Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics

(ISO 1133 : 1997)

English version of DIN EN ISO 1133

DIN EN ISO 1133

ICS 83.080.20

Supersedes DIN ISO 1133, February 1993 edition.

Kunststoffe – Bestimmung der Schmelze-Massefließrate (MFR) und der Schmelze-Volumenfließrate (MVR) von Thermoplasten (ISO 1133 : 1997)

European Standard EN ISO 1133 : 1999 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been published in accordance with a decision taken by CEN/TC 249 to adopt, without alteration, International Standard ISO 1133 as a European Standard.

The responsible German body involved in its preparation was the *Normenausschuss Kunststoffe* (Plastics Standards Committee), Technical Committee *Physikalische, rheologische und analytische Prüfungen*.

The DIN Standards corresponding to the International Standards referred to in clause 2 of the EN are as follows:

ISO Standard	DIN Standard(s)
ISO 1622-1	DIN 7741-1 and DIN EN ISO 1622-1
ISO 1872-1	DIN 16776-1 and DIN EN ISO 1872-1
ISO 1873-1	DIN EN ISO 1873-1
ISO 2580-1	DIN 16772-1 and DIN EN ISO 2580-1
ISO 2897-1	DIN 16771-1 and DIN EN ISO 2897-1
ISO 4613-1	DIN 16778-1 and DIN EN ISO 4613-1
ISO 4894-1	DIN 16775-1 and DIN EN ISO 4894-1
ISO 6402-1	DIN 16777-1 and DIN EN ISO 6402-1
ISO 6507-1	DIN EN ISO 6507-1
ISO 7391-1	DIN 7744-1
ISO 8257-1	DIN 7745-1
ISO 8986-1	DIN EN ISO 8986-1
ISO 9988-1	DIN 16781-1
ISO 10366-1	DIN EN ISO 10366-1

Amendments

ISO 1133 having been adopted as a European Standard, the status of the corresponding DIN Standard (DIN ISO 1133) has been changed accordingly.

Previous editions

DIN 53735: 1970-08, 1977-11, 1983-01, 1988-02; DIN ISO 1133: 1993-02.

Continued overleaf.
EN comprises 15 pages.

Ref. No. DIN EN ISO 1133 : 2000-02
English price group 10 Sales No. 1110
07.00

National Annex NA

Standards referred to

(and not included in **Normative references** and **Annex ZA**)

DIN 7741-1	Polystyrene (PS) moulding materials – Classification and designation
DIN 7744-1	Polycarbonate (PC) moulding materials – Classification and designation
DIN 7745-1	Polymethyl methacrylate (PMMA) moulding materials – Classification and designation
DIN 16771-1	Styrene/butadiene (SB) moulding materials – Classification and designation
DIN 16772-1	Acrylonitrile-butadiene-styrene (ABS) moulding materials – Classification and designation
DIN 16775-1	Styrene-acrylonitrile (SAN) moulding materials – Classification and designation
DIN 16776-1	Polyethylene (PE) moulding materials – Classification and designation
DIN 16777-1	Impact resistant acrylonitrile/styrene (ASA, AES, ACS) moulding materials (except for butadiene-modified moulding materials) – Classification and designation
DIN 16778-1	Plastics – Ethylene/vinyl acetate (EVAC) moulding and extrusion materials – Designation and specification
DIN 16781-1	Polyoxymethylene (POM) moulding materials – Classification and designation
DIN EN ISO 1622-1	Polystyrene (PS) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 1622-1 : 1994)
DIN EN ISO 1872-1	Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 1872-1 : 1993)
DIN EN ISO 1873-1	Polypropylene (PP) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 1873-1 : 1995)
DIN EN ISO 2580-1	Acrylonitrile/butadiene/styrene (ABS) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 2580-1 : 1997)
DIN EN ISO 2897-1	Impact-resistant polystyrene (PS-I) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 2897-1 : 1997)
DIN EN ISO 4613-1	Ethylene/vinyl acetate (E/VAC) moulding and extrusion materials – Part 1: Designation and specification (ISO 4613-1 : 1993)
DIN EN ISO 4894-1	Styrene/acrylonitrile (SAN) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 4894-1 : 1997)
DIN EN ISO 6402-1	Impact-resistant acrylonitrile/styrene (ASA, AES, ACS) moulding and extrusion materials, excluding butadiene-modified materials – Part 1: Designation system and basis for specifications (ISO 6402-1 : 1997)
DIN EN ISO 6507-1	Metallic materials – Vickers hardness test – Part 1: Test method (ISO 6507-1 : 1997)
DIN EN ISO 8986-1	Polybutene (PB) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 8986-1 : 1993)
DIN EN ISO 10366-1	Methyl methacrylate/acrylonitrile/butadiene/styrene (MABS) moulding and extrusion materials – Part 1: Designation system and basis for specifications (ISO 10366-1 : 1993)

