



**International
Standard**

ISO 12834

**Textiles — Synthetic filament
yarns — Determination of dynamic
thermal draw-force of partially
oriented yarns (POY)**

*Textiles — Fils de filaments synthétiques — Détermination de
la force d'étirage thermique dynamique des fils partiellement
orientés (POY)*

**First edition
2024-08**



COPYRIGHT PROTECTED DOCUMENT

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Licensed to TBS TEXTILE SECTION
Order # NUMBER/Downloaded: 2024-08-27
Single-user licence only, copying and networking prohibited.
© ISO 2024 – All rights reserved

Contents		Page
Foreword.....		iv
1	Scope.....	1
2	Normative references.....	1
3	Terms and definitions.....	1
4	Principle.....	1
5	Apparatus.....	1
6	Testing conditions.....	2
6.1	Pretension.....	2
6.2	Heater temperature.....	2
6.3	Draw-ratio.....	2
6.4	Testing speed.....	3
6.5	Testing length.....	3
7	Sampling.....	3
8	Test procedure.....	3
8.1	Preparation of test specimen.....	3
8.2	Setting of testing conditions.....	3
8.3	Threading of test specimen.....	4
8.4	Specimen testing.....	4
9	Calculation and expression of results.....	5
10	Precision.....	5
11	Test report.....	5
Annex A (informative) Optimization of heater temperature, testing speed and draw-ratio in determination of dynamic thermal draw-force.....		6
Annex B (normative) Calculation of statistic values.....		9
Annex C (informative) Precision.....		11
Bibliography.....		12

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarn*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Textiles — Synthetic filament yarns — Determination of dynamic thermal draw-force of partially oriented yarns (POY)

1 Scope

This document specifies a method for the determination of the dynamic thermal draw-force of partially oriented synthetic filament yarns.

It is applicable to partially oriented polyester (PES), polyamide (PA) and polypropylene (PP) filament yarns, with a linear density less than 800 dtex.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 2076, *Textiles — Man-made fibres — Generic names*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 2076 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp/ui>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

dynamic thermal draw-force

force caused by drawing the running filament yarns to a certain ratio under a certain heater temperature and testing speed

4 Principle

The continuous filament yarn runs into the dynamic thermal draw-force tester at a certain testing speed under constant pretension, then passes a heater and drawing device. It is drawn to a specific ratio while being heated at a specified temperature. The dynamic thermal draw-force is determined.

5 Apparatus

5.1 Dynamic thermal draw-force tester, which meets the following requirements:

- a) tensioning device to apply specified pretension on filament yarns and maintain tension to an accuracy of $\pm 10\%$;
- b) heater to maintain temperature to an accuracy of $\pm 2\text{ }^{\circ}\text{C}$;

NOTE The results of thermal draw-force being tested in heaters with different length can differ.

- c) feeding device to adjust testing speed, with a speed variation less than 2 %;
- d) drawing device to adjust draw-ratio within [1,20, 1,90], with a speed variation less than 2 %;
- e) force measuring and data collecting device to indicate force values with an error less than 1 % of the nominal value, within [10 %, 90 %] of the full range;
- f) yarn aspirator to clear the tested yarns and thereby allow continuous testing.

5.2 Sample holder, to support packages.

6 Testing conditions

6.1 Pretension

Pretension per unit linear density is intended to be $(0,050 \pm 0,005)$ cN/dtex.

6.2 Heater temperature

Heater temperatures are variable for different types and nominal linear densities of yarns.

Recommended values of heater temperature are listed in [Table 1](#).

Other heater temperature values may be determined on agreement between the interested parties. Additional information is given in [Annex A](#).

Table 1 — Heater temperature for different types of filament yarns

Type of the yarns	Heater temperature (°C)
poly (ethylene terephthalate) (PET)	170 ± 2
poly (trimethylene terephthalate) (PTT)	145 ± 2
poly (butylene terephthalate) (PBT)	150 ± 2
polypropylene (PP)	140 ± 2
polyamide 6 (PA6)	150 ± 2
polyamide 66 (PA66)	170 ± 2

6.3 Draw-ratio

Draw-ratios are related to the tensile properties of the yarns.

Recommended values of draw-ratio are listed in [Table 2](#).

Other draw-ratio values may be determined on agreement between the interested parties.

