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Wool — Determination of short-term irregularity of linear density of slivers, rovings and yarns, by means of an electronic evenness tester

Laine — Détermination de l'irrégularité de masse linéique à court terme des rubans, mèches et fils, à l'aide d'un régularimètre électronique

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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 2649 was drawn up by Technical Committee ISO/TC 38, and circulated to the Member Bodies in June 1972.

It has been approved by the Member Bodies of the following countries :

Belgium	India	Spain
Brazil	Iran	Sweden
Bulgaria	Ireland	Switzerland
Canada	Israel	Thailand
Czechoslovakia	Italy	Turkey
Denmark	Japan	United Kingdom
Egypt, Arab Rep. of	New Zealand	U.S.A.
Finland	Poland	U.S.S.R.
Germany	Romania	
Hungary	South Africa, Rep. of	

This International Standard has also been approved by the International Bureau for the Standardization of man-made Fibres (BISFA).

The Member Body of the following country expressed disapproval of the document on technical grounds :

France

This International Standard is based on the IWTO test method 18, drawn up by the International Wool Secretariat (IWS).

Wool — Determination of short-term irregularity of linear density of slivers, rovings and yarns, by means of an electronic evenness tester

0 INTRODUCTION

The determination of short-term cross-sectional irregularity is of great importance, both for the evaluation of sliver or yarn quality and for an active control of preparation for spinning.

In order to obtain an irregularity value as near as possible to a well-defined absolute value, it is necessary to standardize the test method applied for the determination, and to observe certain precautions in the control and operation of the evenness tester.

The object of this International Standard is to give the necessary guidance in this respect.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method applicable for the determination of short-term irregularity of linear density of yarns, rovings and slivers of pure wool, from 5 tex up to 40 kilotex.

The method is not directly applicable to fibre blends.

2 GENERAL

The aim of a measurement of short-term cross-sectional irregularity obtained by an electronic evenness tester is to evaluate the total cross-sectional irregularity for the yarn or sliver delivered by one machine head.

Appreciable differences in mean count may, in fact, exist between various heads of the same machine (i.e. in linear density determined on lengths between about 20 and 100 m). These differences between heads will not be included in the total cross-sectional irregularity considered here, as the variations from the mean are determined for each head in relation to the mean linear density of the material delivered by the head in question.

Thus an evaluation is made of the dispersion between the masses of short lengths L_b of yarn or sliver within a very long length L_p corresponding to the total length of a production unit delivered by one machine head. (This production unit may be a ball of top, a can of preparation sliver or roving, a package of yarn, etc.)

The parameter used to characterize this dispersion will be the coefficient of variation between the masses of the lengths L_b within the length L_p (b = between, p = package).

In principle, to obtain a value as near as possible to the total cross-sectional irregularity L_b should tend towards 0 and L_p towards infinity.

In practice, as the components of the high frequency spectrum make only a small contribution to the total irregularity, there is not much point in reducing L_b below about 10 mm; moreover, considerations of maximum sensitivity and admissible drift for electronic evenness testers prevent a value much lower than this limit being used.

Length L_b for electronic evenness testers is generally 10 ± 3 mm for yarns and rovings, and may reach 20 mm for slivers.

Regarding L_p , experience shows that irregularity within a length of 250 m (yarn or sliver) is practically always comparable with total irregularity.

The coefficient of variation CV (L_b , 250 ml), with $L_b = 10 \pm 3$ mm will thus be considered as a reference measurement to which the result obtained with the evenness tester must correspond as closely as possible.

In its normal method of operation (Normal Test) an electronic evenness tester fitted with an "integrator" enables the evaluation of the coefficient of variation CV , or the coefficient of deviation CD designated as $U^{1)}$, between the masses of short lengths L_b within a long length $L_w^{2)}$, these lengths being defined as follows :

1) Length L_b is practically equal to length L_c (measured in the yarn direction) of the electrodes of the measuring condenser. On any one machine it may vary for different forms of material according to the condenser chosen. The lengths L_c of the Zellweger-Uster evenness tester for yarns, rovings and slivers, are given in clause 3.

1) The coefficient of deviation CD or mean deviation divided by the mean is designated " U " on the dial of the Zellweger-Uster integrator.

2) L_w : w = within.