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN ISO 1133

May 1999

ICS 83.080.20

English version

Plastics

Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics

(ISO 1133 : 1997)

Plastiques – Détermination de l'indice de fluidité à chaud des thermoplastiques, en masse (MFR) et en volume (MVR) (ISO 1133 : 1997)

Kunststoffe – Bestimmung der Schmelze-Massefließrate (MFR) und der Schmelze-Volumenfließrate (MVR) von Thermoplasten (ISO 1133 : 1997)

This European Standard was approved by CEN on 1999-04-16.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN ISO 1133 : 1999 E

Foreword

International Standard

ISO 1133 : 1997 Plastics – Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics,

which was prepared by ISO/TC 61 'Plastics' of the International Organization for Standardization, has been adopted by Technical Committee CEN/TC 249 'Plastics', the Secretariat of which is held by IBN, as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by November 1999 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 1133 : 1997 was approved by CEN as a European Standard without any modification.

NOTE: Normative references to international publications are listed in Annex ZA (normative).

1 Scope

1.1 This International Standard specifies a method for the determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastic materials under specified conditions of temperature and load. Normally, the test conditions for measurement of melt flow rate are specified in the material standard with a reference to this International Standard. The test conditions normally used for thermoplastics are listed in annexes A and B. The melt volume-flow rate will normally be found useful when comparing filled and unfilled thermoplastics. The melt flow rate can now be determined by automatic measurement provided the melt density at the test temperature is known.

This method is not applicable to thermoplastics for which the rheological behaviour is affected by phenomena such as hydrolysis, condensation or crosslinking.

1.2 The melt mass-flow rate and melt volume-flow rate of thermoplastics are dependent on the rate of shear. The rates of shear in this test are much smaller than those used under normal conditions of fabrication, and therefore data obtained by this method for various thermoplastics may not always correlate with their behaviour in actual use. Both methods are useful in quality control.

2 Normative references

The following standards 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 standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 468:1982, *Surface roughness — Parameters, their values and general rules for specifying requirement.*

ISO 1622-1:1994, *Plastics — Polystyrene (PS) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 1872-1:1993, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 1873-1:1995, *Plastics — Polypropylene (PP) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 2580-1:1990, *Plastics — Acrylonitrile/butadiene/styrene (ABS) moulding and extrusion materials — Part 1: Designation.*

ISO 2897-1:1990, *Plastics — Impact-resistant polystyrene (SB) moulding and extrusion materials — Part 1: Designation.*

ISO 4613-1:1993, *Plastics — Ethylene/vinyl acetate (E/VAC) moulding and extrusion materials — Part 1: Designation and specification.*

ISO 4894-1:1990, *Plastics — Styrene/acrylonitrile (SAN) copolymer moulding and extrusion materials — Part 1: Designation.*

ISO 6402-1:1990, *Plastics — Impact-resistant acrylonitrile/styrene moulding and extrusion materials (ASA, AES, ACS), excluding butadiene-modified materials — Part 1: Designation.*

ISO 6507-1:—[1], *Metallic materials — Vickers hardness test — Part 1: Test method.*

ISO 7391-1:—[2], *Plastics — Polycarbonate moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 8257-1:—[3], *Plastics — Poly(methyl methacrylate) (PMMA) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 8986-1:1993, *Plastics — Polybutene (PB) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 9988-1:1991, *Plastics — Polyoxymethylene (POM) moulding and extrusion materials — Part 1: Designation.*