Table 2 — Draw-ratios for different types of filament yarns

Type of the yarns	Draw-ratio
poly (ethylene terephthalate) (PET)	$1,65 \pm 0,01$
poly (trimethylene terephthalate) (PTT)	$1,75 \pm 0,01$
poly (butylene terephthalate) (PBT)	$1,25 \pm 0,01$
polypropylene (PP)	$1,70 \pm 0,01$
polyamide 6 (PA6)	$1,25 \pm 0,01$
polyamide 66 (PA66)	$1,25 \pm 0,01$

In order to ensure the comparability of test results, tests shall be carried out under the same draw-ratio.

6.4 Testing speed

Testing speeds are varied with different types and nominal linear densities of yarns.

Recommended testing speed is (100 ± 2) m/min.

Other testing speed values may be determined on agreement between the interested parties. Additional information is given in [Annex A](#).

6.5 Testing length

Recommended testing length is (100 ± 2) m.

Other testing length values may be determined on agreement between the interested parties.

7 Sampling

Sampling shall be performed as follows:

- a) bulk laboratory sample shall be taken on request;
- b) number of lot sample and laboratory sample are listed in [Table 3](#).

Packages that have been dampened, bruised, or opened during the transportation shall not be sampled.

Table 3 — Number of lot sample and laboratory sample

Number of containers in the consignment	Number of containers in the first selection	Number of containers taken for consignment sample	Number of packages sampled from each container	Number of packages chosen for laboratory sample
10 or less	all	all	See footnote ^a	20 approx.
11 to 20	10	10	2	20
21 to 40	20	10	2	20
more than 40	40	20	1	20

^a Take an equal number of packages from container. The number of packages for laboratory sample should be at least 20. If the consignment includes less than 20 packages, sample all of them.

8 Test procedure

8.1 Preparation of test specimen

Discard yarns on the outer layer of the packages. Afterwards, condition the packages in accordance with ISO 139.

For bulk laboratory samples, each package is tested twice, and the total number of tests shall not be less than 20 for one lot.

For batch laboratory samples, each package is tested twice and the total number of tests shall not be less than 40.

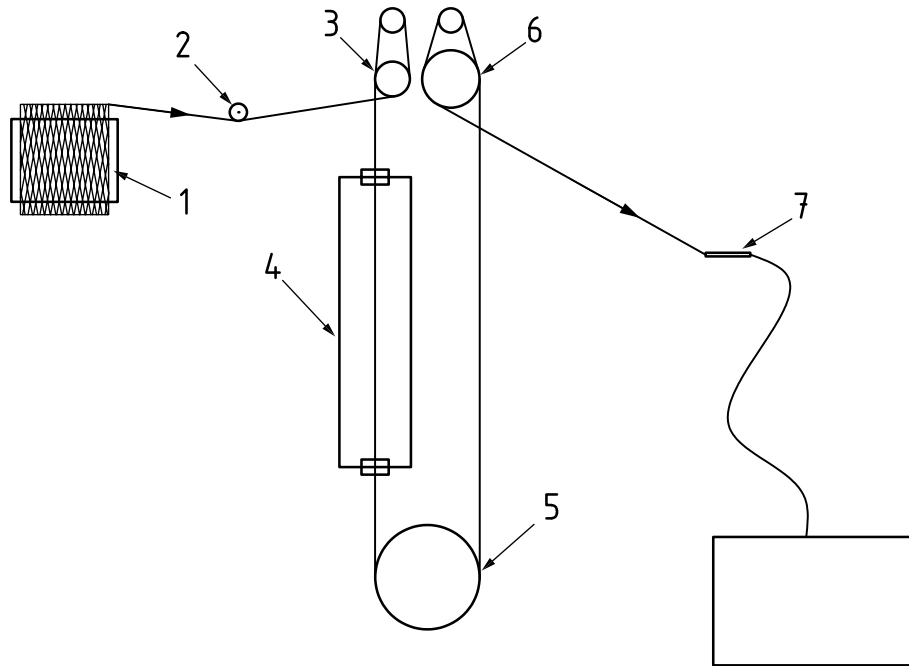
8.2 Setting of testing conditions

Turn on the tester and set pretension, heater temperature, draw-ratio, testing speed and testing length. Wait until the heater reaches the specified temperature and equilibrate for at least 10 min.