2) Length L_w is determined by the following three factors, the third being of minor importance :

- the electrical characteristics of the integrator (more precisely : the time constants T_1 and T_2 expressed in seconds);
- the running speed V of the yarn or sliver in the machine expressed in metres per second;
- the slope ($-n$) in logarithmic co-ordinates of the length variance curve $B(L)$ of the specimen yarn or sliver. (n is a function of the relative size of the long-term irregularities. The $B(L)$ curve is defined as the CV^2 of mass of length L as a function of this length L .)

In order to obtain a value of $CV(L_b, L_w)$ as defined above, L_w must be made as large as possible by selecting the highest admissible running speed; it will also be necessary to measure a sufficiently long length L_s ¹⁾ of a production unit, and always greater than L_w .

In some cases (rovings and slivers) the running speed will be limited by the properties of the material, and in other cases (yarns) by considerations of frequency response of the evenness tester or capacitance limits of auxiliary instruments (for example the imperfection indicator). The speeds and times of measurement ($T_s = L_s/V$) laid down in the method described are the best compromise.

In this way, in the majority of cases corresponding to normal yarns and slivers, a $CV(L_b, L_w)$ value will be obtained which is a sufficiently accurate estimation of the reference measurement $CV(L_b, 250 \text{ m})$ to within 5 % (relative).

The $CV(L_b, L_w)$ measurement obtained by the method described may thus be generally used directly, without correction, as the origin of a curve $B(L)$ to the abscissa $L = L_b$ (with exceptions which are given later).

Annex C, item a), gives the table of the relations $r = [CV(8 \text{ mm}, L_w)]/[CV(8 \text{ mm}, 250 \text{ m})]$ for all possible running speeds and for different values of slope ($-n$) of curve $B(L)$: it enables the expected under-estimation to be evaluated in each case.

It is found that the method described will give under-estimations over 5 % only in the cases of some abnormal yarns and slivers having wide long-term variations (n between 0,1 and 0,3).

The following procedure shall therefore be adopted :

- if the determination of short-term irregularity only is required, and if it is performed according to the above method, only the value of $CV(L_b, L_w)$ is mentioned in the test report;
- if the determination of short-term irregularity forms part of a summary of the $B(L)$ curve and if r is lower than 0,96 a more exact estimation of CV

($L_b, 250 \text{ m}$) $\approx CV(L_b, L_p)$ is obtained by multiplying the result $CV(L_b, L_w)$ of the test by $1/r$; r must be taken from the table in annex C a);

- if only the short term cross-sectional irregularity is required, but if it is impossible (for example because of insufficient length of sample) to conform to the method described and in particular if it is impossible to use the prescribed values of running speeds and test times, the instructions given in annex D are to be followed.

Total length L_t . As samples must normally be taken from several production units (i.e. several packages or cans), according to the instructions in clause 6, L_t will indicate the total length of yarn used for a regularity test on the total of production units examined (L_s being the length drawn from one production unit only).

3 PRINCIPLE

The measurement of short-term cross-sectional irregularity is performed using an electronic device employing a capacitive measuring head.

The textile material, passing between the electrodes of a condenser, causes a variation in its capacity, proportional to the mass of material present between the electrodes.

An electronic transducer then provides a variation in signal corresponding to this variation in capacity.

Thus the instrument measures continuously a function $f(t)$, representing the mass of the L_c mm of yarn or sliver present at time t , between the plates of the measuring condenser. ($L_c = 8 \text{ mm}$ for yarns, slots 5 to 8; 12 mm for roving, slots 2, 3, 4; 20 mm for slivers, slot 1.)

This electric signal $f(t)$ is recorded on graph paper and transferred to a simplified analogue computer, called an "integrator". This evaluates the variation between the masses of the L_c mm of yarn or sliver within a fairly long length L_w , by calculating a coefficient of variation $CV(L_b, L_w)$, which constitutes a value close to $CV(L_b, L_p)$ defined above. (It will be recalled that $L_b \approx L_c$.) Some types of integrator evaluate a coefficient of deviation $CD(L_b, L_w)$.

NOTE — Up to the present the coefficient of variation $CV(L_b, L_w)$ is indicated in evenness tester instruction manuals as C.V. and the coefficient of deviation $CD(L_b, L_w)$ as U, these two values being generally expressed as a percentage of the mean of the mass per unit length of yarn.