ISO 10366-1:1993, *Plastics — Methyl methacrylate/acrylonitrile/butadiene/styrene (MABS) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

3 Apparatus

3.1 Basic apparatus

3.1.1 The apparatus is basically an extrusion plastometer operating at a fixed temperature. The general design is as shown in figure 1. The thermoplastic material, which is contained in a vertical cylinder, is extruded through a die by a loaded piston. The apparatus consists of the following essential parts:

3.1.2 Cylinder, fixed in a vertical position. The cylinder shall consist of a material resistant to wear and corrosion up to the maximum temperature of the heating system and shall be inert to the test sample. For particular materials, measurements may be required at temperatures up to 450 °C. The cylinder length shall be between 115 mm and 180 mm and the internal diameter 9,550 mm ± 0,025 mm. The base of the cylinder shall be thermally insulated in such a way that the area of the exposed metal is less than 4 cm^2, and it is recommended that an insulating material such as Al_2O_3 ceramic fibre or another suitable material be used in order to avoid sticking of the extrudate.

The bore shall be hardened to a Vickers hardness of no less than 500 (HV 5 to HV 100) (see ISO 6507-1) and shall have a surface roughness less than R_a (arithmetic mean discrepancy) = 0,25 μm (see ISO 468). If necessary, a piston guide shall be provided to keep friction caused by misalignment of the piston does not differ down to a level at which the actual load from the nominal load by more than ± 0,5 %.

3.1.3 Steel piston, having a working length at least as long as the cylinder. The piston shall have a head 6,35 mm ± 0,10 mm in length. The diameter of the head shall be less than the internal diameter of the cylinder by 0,075 mm ± 0,010 mm. The upper edge shall have its sharp edge removed. Above the head, the piston shall be

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1) To be published. (Revision of ISO 6507-1:1982, ISO 6507-2:1983, ISO 6507-3:1989, ISO 409-1:1982, ISO 409-2:1983 and ISO/DIS 409-3)

2) To be published. (Revision of ISO 7391-1:1987)

3) To be published. (Revision of ISO 8257-1:1987)

relieved to about 9 mm diameter. A stud may be added at the top of the piston to support the removable load, but the piston shall be thermally insulated from the load. Along the piston stem, two thin annular reference marks shall be scribed 30 mm apart and so positioned that the upper one is aligned with the top of the cylinder when the distance between the lower edge of the piston head and the top of the die is 20 mm. These annular marks on the piston are used as reference points during the determination (see 6.3 and 7.4).

To ensure satisfactory operation of the apparatus, the cylinder and the piston shall be made of materials of different hardness. It is convenient for ease of maintenance and renewal to make the cylinder of the harder material.

The piston may be either hollow or solid. In tests with lower loads, the piston shall be hollow, otherwise it may not be possible to obtain the lowest prescribed load. When the test is performed with the higher loads, the hollow piston is not desirable, as the higher load may distort such a piston. In such tests, a solid piston or a hollow piston with suitable guides shall be used. When using this latter modification, it is essential that the heat loss along the piston, which is generally longer than usual, does not alter the test temperature of the material.