8.3 Threading of test specimen

Place the package on a sample holder. Thread the filament yarn successively through tensioning device, feeding roller, heater, force measuring device and drawing roller. Sufficient turns are required on both rollers to avoid slippage. Finally, guide it into yarn aspirator. [Figure 1](#) shows a design example of a tester and the appropriate threading.

Different instruments are available, e.g. with electronic gear boxes and software settings to select the draw-ratio or different arrangement of drawing rollers and force measuring devices.



Key

- 1 package
- 2 tensioning device
- 3 feeding roller
- 4 heater
- 5 force measuring device
- 6 drawing roller
- 7 yarn aspirator

Figure 1 — Example of tester and test specimen threading

8.4 Specimen testing

Allow the tester to operate under specified conditions. After the testing speed is steady, begin to collect data of thermal draw-force and corresponding testing length. Operate at least for 1 min.

During the test, ascertain that the yarn does not show slippage at the rollers. Discard those measurements falsified by slippage or other abnormalities.

If the number of discarded measurements exceeds 10 % of the total number of tests, the tester should be checked and adjusted. Then restart the test.

9 Calculation and expression of results

Calculate arithmetic mean value, standard deviation, and coefficient of variation (C_V) for thermal draw-force in accordance with [Annex B](#).

Express arithmetic mean value and standard deviation in cN, to be rounded to the first decimal.

Express coefficient of variation in percentage, to be rounded to the nearest 0,01 %.

10 Precision

Refer to [Annex C](#).

11 Test report

The test report shall include at least the following information:

- a) a reference to this document, i.e. ISO 12834:2024;
- b) all details necessary for the identification of the sample tested;
- c) the linear density of sample;
- d) the number of packages and the number of test specimens per package;
- e) information related to the dynamic thermal draw-force tester (including its model, heater length, etc.);
- f) testing conditions (including pretention, heater temperature, draw-ratio, testing speed and testing length);
- g) test results (including arithmetic mean value, standard deviation, and coefficient of variation of thermal draw-force);
- h) any deviation, by agreement or otherwise, from the procedure specified;
- i) any unusual features observed;
- j) the date of the test;
- k) any information needs to be indicated.

Annex A (informative)

Optimization of heater temperature, testing speed and draw-ratio in determination of dynamic thermal draw-force

A.1 General

Select the appropriate heater temperature, testing speed and draw-ratio, to ensure stable and meaningful test results in the determination of dynamic thermal draw-force.

A.2 Selection of draw-ratio

The draw-ratio is usually selected as in the subsequent production process of POY, e.g. given by the ratio of the linear density of POY to post-processed drawn textured yarn (DTY) in texturizing.

If no draw-ratio in the instrument setup matches the above ratio, select the closest higher draw-ratio.

A.3 Selection of heater temperature and testing speed

A.3.1 Requirement

Select suitable combination of heater temperature and testing speed, in order to elevate the yarn temperature in the heater above its glass transition temperature (T_g). Thus, the most stable and meaningful test results are obtained.

In this situation, testing speed/thermal draw-force curve is relatively flat.

A.3.2 Heater temperature

The heater temperature is chosen depending on the yarn type and linear density of the yarn. Under the condition of fixed draw-ratio and testing speed, several heater temperature points can be selected for testing in a certain range.

A.3.3 Testing speed

Under the condition of fixed draw-ratio and heater temperature, several testing speeds within a certain range can be selected for testing.

