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# Textiles — Synthetic filament yarns — Determination of shrinkage in dry-hot air (after treatment)

*Textiles - Fils de filaments synthétiques - Détermination du taux de retrait dans l'air sec et chaud*



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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

 

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# Foreword

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The committee responsible for this document is ISO/TC 38, *Textiles*, Subcommittee SC 23, *Fibres and yarns*.



 

# Textiles — Synthetic filament yarns — Determination of shrinkage in dry-hot air (after treatment)

## 1 Scope

This International Standard specifies methods for the determination of dry-hot air shrinkage (after treatment) of synthetic filament yarns, skein method and single-end method. The skein method provides two forms of measurement which are of manual and automatic types. The single-end method gives the result by manual measurement.

In case of dispute, manual measurement procedure is to be used.

If these methods are not applicable, the corresponding test methods may be agreed between interested parties.

This International Standard is applicable to synthetic filament yarns of linear density less than 3 000 dtex.

This International Standard is not applicable to partially oriented yarns.

## 2 Normative references



The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

## 3 Terms and definition

For the purposes of this document, the following terms and definitions apply.

**3.1**
**shrinkage in dry-hot air (after treatment)**
decrease in length of a specimen as a result of thermal treatment in dry-hot air, expressed as a percentage of its original length, which measured under tension before and after treatment

## 4 Principle

Under specific condition, a test specimen is treated in dry-hot air. Shrinkage is calculated as variation in length, measured before and after treatment.

## 5 Apparatus and materials

**5.1 Skein winding reel**, which meets the following requirements:

a) 1 000 ± 2,5 mm reel circumference, driven either automatically or manually;

b) a traversing mechanism to avert overlapping when several skeins are wound at the same time;

c) a tensioning device to maintain tension within the recommended limits, accurate to within ± 10 %;

d) a device to count reel revolutions, preferably capable to stop winding automatically and warn when nearing the specified number of reel revolutions;

e) a mechanism to reduce the reel circumference for easy removal of the skein.

**5.2 Length-measuring stand,** which meets the following requirements:

a) a stand for measuring specimen length of least 1 mm gauge length;

b) a millimetre scale to determine specimen length, accurate to within ±1 mm;

c) a steel hook or a clamp, where the top of the hook or the lower side of the clamp (where the specimen hung from) is positioned in line with the zero index of the scale;

d) tensioning weights with hooks or clamps for applying tensile force to specimens, accurate to within ±10 %.

**5.3 Automatic shrinkage tester,** which meets the following requirements:

a) automatically applies specified tension, measures specimen length, and calculates the shrinkage based on length values;

b) 0,05 mm resolution of length measurement;.

c) a specimen holder for suspending specimens more than 600 mm high, which can consistently hold 2,5 cN load per skein for the duration of the testing procedure with several skeins arranged and tested in succession.

NOTE Other mechanical devices may be used for the test provided that equivalent results are obtained.



**5.4 Ventilated oven,** which meets the following requirements:

a) a holder for suspending specimens in the oven more than 600 mm high during manual measurement, with test specimens adequately spaced apart so as not to touch each other and the interior sides of the oven;



b) at least 600 mm high interior to accommodate the holder in an upright position, with occupied space not more than 80 % of the volume;

c) a thermometer to measure and record the hot air temperature in the vicinity of the specimens;

d) adequate ventilation to maintain oven temperature to an accuracy of ±3 °C.

## 6 Sampling and preparation of the test specimen

### 6.1 Sampling

Sampling shall be performed as follows:

a) in accordance with the directions given in the material specification;

b) bulk laboratory sample shall be taken on demand;

c) number of lot sample and laboratory sample are listed in Table 1.

 

**Table 1 — 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 note below | 20 approx. |
| 11 to 20 | 10 | 10 | 2 | 20 |
| 21 to 40 | 20 | 10 | 2 | 20 |
| more than 40 | 40 | 20 | 1 | 20 |
| NOTE 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. | | | | |

## 6.2 Preconditioning and conditioning

**6.2.1** The standard atmosphere for conditioning and testing shall be as specified in ISO 139.

**6.2.2** When actual moisture regain exceeds commercial value, the test specimen shall be preconditioned. Specimens should be exposed in standard atmosphere for more than 30 min to reach moisture equilibrium.

## 6.3 Preparation of the test specimen



### 6.3.1 Skein method

#### 6.3.1.1 Turns of reel



The number of turns needed to obtain the set linear density of the skein is calculated according to Formula (1):

$$n = \frac{T_t}{2 \times T} \tag{1}$$

where

$n$ is the number of turns rounded to nearest whole number;

$T_t$ is the set linear density of the skein expressed in dtex, listed in Table 2;

$T$ is the nominal linear density of the specimen expressed in dtex.