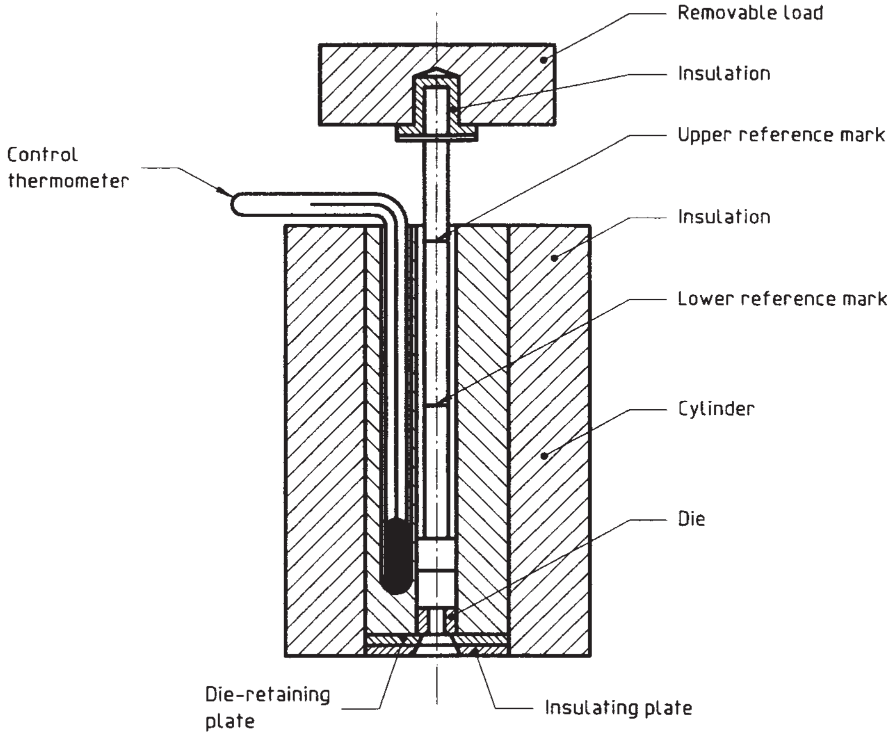

Figure 1 — Typical apparatus for determining melt flow rate (showing one of the possible methods of retaining the die and one type of piston)

3.1.4 Temperature-control system.

For all cylinder temperatures that can be set, the temperature control shall be such that between the die and the permissible filling height of the barrel, the temperature differences measured at the wall do not exceed those given in table 1 throughout the duration of the test.

NOTE — The wall temperature may be measured with thermocouples of Pt thermometers embedded in the wall. If the apparatus is not equipped in this way, the temperature is measured in the melt at a certain distance from the wall, depending on the type of thermometer used.

The temperature-control system shall allow the test temperature to be set in steps of 1 °C or less.

Table 1 — Maximum allowable variation in temperature with distance and with time

Test temperature, θ °C	**Variation in temperature,** °C	
	with distance	with time
$\theta \leqslant 200$	± 1	± 0,5
$200 < \theta \leqslant 300$	± 1,5	± 1,0
$\theta > 300$	± 2	± 1,5

3.1.5 Dies, made of tungsten carbide or hardened steel, 8,000 mm ± 0,025 mm in length. The interior shall be circular, straight and uniform in diameter such that in all positions it is within 0,005 mm of a true cylinder of nominal diameter 2,095 mm.

The bore shall be hardened to a Vickers hardness of no less than 500 (HV 5 to HV 100) (see ISO 6507-1) and shall have a surface roughness less than R_a (arithmetic mean discrepancy) = 0,25 µm (see ISO 468). The die shall not project beyond the base of the cylinder (see figure 1) and shall be mounted so that its bore is co-axial with the cylinder bore.

3.1.6 Means of setting and maintaining the cylinder truly vertical

A two-directional bubble level, set normal to the cylinder axis, and adjustable supports for the apparatus are suitable for the purpose.

NOTE — This is to avoid excessive friction caused by the piston or bending under heavy loads. A dummy piston will a spirit level on its upper end is a suitable means of checking conformity with this requirement.

3.1.7 Removable load, on the top of this piston, which consists of a set of weights which may be adjusted so that the combined mass of the load and the piston gives the selected nominal load to an accuracy of 0,5 %. An alternative mechanical loading device may be used for higher loads.

3.2 Accessory equipment

3.2.1 General

3.2.1.1 Equipment for introducing test samples into the cylinder, consisting of a packing rod made of non-abrasive material.

3.2.1.2 Cleaning equipment.

3.2.1.3 Mercury-in-glass thermometer (calibration thermometer) or another temperature-measuring device. This measuring device shall be calibrated to permit temperature measurement to ± 0,5 °C at the temperature and immersion conditions to be used when calibrating the temperature-control system in accordance with 5.1.