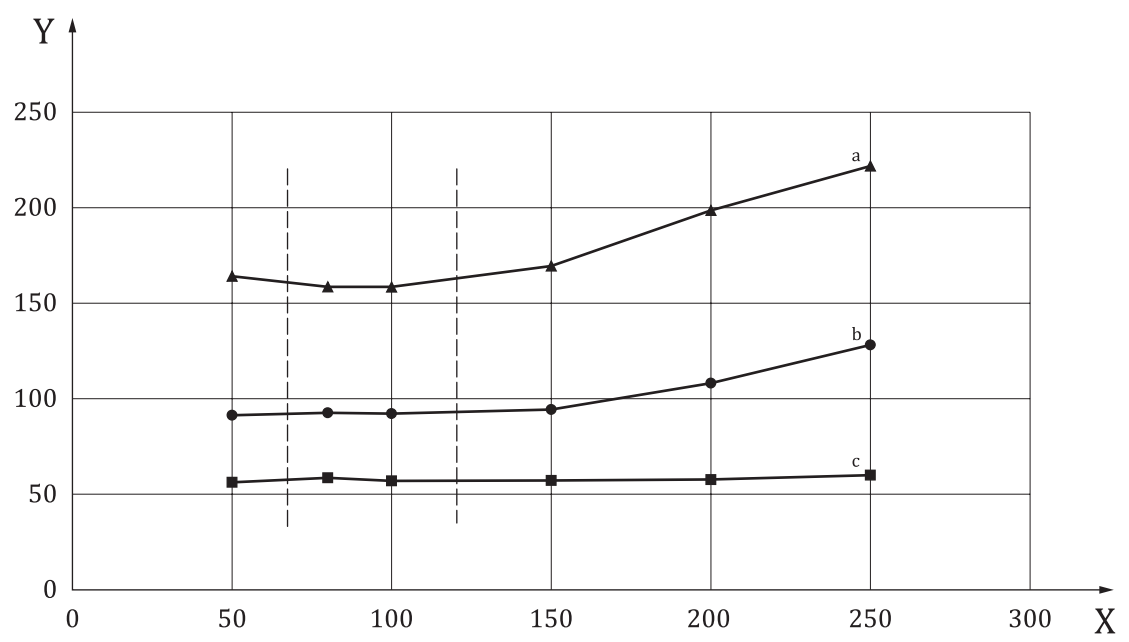
A.3.4 Confirmation of heater temperature and testing speed

Draw a series of testing speed/thermal draw-force curves at different temperatures. Select the combination of heater temperature and testing speed on the flat part of the curve.

It is generally considered that the testing speed is more suitable in the region where the thermal draw-force is rather stable in a certain interval of testing speeds in the testing speed/thermal draw-force curve.

A.4 Examples

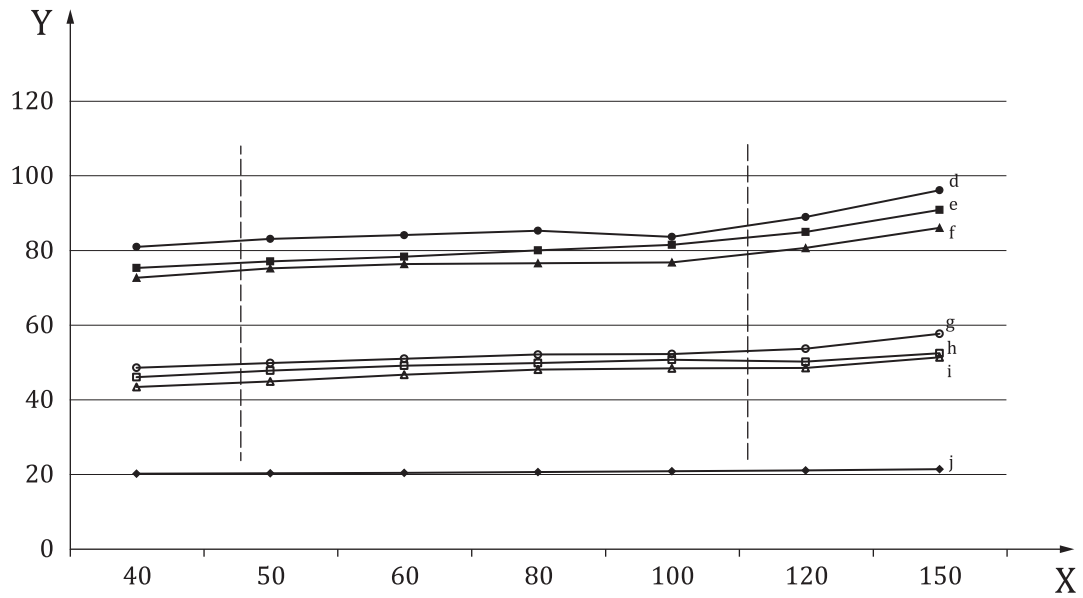
The combinations of selected and confirmed heater temperature and testing speed of poly (ethylene terephthalate) and polyamide 6 POY under the specified draw-ratio are shown in [Figure A.1](#) and [Figure A.2](#).