**Table 2 — Set linear density of skein**

| Nominal linear density of the specimen | Set linear density of the skein |
|---|---|
| ≤400 dtex | 2 500 dtex |
| >400 dtex ~ 3000 dtex | 10 000 dtex |

#### 6.3.1.2 Reeling

Discard yarns on the outer layer of the package. Lead the yarn through the tension device and fix the end on the clip of the reel. Smoothly reel the skein using uniform tension lower than the specific tension [calculated as Formula (3)] and reel the specific turns (see 6.3.1.1).

Cut the yarn close to the clip and tie two yarn ends together, without stretching the yarns. Remove the skein from the reel carefully and avoid tangling.

The test specimens are conditioned in a loose and tension-free state as specified in 6.2. It is recommended that polyester and polypropylene specimens should be conditioned for more than 2 h, while polyamide specimens for at least 3 h.

#### 6.3.2 Single-end method

Discard yarns on the outer layer of the package. Cut yarn in a length of 60 cm-70 cm from the package.

The test specimens are conditioned in a loose and tension-free state as specified in 6.2. It is recommended that polyester and polypropylene specimens should be conditioned for more than 2 h, while polyamide specimens for at least 3 h.

### 6.4 Number of specimens

For bulk laboratory samples, the minimum number of specimens shall be two from each package and a total of 10 from one lot.

For batch laboratory samples, prepare one specimen from each package and not less than 20 total. In case of arbitration, prepare three specimens from each package and not more than 60 total.

## 7 Testing conditions

### 7.1 Dry-hot air treatment conditions



Dry-hot air treatment conditions vary for different kinds of yarns. Recommended temperature and treatment duration are listed in Table 3.



For yarns not mentioned in Table 3, temperature and treatment time will be determined as agreed.



**Table 3 — Hot air temperature and thermal treatment time**

| Shape of the yarns | Type of the yarns | Hot air temperature (°C) | Thermal treatment time (min) |
|---|---|---|---|
| Multifilament | polyester, polyamide 66 | 190 ± 3 | 15 ± 1 |
| | polyamide 6 | 170 ± 3 | 15 ± 1 |
| | polypropylene | 110 ± 3 | 15 ± 1 |
| Monofilament | polyester | 180 ± 3 | 15 ± 1 |
| | polyamide 66 | 180 ± 3 | 10 ± 1 |
| | polyamide 6 | 150 ± 3 | 10 ± 1 |
| | polypropylene | 110 ± 3 | 15 ± 1 |

### 7.2 Tension for the test specimen

Calculate the tension in skein method according to Formula (2):

$$F = P \times T_t \tag{2}$$

where

$F$ is the tension expressed in cN;

$P$ is the tension per unit linear density expressed in cN/dtex;

$T_t$ is the set linear density of the skein expressed in dtex.

Calculate the tension in single-end method according to Formula (3):

$$F = P \times T \tag{3}$$

where

$F$ is the tension expressed in cN;

$P$ is the tension per unit linear density expressed in cN/dtex;

$T$ is the nominal linear density of the yarn expressed in dtex.

Tension per unit linear density is intended to be:

— non-texture yarns: (0,05 ± 0,01) cN/dex;

— textured yarns: (0,20 ± 0,04) cN/dtex.

For those filament yarns not applicable, tension will be determined as agreed.

### 7.3 Equilibrium time for test specimen after thermal treatment

Test specimens should reach moisture equilibrium after thermal treatment in standard atmosphere specified in 6.2.2.

It is recommended that polyester and polypropylene specimens should be conditioned for more than 2 h, while polyamide specimens for at least 3 h.



## 8 Testing procedure



### 8.1 Skein method A (Manual measurement)

#### 8.1.1 Measuring the initial length of the test specimens

Hang one conditioned skein from the hook at the top of the length-measuring stand (5.2), with the knot placed at the hook.

Carefully add sufficient weight on the bottom of the skein, to produce the tension calculated in 7.2. This tension shall be reached slowly to prevent any over-tensioning.

Maintain the tension for (30 ± 3) s and measure the straightened length ($L_0$) to an accuracy of 1 mm.

Remove weight and skein after measurement. Take the skein and suspend it from a holder in the oven (5.4).

Repeat above procedures in sequence, till all skeins have been tested.

#### 8.1.2 Thermal treatment of the test specimens

Preheat the oven (5.4) to the specified temperature according to Table 3 in 7.1 and keep temperature steady. Place the holder into the oven quickly (within 5 s or less), to minimize the temperature decrease in the oven.

When the oven reaches the specified temperature, begin measuring treatment time as specified in 7.1.

#### 8.1.3 Equilibrium after thermal treatment

After treatment, carefully take out the holder with skeins. Condition the skeins as specified in 7.3, with skeins in loose and tension-free state.