3.2.2 For procedure A

3.2.2.1 Cutting tool, for cutting off extruded sample. A sharp-edged spatula has been found suitable.

3.2.2.2 Timer, accurate to ± 0,1 s.

3.2.2.3 Balance, accurate to ± 0,5 mg.

3.2.3 For procedure B

Measurement equipment, for the automatic measurement of distance and time for the piston movement.

4 Test sample

4.1 The test sample may be in any form that can be introduced into the bore of the cylinder, for example powder, granules or strips of film.

NOTE — Some materials in powder form do not give a bubble-free filament if they are not previously compressed.

4.2 The test sample shall be conditioned and, if necessary, stabilized prior to the test, in accordance with the material specifications.

5 Temperature calibration, cleaning and maintenance of the apparatus

5.1 Calibration of the temperature-control system

5.1.1 It is necessary to verify regularly the accuracy of the temperature-control system (3.1.4). For this purpose, adjust the temperature-control system until the cylinder will remain at the required temperature as indicated by the control thermometer. Preheat a calibration thermometer (3.2.1.3) to the same temperature. Then charge the cylinder with a quantity of the material to be tested, or a material representative thereof (see 5.1.2), using the same technique as for a test (see 6.2). Four minutes after completing the charging of the material, introduce the calibration thermometer into the sample chamber and immerse it in the material therein until the tip of the bulb is 10 mm from the upper face of the die. After a further interval of not less than 4 min and not more than 10 min, correct the temperature indicated by the control thermometer by algebraic addition of the difference between the temperatures read on the two thermometers. It is also necessary to verify the temperature profile along the cylinder. For this, measure the temperature of the material every 10 mm up to a point 60 mm above the upper face of the die. The maximum variation between the extreme values shall conform to table 1.

5.1.2 It is essential that the material used during calibration be sufficiently fluid to permit, for instance, a mercury-filled thermometer bulb to be introduced without excessive force or risk of damage. A material with an MFR of greater than 45 g/10 min (2,16 kg load) at the calibration temperature has been found suitable.

If such a material is used for calibration purposes in place of a more viscous material which is to be tested, the dummy material shall have a thermal diffusivity similar to that of the material to be tested, so that warm-up behaviour is similar. It is necessary that the quantity charged for calibration be such that, when the calibration thermometer is subsequently introduced, the appropriate length of the thermometer stem is immersed for accurate temperature measurement. This can be checked by inspecting the upper limit of the material coating the end of the calibration thermometer, removing the thermometer from the cylinder if necessary.

5.2 Cleaning the apparatus

The apparatus shall be cleaned thoroughly after each determination. The cylinder may be cleaned with cloth patches. The piston shall be cleaned while hot with a cloth. The die may be cleaned with a closely fitting brass reamer or wooden peg. Pyrolytic cleaning in a nitrogen atmosphere at about 550 °C may also be used. Abrasives or materials likely to damage the surface of the piston, cylinder or die shall not be used. Take care that the cleaning procedure used does not affect the die dimensions or surface finish.

If solvent are used to clean the cylinder, take care that any effect they may have on the next determination is negligible.

NOTE — It is recommended that, at fairly frequent intervals, for example once a week for instruments in constant use, the insulating plate and the die-retaining plate, if fitted as in figure 1, be removed, and the cylinder cleaned throughout.

6 Procedure A

6.1 Clean the apparatus (see 5.2). Before beginning a series of tests, ensure that the cylinder (3.1.2) has been at the selected temperature for not less than 15 min.

6.2 Then charge the cylinder with 3 g to 8 g of the sample according to the anticipated melt flow rate (see, as a guide, table 2). During the charging, compress the material with the packing rod (3.2.1.1), using hand pressure. To ensure a charge as free from air as possible for material susceptible to oxidative degradation, complete the charging process in 1 min. Put the piston, loaded or unloaded according to the flow rate of the material, in the cylinder.

If the melt flow rate of the material is high, that is, more than 10 g/10 min, the loss of sample during preheating will be appreciable. In this case, use an unloaded piston or one carrying a smaller weight during the preheating period, and then change to the desired weight at the end of the 4 min preheating time. In the case of very high melt flow rates, a die-plug may be necessary.