Key

- Y thermal draw-force, expressed in cN
- X testing speed, expressed in m/min
- a 140 dtex/72 f (heater temperature 170 °C).
- b 267 dtex/48 f (heater temperature 175 °C).
- c 368 dtex/288 f (heater temperature 180 °C).

Figure A.1 — Testing speed/thermal draw-force curves of poly (ethylene terephthalate) POY



Key

- Y thermal draw-force, expressed in cN
X testing speed, expressed in m/min
d 90 dtex/66 f (heater temperature 150 °C).
e 93 dtex/24 f (heater temperature 150 °C).
f 93 dtex/48 f (heater temperature 150 °C).
g 66 dtex/24 f (heater temperature 150 °C).
h 53 dtex/34 f (heater temperature 150 °C).
i 52 dtex/34 f (heater temperature 150 °C).
j 27 dtex/7 f (heater temperature 150 °C).

Figure A.2 — Testing speed/thermal draw-force curves of polyamide 6 POY

Annex B (normative)

Calculation of statistic values

B.1 Arithmetic mean value

Arithmetic mean value is calculated according to [Formula \(B.1\)](#).

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n} \quad (\text{B.1})$$

Where

- \bar{x} is arithmetic mean value of thermal draw-force, expressed in cN;
- x_i is individual value of thermal draw-force, expressed in cN;
- n is number of tests.

B.2 Standard deviation

Standard deviation is calculated according to [Formula \(B.2\)](#).

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} \quad (\text{B.2})$$

Where

- s is standard deviation of thermal draw-force, expressed in cN;
- x_i is individual value of thermal draw-force, expressed in cN;
- \bar{x} is arithmetic mean value of thermal draw-force, expressed in cN;
- n is number of tests.

B.3 Coefficient of variation (C_V)

Coefficient of variation (C_V) is calculated according to [Formula \(B.3\)](#).

$$C_V = \frac{s}{\bar{x}} \times 100 \% \quad (\text{B.3})$$

Where

- C_V is coefficient of variation of thermal draw-force;
- s is standard deviation of thermal draw-force, expressed in cN;
- \bar{x} is arithmetic mean value of thermal draw-force, expressed in cN.

Annex C (informative)

Precision

C.1 General

Twelve laboratories participated in the experiment, providing test results for three poly (ethylene terephthalate) POY samples and each one repeated twice. Results are analysed according to ISO 5725-2.

C.2 Repeatability

Following the normal and the right operation method specified in this document, one operator, using the same apparatus, tested identical test items within short intervals of time.

The absolute difference between the two independent test results obtained under the repeatability condition shall not be greater than the repeatability limit (r) listed in [Table C.1](#), provided that the case greater than the repeatability limit (r) is not more than 5 %.

C.3 Reproducibility

Following the normal and the right operation method specified in this document, operators in different laboratories, using different apparatus, tested identical test items.

The absolute difference of the independent test results obtained under the reproducibility condition shall not be greater than the reproducibility limit (R) listed in [Table C.1](#), provided that the case greater than the reproducibility limit (R) is not more than 5 %.

Table C.1 — Precision of test results of three Poly (ethylene terephthalate) POY samples

Specifications	repeatability r	reproducibility R	Mean value (cN)	number of acceptable test values	number of acceptable labo- ratories
88 dtex / 72 f	0,14	1,62	34,36	24	12
278 dtex / 288 f	0,92	8,08	114,26	24	12
510 dtex / 576 f	1,55	7,21	200,14	24	12

Bibliography

- [1] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*
- [2] ASTM D5344-22, *Standard Test Method for Extension Force of Partially Oriented Yarn*
- [3] BISFA *Testing methods for polyester filament yarns (2004) Chapter 12- DRAWING PROPERTIES OF POY*
- [4] DIN 53829-1:2014, *Testing of textiles — Determination of the evenness of filament yarns — Part 1: Testing of the force and extension on the running yarn, principles*
- [5] FZ/T 50051-2020, *Test method for dynamic thermal stress of polyester (PET) partially oriented yarn*



ICS 59.080.20

Price based on 12 pages

© ISO 2024
All rights reserved

Licensed to TBS TEXTILE SECTION
Order # NUMBER/Downloaded: 2024-08-27
Single-user licence only, copying and networking prohibited.