4 APPARATUS

An **electronic evenness tester**²⁾ with the following characteristics :

1) The main instrument

having on the front the measuring condensers for various types of material grouped into one unit, together with the various control knobs and a milliammeter with

1) L_s = length of sample.

2) A more fully automated tester may be used, in which case the apparatus description and test procedure will need slight modification.

central zero graduated from -100% to $+100\%$ and showing the function $f(t)$. The main instrument is fitted with several accessories allowing various types of material to be unwound and suitable for all types of package carriers.

2) The integrator

This exists in two types, semi-automatic and automatic.

a) The semi-automatic model

This model has control knobs and a dial with two separate scales: an upper scale "integration" indicating a coefficient of deviation $CD\%$ marked $U\%$ on the apparatus, and a small lower scale marked "Average Value" which registers a running mean of mass per unit length of the textile material.

b) The automatic model

This model has control knobs, "Evaluating time" knob indicating the time of integration, and a dial recording only $U\%$ or $CV\%$.

3) The recorder

This enables the function $f(t)$, given by the main instrument, to be recorded on graph paper.

A suitable machine is described in annex B.

5 ATMOSPHERE FOR CONDITIONING AND TESTING

5.1 Conditioning

The sample of yarn or roving to be tested should not be removed from its package (ball, can, etc.) before conditioning or before testing.

The balls or cans are to be exposed to the atmosphere of the testing location for at least 24 h if only one test is to be made on each ball (i.e. if only 250 to 400 m on the outside of the ball are to be unwound).

In the case of yarn packages only, if more than one test is to be carried out (more than 250 to 400 m unwound) it is necessary to extend conditioning to 48 h.

5.2 Testing atmosphere

5.2.1 Control laboratories

Preferably the test is to be performed in the standard atmosphere for testing defined in ISO 139, observing the following points:

- 1) the machine must be sufficiently far away from the air and moisture inlets (at least 1,5 m); this also applies to heat sources;
- 2) the humidification control device is to be set to obtain a sufficiently narrow "dead zone", so that the range of relative humidity during the humidification and rest cycles does not exceed 4 % (otherwise too steep a rise in relative humidity often occurs during the humidification cycle with possible drift on the evenness tester).

5.2.2 Mill laboratories

The standard atmosphere corresponding to the above requirements is preferred but is not essential. It suffices for conditioning and testing to be carried out in a sufficiently stable atmosphere both in temperature and humidity conforming to the following conditions:

- 1) mean temperature to be between 18 and 28 °C; variations around this mean not to exceed $\pm 3\text{ °C}$ during the total duration of conditioning and testing, and the temperature change not at any time to exceed 0,05 °C/min;
- 2) mean relative humidity between 50 and 75 %, but the variations around this mean not to exceed $\pm 3\%$ relative humidity during the total duration of conditioning and testing, and the change in relative humidity never to exceed 0,25 %/min.

At the time of test, the apparatus, (evenness tester and integrator) must have been in the atmosphere of the testing location (standard atmosphere or stable atmosphere as defined above) for at least 5 h.

6 SELECTION OF TEST SPECIMENS

As variations between production units are relatively important it is absolutely necessary to repeat the test described in clause 8 on a number of production units, taken at random from the lot or between machine heads, in order to obtain a value of $CV (L_b, L_w)$ characterizing a lot or any given production with sufficient accuracy.

The following list indicates the minimum specimen required for each type of material:

- top sliver, sliver and roving from 1st, 2nd and 3rd drawing passages: 3 balls or 3 cans;
- finisher roving: 4 balls;
- yarn: 10 packages.

To check whether sampling is sufficient, calculate the coefficient of variation between production units of the $CV (L_b, L_w)$ values found. Allow an interval of confidence of $\pm 4\%$ at 90 % probability for the grand mean.

If the confidence interval found is greater, increase sampling until the accuracy required for the mean is reached.

7 PREPARATION OF SAMPLES FOR TEST

After the conditioning period indicated in 5.1 the packages of yarn or finisher roving are placed directly on the evenness tester, using the appropriate unwinding accessories.

The cans of roving or sliver should also be unwound in the normal way, using the concave channel below the measuring condenser.

For balls of top sliver, a special accessory is used, consisting of a vertical or horizontal spindle mounted on ball-bearings, on which the ball is mounted; the sliver is then taken