Table 2

Melt flow rate 1) g/10 min	**Mass of test sample in cylinder** 2) g	**Extrudate cut-off time-interval** s
⩾ 0,1 but ⩽ 0,5	3 to 5	240
> 0,5 but ⩽ 1	4 to 6	120
> 1 but ⩽ 3,5	4 to 6	60
> 3,5 but ⩽ 10	6 to 8	30
> 10	6 to 8	5 to 15 3)

1) It is recommended that melt a flow rate should not be measured if the value obtained in this test is less than 0,1 g/10 min or greater than 100 g/10 min.

2) When the density of the material is greater than 1,0 g/cm^3, it may be necessary to increase the mass of the test portion.

3) To achieve adequate repeatability when testing materials having an MFR greater than 25 g/10 min, it may be necessary either to control and measure cut-off intervals automatically to less than 0,1 s or to use procedure B.

6.3 Four minutes after completing the introduction of the test sample, during which time the temperature shall have returned to that selected, place the selected load on the piston, if it was unloaded or under-loaded. Allow the piston to descend under gravity, until a bubble-free filament is extruded; this may be done before or after loading, depending on the actual viscosity of the material. The time for this operation shall not exceed 1 min. Cut off the extrudate with the cutting tool (3.2.2.1), and discard. Continue to allow the loaded piston to descend under gravity. When the lower reference mark has reached the top edge of the cylinder, start the timer (3.2.2.2), and simultaneously cut off the extrudate with the cutting tool and again discard.

Then collect successive cut-offs in order to measure the extrusion rate at time-intervals, depending on the melt flow rate, so chosen that the length of a single cut-off is not less than 10 mm and preferably between 10 mm and 20 mm (see cut-off time-intervals in table 2 as a guide).

For low values of MFR (and MVR) and/or materials which exhibit a relatively high degree of die swell, it may not be possible to take a cut-off with a length of 10 mm or more within the maximum time-interval of 240 s. In such cases, procedure A may be used, but only if the mass of each cut-off obtained in 240 s is greater than 0,04 g. If not, procedure B shall be used.

Stop cutting when the upper mark on the piston stem reaches the top edge of the cylinder. Discard any cut-off containing visible air bubbles. After cooling, weigh individually, to the nearest 1 mg, the remaining cut-offs, which shall number at least three, and calculate their average mass. If the difference between the maximum and the minimum value of the individual weighings exceeds 15 % of the average, discard the result and repeat the test on a fresh portion of the sample.

The time between charging the cylinder and the last measurement shall not exceed 25 min.

6.4 The melt mass-flow rate (MFR), expressed in grams per 10 min, is given by the equation

$$\mathrm{MFR}(\theta, m_{\mathrm{nom}}) = \frac{t_{\mathrm{ref}} \cdot m}{t}$$

where

- θ is the test temperature, in degrees Celsius;
- m_{nom} is the nominal load, in kilograms;
- m is the average mass, in grams, of the cut-offs;
- t_{ref} is the reference time (10 min), in seconds (600 s);
- t is the cut-off time-interval, in seconds.

Express the result to two significant figures and record the test conditions used (e.g. 190/2,16).

7 Procedure B

7.1 Principle

The melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) are determined by using either of the following two principles:

a) measurement of the distance the piston moves in a specified time;

b) measurement of the time in which the piston moves a specified distance.

7.2 Optimum measurement accuracy

For repeatable determination of MFR between 0,1 g/10 min and 50 g/10 min or MVR between 0,1 cm^3/10 min and 50 cm^3/10 min, the movement of the piston has to be measured to the nearest ± 0,1 mm and the time to an accuracy of 0,1 s.

7.3 Pretreatment

Follow procedure A specified in 6.1 to 6.3 (to end of first paragraph).

7.4 Determination

7.4.1 When the lower reference mark has reached the top edge of the cylinder, start the automatic measurement.

7.4.2 Take measurements as follows:

a) If using the principle given in 7.1 a), measure the distance moved by the piston at predetermined times.

b) If using the principle given in 7.1 b), measure the times taken by the reference mark to cover a specified distance.

