be taken at several points on each half on the mould and be recorded individually.

4.6 Moulding cycle

While most injection-moulding machines employ reciprocating screws, there are simple plunger systems which have a different moulding cycle. Furthermore, various kinds of timer are used and different portions of the moulding cycle are timed. Under these circumstances, it is necessary to establish certain concepts and definitions so that the cycles may be uniformly described in reports. These concepts and definitions are given in 4.6.1 to 4.6.7 and are shown in the figure.

4.6.1 starting point; zero time : The instant the mould starts to close.

4.6.2 injection time D : The interval of time from closing of the mould until the mould cavity is filled.

NOTE – With screw-injection machines, filling of the mould commences as soon as the screw, now functioning as a plunger, begins its forward movement.

With plunger-type machines, it takes a measurable amount of time for the plunger to advance, compress the granules, and then build up pressure. If the machine is opened, the time from the plunger starting to go forward to the appearance of plastic flow from the nozzle can be measured. This "dead time" varies from one machine to another and with granular density, size of shot, etc.

4.6.3 pressure dwell time H : The interval from the time the cavity is filled until the screw or plunger begins to retract.

4.6.4 cooling time E : The elapsed time from the beginning of pressure dwell time until the mould opens and the moulded piece is ejected. Cooling time includes not only the pressure dwell time but also the time needed to retract the plunger or screw before the latter starts to plasticate material for the next shot. Increased cooling time may be necessary if the moulded piece is not rigid enough to be ejected without deformation.

4.6.5 mould closed time B : The interval beginning immediately after closing of the mould and ending as soon as the mould begins to reopen.

4.6.6 mould open time C : The interval during which the mould is open. It includes the time needed to open and close the mould.

NOTE – It may be necessary to increase this interval if the plastic material needs to remain longer in the heating cylinder before the next cycle is started.

4.6.7 total cycle time A : The sum of mould closed time and mould open time. It is the total time from one point of one cycle to the same point of the next cycle.

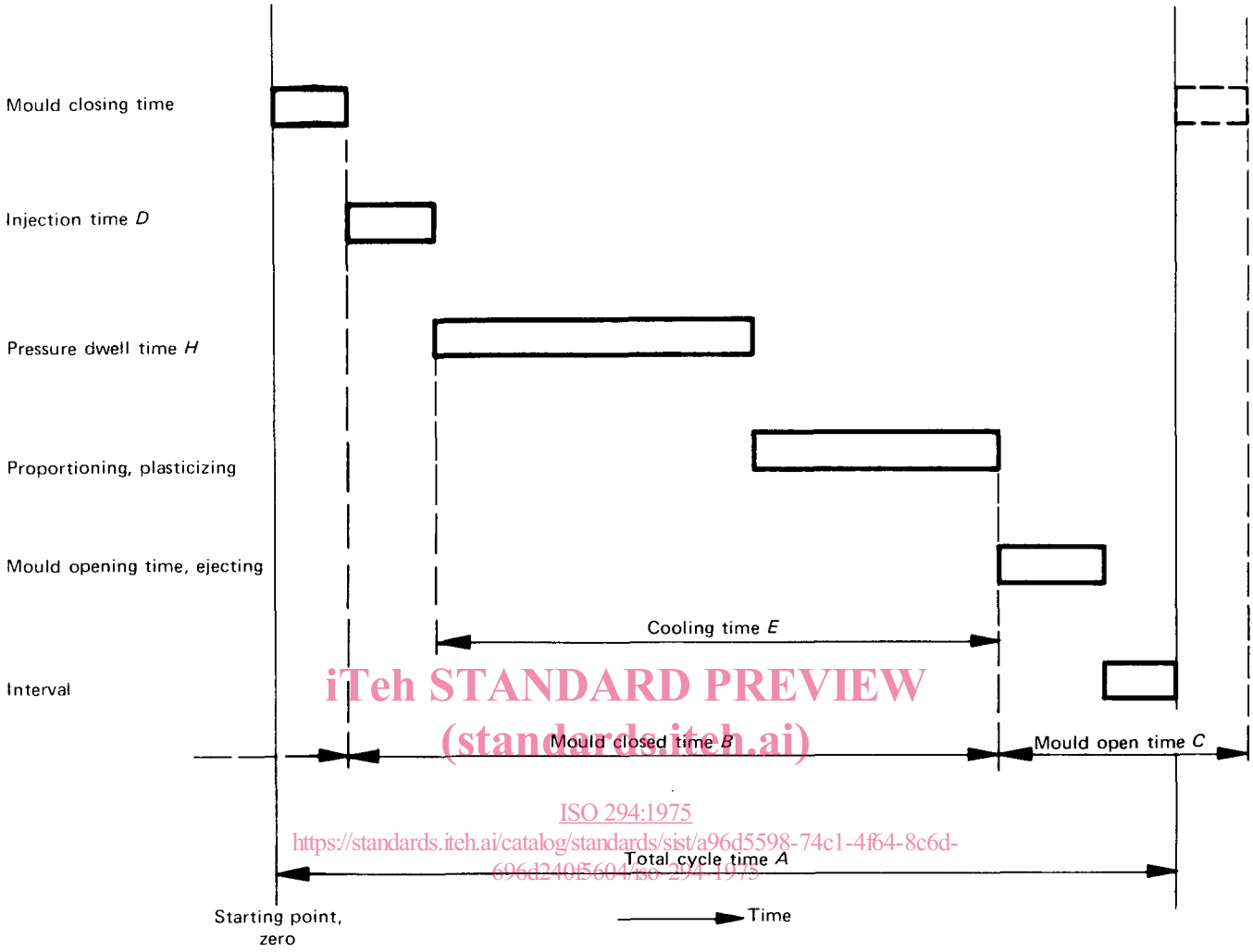

FIGURE — **Moulding cycle**

4.7 Number of mouldings

The total number of mouldings to be made depends upon the number of test specimens required and upon the need to reach moulding equilibrium so that test specimens produced are all truly made under one set of conditions.

The cycles must be repeated enough times so that steady conditions hold. Interruptions disturb this equilibrium, so that a number of mouldings must be discarded after each operation change.

5 REPORT

The report shall include the following items :

a) date, place and time of moulding;

b) material (type, designation, pre-treatment and, if relevant, moisture content);

c) mould (specimen, description, number of cavities per shot, nozzle size, nozzle location in relation to test specimen and description);

d) injection-moulding machine (make of machine, rated capacity, maximum practical shot, cylinder capacity, control system);

e) moulding conditions (machine-temperature settings, measured temperature of plastic material, mould surface temperatures, injection pressure, total cycle, mould open time, mould closed time, injection time, pressure dwell time, cooling time, clamping pressure);

f) other relevant details (mass of moulding plus sprue plus runners, number of mouldings made, number of mouldings discarded before selection of specimens, etc.).