Stop the measurement when the upper mark on the piston stem reaches the top edge of the cylinder.

7.4.3 The time between charging the cylinder and the last measurement shall not exceed 25 min.

7.5 Expression of results

7.5.1 The melt volume-flow rate (MVR), expressed in cubic centimetres per 10 min, is given by the equation

$$\mathrm{MVR}(\theta, m_{\mathrm{nom}}) = \frac{A \cdot t_{\mathrm{ref}} \cdot l}{t} = \frac{427 l}{t}$$

where

θ is the test temperature, in degrees Celsius;

m_{nom} is the nominal load, in kilograms;

A is the mean cross-sectional area, in square centimetres of the piston and the cylinder (= 0,711 cm^2);

t_{ref} is the reference time (10 min), in seconds (600 s);

t is the predetermined time of measurement [see 7.4.2a)] or the mean value of the individual time measurements [see 7.4.2b)], in seconds;

l is the predetermined distance moved by the piston [see 7.4.2b)] or the mean value of the individual distance measurements [see 7.4.2a)], in centimetres.

7.5.2 The melt mass-flow rate (MFR), expressed in grams per 10 min, is given by the equation

$$\mathrm{MFR}(\theta, m_{\mathrm{nom}}) = \frac{A \cdot t_{\mathrm{ref}} \cdot l \cdot \rho}{t} = \frac{427 \cdot l \cdot \rho}{t}$$

where

θ, m_{nom}, A, t_{ref}, t and l are as defined in 7.5.1;

ρ is the density, in grams per cubic centimetre, of the melt at the test temperature and is given by the equation

$$\rho = \frac{m}{0{,}711 l}$$

m being the mass, determined by weighing, of extrudate expelled by a piston movement of l cm.

7.5.3 Express the result to two significant figures and record the test conditions used (e.g. 190/2,16).

8 Flow rate ratio (FRR)

The relationship between two values of MFR (or MVR) is called the flow rate ratio, e.g.

$$\mathrm{FRR} = \frac{\mathrm{MFR}\ (190/21{,}6)}{\mathrm{MFR}\ (190/2{,}16)}$$

It is commonly used as an indication of the way in which the rheological behaviour is influenced by the molecular mass distribution of the material.

NOTE — The conditions to be used for the determination of the flow rate ratio are given in the appropriate material standards.

9 Precision

When the method is used with certain materials, consideration shall be given to the factors leading to a decrease in repeatability. Such factors include the following:

a) thermal degradation or crosslinking of the material, causing the melt flow rate to change during the preheating or test period (powdered materials requiring long preheating times are sensitive to this effect and, in certain cases, the inclusion of stabilizers is necessary to reduce the variability);

b) filled or reinforced materials, where the distribution or orientation of the filler may affect the melt flow rate.

The precision of the method is not known because interlaboratory data are not available. A single precision statement would not be suitable because of the number of materials covered. However, a coefficient of variation of about ± 10 % could be expected.

10 Test report

The test report shall include the following particulars:

a) a reference to this International Standard;

b) all details necessary for the complete identification of the test sample, including the physical form of the material with which the cylinder was charged;

c) the details of conditioning;

d) the details of any stabilization (see 4.2);

e) the temperature and load used in the test;

f) for procedure A, the masses of the cut-offs and the cut-off times-intervals or, for procedure B, the predetermined time of measurement or distance moved by the piston and the corresponding measured values of the distance moved by the piston or time of measurement;

g) the melt mass-flow rate, in grams per 10 min, or the melt volume-flow rate, in cubic centimetre per 10 min, expressed to two significant figures (when more than one value has been obtained, all the individual values shall be reported);

h) if desired, the flow rate ratio (FRR);

i) a report of any unusual behaviour of the test sample, such as discoloration, sticking, extrudate distortion or unexpected variation in melt flow rate;

j) the date of the test.

Annex A
(normative)

Test conditions for melt flow rate determination

The conditions used shall be as indicated in the appropriate material designation or specification. Table A.1 indicates test conditions that have been found useful.

Table A.1

Conditions (code letter)	**Test temperature, θ** °C	**Nominal load (combined), m_{nom}** kg
A	250	2,16
B	150	2,16
D	190	2,16
E	190	0,325
F	190	10,00
G	190	21,60
H	200	5,00
M	230	2,16
N	230	3,80
S	280	2,16
T	190	5,00
U	220	10,00
W	300	1,20
Z	125	0,325

NOTE — If, in the future, conditions other than those listed in this table are necessary, e.g. for new thermoplastics, only the loads already in use shall be chosen. Temperatures shall also be selected from those already in the table. If absolutely necessary, new temperatures might have to be taken because of the nature of the new thermoplastic. In this case, application to ISO/TC 61/SC 5 shall be made to include the new conditions. If approved, a suitable code-letter will provisionally be issued and the standard amended at the 5-year revision.

Annex B
(informative)

Conditions in use for the designation of standards for thermoplastic materials

Table B.1 indicates test conditions that are currently specified in relevant International Standards. Other test conditions not listed here may be used, if necessary, for a particular material.

Table B.1

International Standard (see clause 2)	**Materials**	**Conditions** (code letter)	**Test temperature, θ** °C	**Nominal load (combined), m_{nom}** kg
ISO 1622-1	PS	H	200	5,00
ISO 1872-1	PE	D	190	2,16
ISO 1872-1	PE	E	190	0,325
ISO 1872-1	PE	G	190	21,60
ISO 1872-1	PE	T	190	5,00
ISO 1873-1	PP	M	230	2,16
ISO 2580-1	ABS	U	220	10,00
ISO 2897-1	PS-I	H	200	5,00
ISO 4613-1	E/VAC	B	150	2,16
ISO 4613-1	E/VAC	D	190	2,16
ISO 4613-1	E/VAC	Z	125	0,325
ISO 4894-1	SAN	U	220	10,00
ISO 6402-1	ASA, ACS, AES	U	220	10,00
ISO 7391-1	PC	W	300	1,20
ISO 8257-1	PMMA	N	230	3,80
ISO 8986-1	PB	D	190	2,16
ISO 8986-1	PB	F	190	10,00
ISO 9988-1	POM	D	190	2,16
ISO 10366-1	MABS	U	220	10,00

Annex ZA (normative)
Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

Publication	Year	Title	EN	Year
ISO 1622-1	1994	Plastics – Polystyrene (PS) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 1622-1	1999
ISO 1872-1	1993	Plastics - Polyethylene (PE) moulding and extrusion materials - Part 1: Designation system and basis for specifications	EN ISO 1872-1	1999
ISO 1873-1	1995	Plastics – Polypropylene (PP) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 1873-1	1995
ISO 2580-1	1997	Plastics – Acrylonitrile/butadiene/styrene (ABS) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 2580-1	1999
ISO 2897-1	1997	Plastics – Impact-resistant polystyrene (PS-I) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 2897-1	1999
ISO 4613-1	1993	Plastics – Ethylene/vinyl acetate (E/VAC) moulding and extrusion materials – Part 1: Designation and specification	EN ISO 4613-1	1999

ISO 4894-1	1997	Plastics – Styrene/acrylonitrile (SAN) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 4894-1	1999
ISO 6402-1	1997	Plastics – Impact-resistant acrylonitrile/styrene (ASA,AES, ACS) moulding and extrusion materials, excluding butadiene-modified materials – Part 1: Designation system and basis for specifications	EN ISO 6402-1	1999
ISO 6507-1	1997	Metallic materials – Vickers hardness test – Part 1: Test method	EN ISO 6507-1	1997
ISO 7391-1	1996	Plastics - Polycarbonate (PC) moulding and extrusion materials - Part 1: Designation system and basis for specifications	EN ISO 7391-1	1999
ISO 8986-1	1993	Plastics – Polybutene (PB) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 8986-1	1999
ISO 10366-1	1993	Plastics – Methyl methacrylate/ acrylonitrile/butadiene/styrene (MABS) moulding and extrusion materials – Part 1: Designation system and basis for specifications	EN ISO 10366-1	1999